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# Part C1: Agreement and Contract Data

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# Contract Data

The Employer is

**Name** Transnet SOC 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 AC primary circuit breaker control panel at Tussenin, Paul and Arthursview 25kV AC traction substations under the control of the Depot Engineer, Koedoespoort

The site is Tussenin, Paul and Arthursview 25kV AC 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 **R4,000.00 per day**

The assessment day is the 13<sup>th</sup> (thirteenth) of each month

The retention is 10% on the total value of the contract

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 AC primary circuit breaker control panel at Tussenin, Paul and Arthursview 25kV AC traction substations under the control of the Depot Engineer, Koedoespoort The Contractor shall not make use of any sub-Contractor to perform the works or parts thereof without prior permission from the Employer.
- 1.2 The Contractor shall ensure that a safety representative is at site at all times. All safety measures prescribed by Transnet Freight Rail – Electrical Safety Instructions and the "Occupational Health and Safety Act 1993 (Act 85 of 1993)" associated with working on a project of this nature shall be adhered to.
- 1.3 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.

- 1.4 The Contractor shall, in particular, comply with the following Acts and Transnet Specifications:-
  - 1.4.1 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.
  - 1.4.2 The Occupational Health and Safety Act (Act 85 of 1993).
  - 1.4.3 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.
  - 1.4.4 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.
  - 1.4.5 The Contractor shall comply with the current Specification for Works On, Over, Under or Adjacent to Railway Lines and near High Voltage Equipment – BBD 8210, 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.
- 1.5 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.
- 1.6 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.
- 1.7 The Contractor shall make necessary arrangements for sanitation, water and electricity at these relevant sites during the installation of the equipments.
- 1.8 A penalty charge of R4,000 per day will be levied for late completion of the project.
- 1.9 No retention money will be retained.
- 1.10 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 3<sup>rd</sup> party suppliers must be communicated to the Employer or Employer's Deputy in writing.
- 1.11 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.
- 1.12 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.

- 1.13 All processes or the manufacture and assembly of the product components must be subjected to a quality assurance system.
- 1.14 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 3<sup>rd</sup> part suppliers/Manufacturers.
- 1.15 The Contractor shall prove to Transnet Freight Rail that his equipment or those supplied from 3<sup>rd</sup> party suppliers/manufacturers confirms to Transnet freight rail specifications.
- 1.16 The Contractor will remain liable for contractual delivery dates irrespective of deficiencies discovered during workshop inspections.
- 1.17 The Contractor will only receive payment after he has been called by a Transnet technician to commission certain equipment or the complete substation.
- 1.18 The Contractor must submit a site diary and test sheets with the invoice as proof that the work has been done.
- 1.19 The Contractor must wear correct PPE at all times while doing tests in the substations

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## 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 .....

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## Part C2: Pricing Data

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## 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.
- 19 Transnet Freight Rail payment terms: 30 days from month end statement.

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**Contract Data  
Price List**

Item	Description	Unit	Qty	Rate	Price
<b>A</b>	<b>Tussenin 25 kV AC Substation</b>				
1	Supply low SF6 gas indication in control circuitry	ea	1		
2	Supply AC Primary Circuit Breaker control panel. This panel should cater for battery under-voltage relay	ea	1		
3	Supply all Control and Protection Cables from the Primary Circuit Breaker to the Panel and AC disconnects	sum	1		
4	Rewire the protection interlock in panel for phase failure and low SF6 gas with distribution switchgear	sum	1		
5	Installation, Testing and Pre-commissioning	sum	1		
6	Catalogues, Manuals and Drawings	sum	1		
7	P's and G's (Labour, Site establishment, transport, civil works, soil testing and preparations, etc)	sum	1		
8	Cable laying	sum	1		
<b>A</b>	<b>Total Price for Tussenin =</b>		<b>R</b>		
<b>B</b>	<b>VAT (14 % of A) =</b>		<b>R</b>		
<b>C</b>	<b>Gross Total ( A + B) =</b>		<b>R</b>		

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**Contract Data  
Price List**

Item	Description	Unit	Qty	Rate	Price
<b>B</b>	<b>Paul 25 kV AC Substation</b>				
1	Supply low SF6 gas indication in control circuitry	ea	1		
2	Supply AC Primary Circuit Breaker control panel. This panel should cater for battery under-voltage relay	ea	1		
3	Supply all Control and Protection Cables from the Primary Circuit Breaker to the Panel and AC disconnects	sum	1		
4	Rewire the protection interlock in panel for phase failure and low SF6 gas with distribution switchgear	sum	1		
5	Installation, Testing and Pre-commissioning	sum	1		
6	Catalogues, Manuals and Drawings	sum	1		
7	P's and G's (Labour, Site establishment, transport, civil works, soil testing and preparations, etc)	sum	1		
8	Cable laying	sum	1		
<b>A</b>	<b>Total Price for Paul =</b>			<b>R</b>	
<b>B</b>	<b>VAT (14 % of A) =</b>			<b>R</b>	
<b>C</b>	<b>Gross Total ( A + B) =</b>			<b>R</b>	

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**Contract Data**  
**Price List**

Item	Description	Unit	Qty	Rate	Price
<b>A</b>	<b>Arthursview 25 kV AC Substation</b>				
1	Supply low SF6 gas indication in control circuitry	ea	1		
2	Supply AC Primary Circuit Breaker control panel. This panel should cater for battery under-voltage relay	ea	1		
3	Supply all Control and Protection Cables from the Primary Circuit Breaker to the Panel and AC disconnects	sum	1		
4	Rewire the protection interlock in panel for phase failure and low SF6 gas with distribution switchgear	sum	1		
5	Installation, Testing and Pre-commissioning	sum	1		
6	Catalogues, Manuals and Drawings	sum	1		
7	P's and G's (Labour, Site establishment, transport, civil works, soil testing and preparations, etc)	sum	1		
8	Cable laying	sum	1		
<b>A</b>	<b>Total Price for Arthursview</b>		<b>R</b>		
<b>B</b>	<b>VAT (14 % of A )</b>		<b>R</b>		
<b>C</b>	<b>Gross Total ( A + B )</b>		<b>R</b>		

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# Part C3: Scope of Work

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## Contract Data

## Works Information

### 2.0 DESCRIPTION OF WORK.

- 2.1 The Contractor shall electrically connect the newly installed equipment to the existing earthing system.
- 2.2 The Contractor shall test, commission and hand over the equipment.
- 2.3 All fasteners (nuts & bolts) shall be secured using flat or bevelled washers, as necessary, as well as lock washers.
- 2.4 All cables shall terminate in compression type glands. These glands shall be fitted with neoprene shrouds.
- 2.5 The Contractor shall remove all the existing PCB control cables between the primary circuit breaker mechanism box and the 132 or 88kV switch room.
- 2.6 The Contractor shall supply and install new control cables between the primary circuit breaker and the control panel in the 132 or 88kV switch room. The Contractor shall be responsible to connect and interconnect all new and existing functions in the control panel.
- 2.7 A new control cable shall be installed between the control panel and the AC disconnects and the fleeting contact be connected to it.
- 2.8 The Contractor shall connect the fleeting contact to the control of the primary circuit breaker to trip the PCB before the contacts of the 132 or 88kV AC disconnects are fully open.
- 2.9 The following types of cables shall be used: -
- Control cable for PCB N04 – 4mm<sup>2</sup>.
- 2.10 The cables shall be fixed to the cable trays using UV stabilised cable ties. Cabling and wiring shall be in accordance with CEE.0023.90 and SANS 10142-1.
- 2.11 When doing any cabling, the ballast stone shall be removed, trenching and laying of cables done, the soil compacted back and the ballast washed and placed back neatly.
- 2.12 No joining of cables will be accepted. The Contractor shall provide cables that are long enough for the application (earthing, control etc.). No junction boxes, underground, shall be used.
- 2.13 All the control cables shall be housed in a 110mm diameter PVC pipe between the PCB and the cement cable ducting.
- 2.14 The Contractor shall make use of the concrete cable trench to route the cables to the 132 or 88kV switch room. And these cables must be installed in this order: they shall follow the existing cable duct, a bed of **river sand** should be laid, followed by the cables, on top of the cables put another **river sand**, and finally put the re-enforcement concrete.

- 2.15 Contractor shall use plastic covers to separate the soil from the stone when digging the trenches.
- 2.16 On backfilling of the soil after trenching has been done the Contractor shall compact the soil to the same pressure as the surrounding soil before it is covered with stone.
- 2.17 The Contractor's team/s could be requested to attend the Transnet freight rail's electrical safety training course and be authorised to supervise the Contractor's staff whilst working in the substations on this contract. Transnet freight rail will organise the course and further details will be communicated to the successful Contractor.
- 2.18 The Contractor shall provide his own electrical power whilst working in the substation outdoor yard, since availability of power from Eskom or auxiliary supplies cannot be guaranteed.
- 2.19 Schematic wiring diagrams of the PCB control shall be forwarded to the Employer before the installation of the primary circuit breaker for approval.
- 2.20 On completion of the installation, it will be required from the Contractor to submit as built drawings and schematic diagrams of all newly installed equipment as well as showing interface to the existing equipment.
- 2.21 The contractor shall perform on site, trip, close and speed tests of the PCB after the installation.
- 3.0 **INSTALLATION**
- 3.1 The Contractor shall be responsible for the transport to site, off-loading, handling, storage and security of all material required for the construction/execution of the works.
- 3.2 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.
- 4.0 **DRAWINGS, INSTRUCTION MANUALS AND SPARE PART CATALOGUES**
- 4.1 All as built drawings shall be supplied in electronic format (Microstation/Acad).
- 4.2 The successful Contractor shall be required to submit all drawings (paper prints), within four weeks of award of tender, to the Employer for approval. No construction or manufacturing activity will be allowed prior to the associated drawings having been approved.
- 4.3 During the duration of the contract period, the successful Contractor will be required to inform the Employer of any changes to these drawings and will have to resubmit the affected drawings for approval prior to it being used on this contract.
- 4.4 All drawings, catalogues, instruction book and spares lists shall be in accordance with Transnet Freight Rail's specification CEE.0224.2002.
- 4.5 All final as built drawings shall be provided to Transnet Freight Rail within four weeks after commissioning.
- 4.6 Supply three sets of A3 schematic wiring diagrams in hard copy format and electronic format for approval.

## 5.0 SITE TESTS

- 5.1 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.
- 5.2 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.
- 5.3 Functional on-site tests shall be conducted on all items of equipment and circuitry to prove the proper functioning and installation thereof.
- 5.4 The Contractor shall submit a detailed list of on-site tests for the approval of the Employer.
- 5.5 The Contractor shall arrange for the Employer or his representative to be present to witness the on-site tests.
- 5.6 The on-site tests shall include the following:

Test for the functionality of all electrical circuitry.

Trip tests on relays.

Test on equipment as per manufacturer's instructions.

Insulation tests.

- 5.7 At the completion of the on-site tests, the Employer 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.
- 5.8 Upon rectification of defects, the Contractor shall arrange for the Employer or his representative to certify satisfactory completion of on-site tests.
- 5.9 Acceptance by the Employer 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.

## 6.0 COMMISSIONING OF EQUIPMENT

- 6.1 Commissioning will only take place after all defects have been rectified to the satisfaction of the Employer.
- 6.2 On completion of commissioning, the Contractor will hand the equipment over to the Employer in terms of the relevant instruction.
- 6.3 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.
- 6.4 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.
- 6.5 The Contractor shall be present during the testing and setting of the protection to rectify any faults found.

## 7.0 GUARANTEE AND DEFECTS

- 7.1 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.



- 7.2 The Contractor shall be issued with a completion certificate with the list of all defects to be repaired within 14 working days after commissioning.
- 7.3 The guarantee period for these standby plants shall expire after: A period of 12 months commencing on the date of completion of the contract or the date the standby plant was handed over to Transnet Freight Rail.
- 7.4 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.
- 7.5 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.
- 7.6 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.
- 7.7 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 and at the cost of the Contractor.
- 7.8 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.

## 8.0 QUALITY AND INSPECTION

- 8.1 Transnet Freight Rail shall inspect the equipment under contract on the premises of the Manufacturer or successful Contractor.
- 8.2 The Contractor shall notify Transnet Freight Rail 14 days in advance of such an inspection date.
- 8.3 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.
- 8.4 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.

## Scope of Works

### Works Information

#### 9.0 SPECIFICATIONS

##### 9.1 South African National Standards:

- 9.1.1 SANS 1091 National colour standard
- 9.1.2 SANS 8528 Reciprocating internal combustion engine driven alternating current generating set
- 9.1.3 SANS 10142 Wiring Code

##### 9.2 Transnet Freight Rail:

- 9.2.1 BBB 1267 version 9 Specification for outdoor high voltage alternating-current circuit breakers for traction and distribution substations.
- 9.2.2 BBB 7842 version 1 Outdoor, high voltage, alternating current disconnectors combined with earthing switches.
- 9.2.3 S420 (1999) Specification for concrete work.
- 9.2.4 BBC 0198 version 1 Specifications for the supply of cables.
- 9.2.5 CEE.0023.90 Specifications for installation of cables.
- 9.2.6 CEE.0111.99 Specification for 25kV traction substation.
- 9.2.7 CEE.0224.2002 Drawings, catalogues, instruction manuals and spares list for electrical equipment supplied under contract.
- 9.2.8 CEE-TBD-8 Earthing arrangement 25kV AC Traction Substation.
- 9.2.9 CEE-TBK-0027 Control circuit diagrams – NO volt operation
- 9.2.10 CEE TBK 0028 Trip, lockout and indication circuit diagram.
- 9.2.11 BBB 2721 version 9 AC Primary Circuit Breaker Control Panel and AC/DC Distribution Panel for 3kV DC Traction substation.
- 9.2.12 CEE-TBD-0007 Earthing arrangement for traction substations.

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

- 10 Occupational Health and Safety Act No. 85 of 1993 (Available at depot for referral).
- 11 Constraints on how the *Contractor Provides the Works*
- 12 The constraints shall be as specified in the specifications of the particular equipment.
- 13 Requirements for the programme
  - 13.1 Programme of work: To be submitted by successful Contractor
  - 13.2 CIDB rating : 3EP or above
  - 13.3 Format : Gantt chart
  - 13.4 Information : How work is going to be executed and commissioned

- 13.5 Submission : 3 weeks after the award of contract
- 13.6 Site diary : Successful Contractor to supply in triplicates carbon copies
- 13.7 Site instruction book: Successful Contractor to supply in triplicates carbon copies

**14 Services and other things provided by the *Employer***

- 14.1 Transnet Freight Rail shall inspect all equipment before the equipment can be dispatched to site.
- 14.2 Transnet Freight Rail shall have an electrician available for isolation and the erection of barriers to live electrical equipment and issuing of work permits.
- 14.3 Upon successful completion of the works to the satisfaction of Transnet Freight Rail, Transnet Freight Rail shall perform necessary protection tests and commission the equipment.

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**TRANSNET**  
freight rail

**TECHNOLOGY MANAGEMENT.**  
**SPECIFICATION.**

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

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

Date: 21<sup>st</sup> September 2009

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 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 groupd flashes per square kilometre per annum.
	Pollution:	Heavily salt laden or polluted with smoke from industrial sources.

##### 5.2 ELECTRICAL CONDITIONS

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

5.2.2 Frequency: Frequency of the supply voltage is  $50 \pm 2.5$  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 HEXAFLUORIDE CIRCUIT BREAKERS. (SF6)

- 6.35.1 The SF6 circuit breaker shall be fitted with a pressure gauge/densimeter to monitor the gas pressure.
- 6.35.2 The pressure gauge/densimeter circuit shall be provided with a minimum of two sets of contacts for alarm and indication for the substation's annunciator or flag circuit.
- 6.35.3 The supplier shall wire the SF6 circuit breaker local control circuit, such that in the event of a gas leakage or drop in gas pressure, the SF6 circuit breaker will trip and lockout.
- 6.35.4 A set of normally closed contacts shall be provided in the circuit breaker mechanism control box for the low gas trip circuitry.
- 6.35.5 The SF6 circuit breaker shall trip and lockout before the minimum safe SF6 gas pressure is reached.
- 6.35.6 In terms of the Occupational Health and Safety Act No 85 of 1993. Code 1704 (pressure vessels) the successful tenderer shall furnish a certificate of manufacture complying with the terms of the Act for the circuit breakers.

### 6.36 INSULATION LEVELS, CREEPAGE DISTANCES AND CLEARANCES

#### 6.36.1 INSULATION LEVELS

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

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

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

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

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

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

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

### 6.36.2 CREEPAGE DISTANCES

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

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

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

### 6.36.3 CLEARANCES

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

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

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

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

**6.37 SUPPORT STEELWORK.**

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

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

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

**8.0 TRAINING.**

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

**9.0 TEST CERTIFICATES.**

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

**10.0 GUARANTEE AND DEFECTS.**

- 10.1 The contractor shall guarantee the satisfactory operation of the circuit breaker supplied and accept liability for maker's defects, which may appear in design, materials and workmanship.
- 10.2 The guarantee period shall expire after:  
A period of 12 months commencing on the date of energising of the circuit breaker.

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

**11.0 INSPECTION.**

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

**12.0 PACKAGING AND TRANSPORT.**

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

**13.0 BIBLIOGRAPHY**

- [1] SANS 1019: 2008. Edition 2.5

**END**

**SCHEDULE OF REQUIREMENTS**  
(To be completed by client)

**1.0 SYSTEM DETAIL**

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

**DETAIL OF AC CIRCUIT BREAKERS.**

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

**END**

**TECHNICAL DATA SHEET**  
(To be completed by tenderer)

**DETAIL OF CIRCUIT BREAKER**

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



# TECHNOLOGY MANAGEMENT

## SPECIFICATION

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

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## 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:	Degr�ee 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 maximum 128 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 ANNUNCIATOR 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 Buchholz operation.
- Aux transformer Buchholz 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 1 ampere.
- 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 95mm<sup>2</sup> 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 it 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 mm<sup>2</sup> 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 mm<sup>2</sup> 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 95mm<sup>2</sup> 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 braking 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.

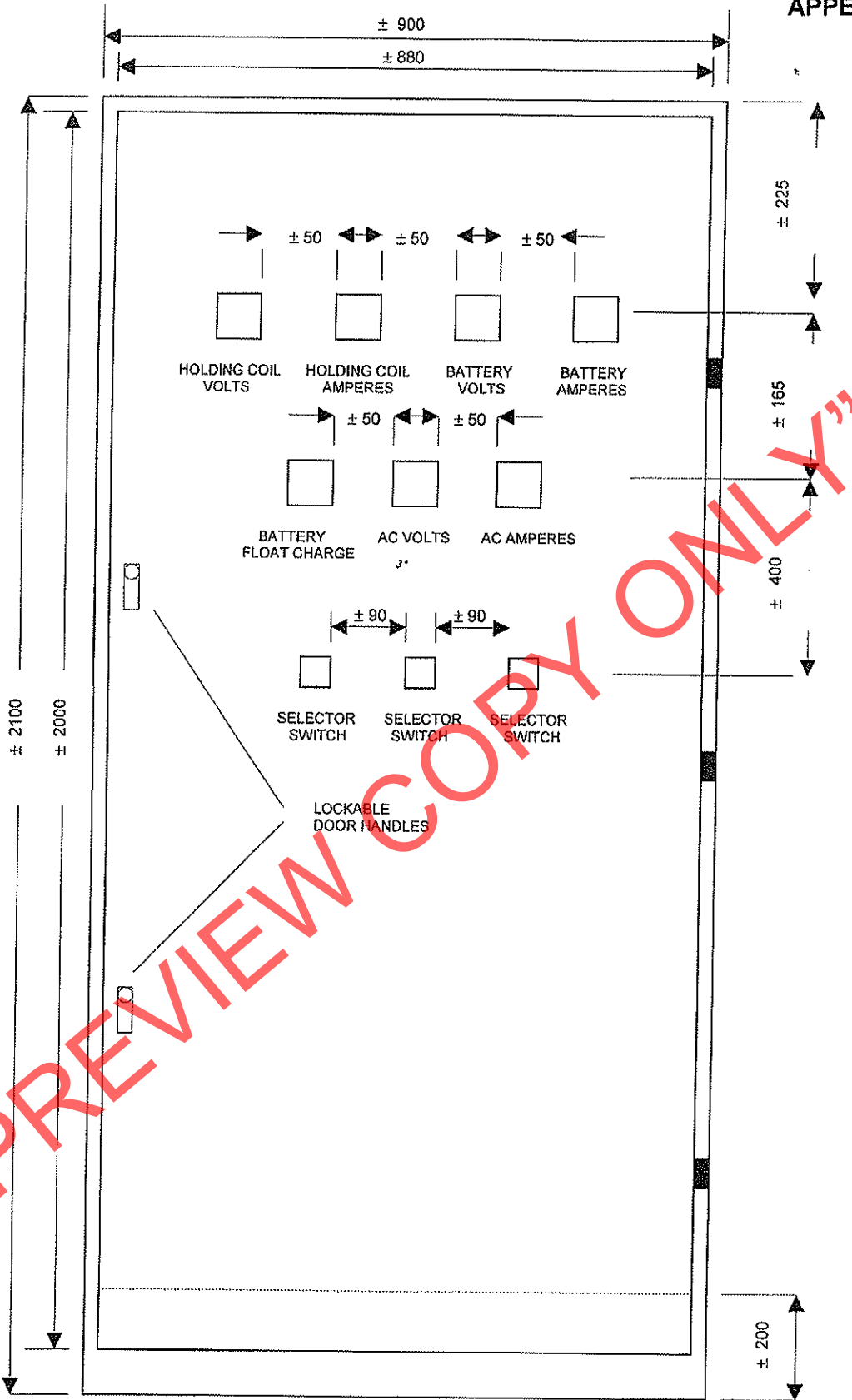
21.4 If urgent repairs have to be carried out by Transnet Freight Rail's staff to maintain supply during the guarantee period the contractor shall inspect such repairs to ensure that the guarantee period is not affected and should they be covered by the guarantee, reimburse Transnet Freight Rail the 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.

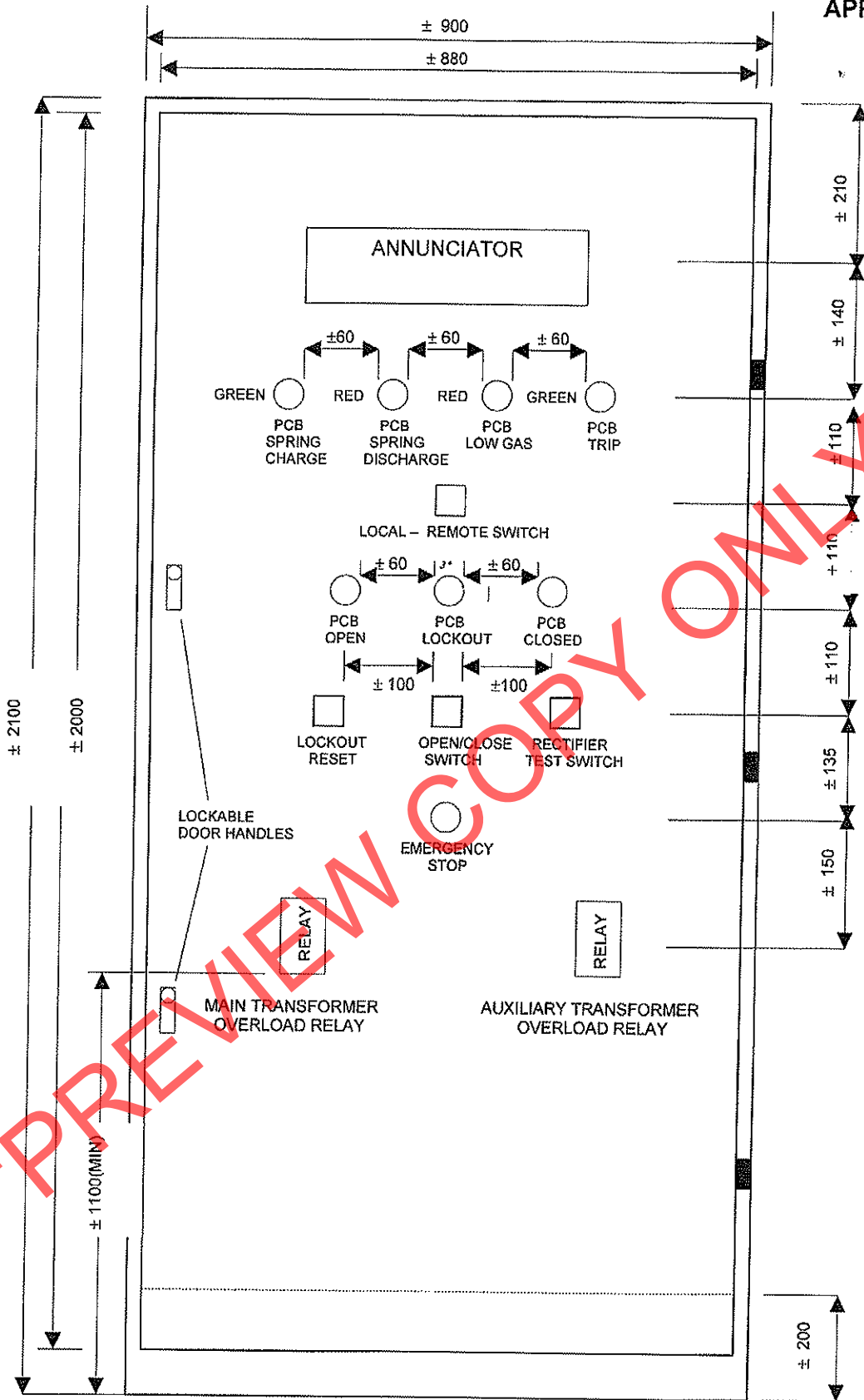
22.2 The tenderer shall provide transport for the delivery of the equipment to the site where required.

**END**



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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



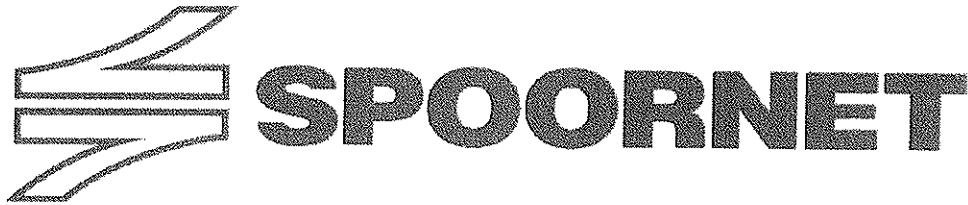
**SCHEDULE OF REQUIREMENTS**

(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 |

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**ENGINEERING & TECHNOLOGY  
TECHNOLOGY MANAGEMENT**

**SPECIFICATION**

**OUTDOOR, HIGH VOLTAGE, ALTERNATING CURRENT  
DISCONNECTORS COMBINED WITH EARTHING  
SWITCHES**

Author: Engineering Technician D.O. Schulz  
Technology Management

Approved: Senior Engineer L.O. Borchard  
Technology Management

Authorised: Principal Engineer W.A. Coetzee  
Technology Management

*[Signature]*

*[Signature]*

*[Signature]*

Date: 18th Oct 2004

Circulation restricted to:

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- Engineering & Technology: Infrastructure Engineering
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**1.0 SCOPE**

- 1.1 This specification covers Spoomet's requirements for the supply of outdoor, 3 phase, 50 hertz disconnectors combined with earthing switches for voltages above 1 000 V.
- 1.2 Equipment is required for installation at the end of overhead transmission lines to control the power supply to traction substations and step- down points and shall consist of a 3 pole disconnector to be connected to the line and provided with facilities to earth the "load" side of the circuit.

**2.0 STANDARDS AND PUBLICATIONS**

The following publications and documents (latest edition) are referred to herein.

**2.1 SOUTH AFRICAN NATIONAL STANDARDS**

- SANS 121 : Hot dip galvanized coatings for fabricated iron or steel article.
- SANS 60273 : Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V.
- SANS 60815 : Guide for selection of insulators in respect of polluted conditions
- SANS 62271-102 : High voltage switchgear and controlgear part 102: Alternating Current disconnectors and earthing switches

**2.3 SPOORNET SPECIFICATIONS**

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

**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.
- 3.2 A statement of non-compliance shall be motivated by the tenderer.
- 3.3 Tenderers shall complete annexure 2. "Technical data sheet."
- 3.4 Tenderers shall submit descriptive literature consisting of detailed technical specifications, general constructional details and principal dimensions, together with clear illustrations of the equipment offered.
- 3.5 Failure to comply with clauses 3.1, 3.2, 3.3 and 3.4 could preclude a tender from consideration.

**4.0 ANNEXURES**

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

- 4.1 Annexure 1 - "Schedule of Requirements"  
This annexure details the specific requirements for this application.
- 4.2 Annexure 2 - "Technical Data Sheet"  
This annexure calls for specific technical information to be furnished with tenders.
- 4.2.1 This annexure is used during adjudication of tenders to assess the equipment offered.
- 4.2.2 Equipment described in annexure 2 shall comply with, and be supplied in terms of this specification. No changes or substitutions will be allowed without the written consent of Spoomet.

4.2.3 Acceptance of the equipment detailed in this annexure in no way relieves the tenderer of his obligation to fulfil his statement of compliance with the specification.

4.2.4 Tenderers are responsible for the accuracy of information submitted in this annexure.

**5.0 SERVICE CONDITIONS**

5.1 The equipment shall be designed and rated for 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.

**6.0 CLEARANCES**

6.1 The following minimum safety clearances shall be maintained between any live conductor and earthed metal: -

Nominal phase to phase r.m.s system voltage	22kV	33kV	44kV	66kV	88kV	132kV
Highest phase to phase r.m.s voltage for equipment.	24kV	36kV	48kV	72kV	100kV	145kV
Safety clearance	320mm	430mm	540mm	770mm	1000mm	1450mm

**7.0 DISCONNECTORS COMBINED WITH EARTHING SWITCHES**

This section shall be read in conjunction with SANS 62271-102

7.1 The combined AC disconnector and earthing switches shall be designed, manufactured and tested in accordance with SANS 62271-102.

7.2 Disconnectors and earthing switches shall have been type tested to verify performance and safety. Proof of these tests in the form of type test certificates shall be included in the tender documents.

7.3 The disconnectors shall be provided with a means for earthing the "load" side of the circuit, either by means of a separate earthing switch interlocked with its operating mechanism or contacts so placed that when the disconnector is in the "open" position, the "load" side is earthed.

7.4 The disconnectors shall be of the air-break type with the blades operating in a horizontal plane.

7.5 The disconnectors shall be so mounted that the phase-to-phase clearance for both the "open and earthed" and "closed" positions, shall not be less than:

- 22kV - 355mm
- 33kV - 510mm
- 40kV - 610mm
- 66kV - 890mm
- 88kV - 1,14metres
- 132 kV - 1,7metres

7.6 The operation of the disconnector shall be manual. (Dependent or independent).

- 7.7 The operating mechanism shall be constructed of anti-corrosive material to prevent sticking due to rust. All ferrous material shall be galvanised.
- 7.8 The operating handle shall be provided with suitable attachments to enable it to be locked in the up (closed) position and in the down (open and earthed) position by standard locks, supplied by Spornet.
- 7.9 The operating assembly shall be fixed at a satisfactory operating height of approximately 1m from the bottom of the structure.
- 7.10 A mechanism shall be provided to mechanically interlock the operating handle with the associated primary circuit breaker to ensure that operation is only possible when the circuit breaker is in the "open" position.  
It must, however, be possible to close the primary circuit breaker when the earthing switch is in the "earthed" position.
- 7.11 Electrical contacts shall be fitted to interlock the operating handle with the associated primary circuit breaker. In the event of accidental operation or movement of the operating handle the primary circuit breaker will be tripped before the main contacts of the AC disconnector starts opening.
- 7.12 A notice with the following inscription shall be mounted next to the operating mechanism:  
"DO NOT OPERATE UNDER LOAD"  
Refer to clause 11.4.2 of specification.
- 8.0 SUPPORT STRUCTURES**
- 8.1 The combined AC disconnector and earthing switches shall be rigidly mounted on robust, hot-dipped galvanised supporting steel structures or pedestals in accordance with SANS 121.
- 8.2 The supporting steel structures or pedestals shall provide a minimum clearance of 3,6 metres (up to 88 kV) or 4,1 metres (above 88 kV) from the lowest "live" high voltage connection to finished yard level. Outline drawings submitted with tenders must indicate the actual clearances proposed.
- 9.0 CONNECTIONS**
- 9.1 All high voltage connections must be of the solderless, concentric grip, or other approved solderless type, and must be of adequate cross-sectional area to suit both electrical and mechanical requirements. All connections to the disconnectors must be flexible so as not to affect smooth operation of the blade mechanism.
- 10.0 POST INSULATORS**
- This section shall be read in conjunction with SANS 60273.
- 10.1 All post insulators shall be designed, manufactured and tested in accordance with SANS 60273.
- 10.2 Unless otherwise stated in Annexure 1, creepage distances for heavy polluted atmospheres shall be in accordance SANS 60815 Clause 4.
- 11.0 NAMEPLATES AND LABELS**
- 11.1 All nameplates and labels shall be in English.
- 11.2 In addition to the data called for in SANS 62271-102 the nameplate of each device shall indicate the Spornet contract number.
- 11.3 Labels other than interchangeable labels shall be fixed by screws or rivets.
- 11.4 All labels shall be made of composite sandwich type plastic material of the following colour combinations:
- 11.4.1 Identification labels: White lettering on Black background. Letters must be of sufficient size to be clearly legible from a distance of 3 m.

11.4.2 Danger labels: White lettering on Red background. Letters must be of sufficient size to be clearly legible from a distance of 3 m.

11.5 The following is a list of approved labels referred to in the body of this specification.

- On (1)
- Off (0)
- Open (Verb.)
- Close (Verb.)
- Closed
- Open
- Do not operate link under load.
- Open and earthed.

## 12.0 DRAWINGS AND INSTRUCTIONS

12.1 All drawings shall be in accordance with specification CEE-0224.

12.2 The successful tenderer shall supply the following drawings and/or instructions, all of which shall be included in the tender price and be to the satisfaction of Spoonet.

12.2.1 Before delivery to site three (3) sets of detailed operating and maintenance instructions, with illustrations where necessary. These instructions shall be supplied with the "as built" drawings.

12.3 Late submission of drawings and instructions shall incur delivery penalties on the full contract price.

## 13.0 INSPECTION

13.1 Spoonet reserves the right by prior arrangement to inspect the equipment at any stage during manufacture.

## 14.0 TOOLS AND APPLIANCES

14.1 One set of any special tools and appliances required for normal operation and maintenance shall be supplied. All fittings, including holding down bolts, etc. for the complete installation of the equipment offered shall be supplied.

## 15.0 SPARES

15.1 Tenderers shall submit a separate quote for recommended spares for maintenance purposes.

15.2 A detailed description of each item including manufacturer's catalogue number and item number where applicable shall be furnished. Separate prices for each item shall be indicated.

15.3 The spare list shall be divided into two parts, one covering items used in a 12 month period and those likely to be used in a 10 year period.

15.4 Tenderers shall also state whether a complete range of spares is held in stock by their local representatives for subsequent purchase by Spoonet as and when required.

## 16.0 PACKING

16.1 The equipment shall be packed in such a manner that it will be adequately protected during handling and transport.

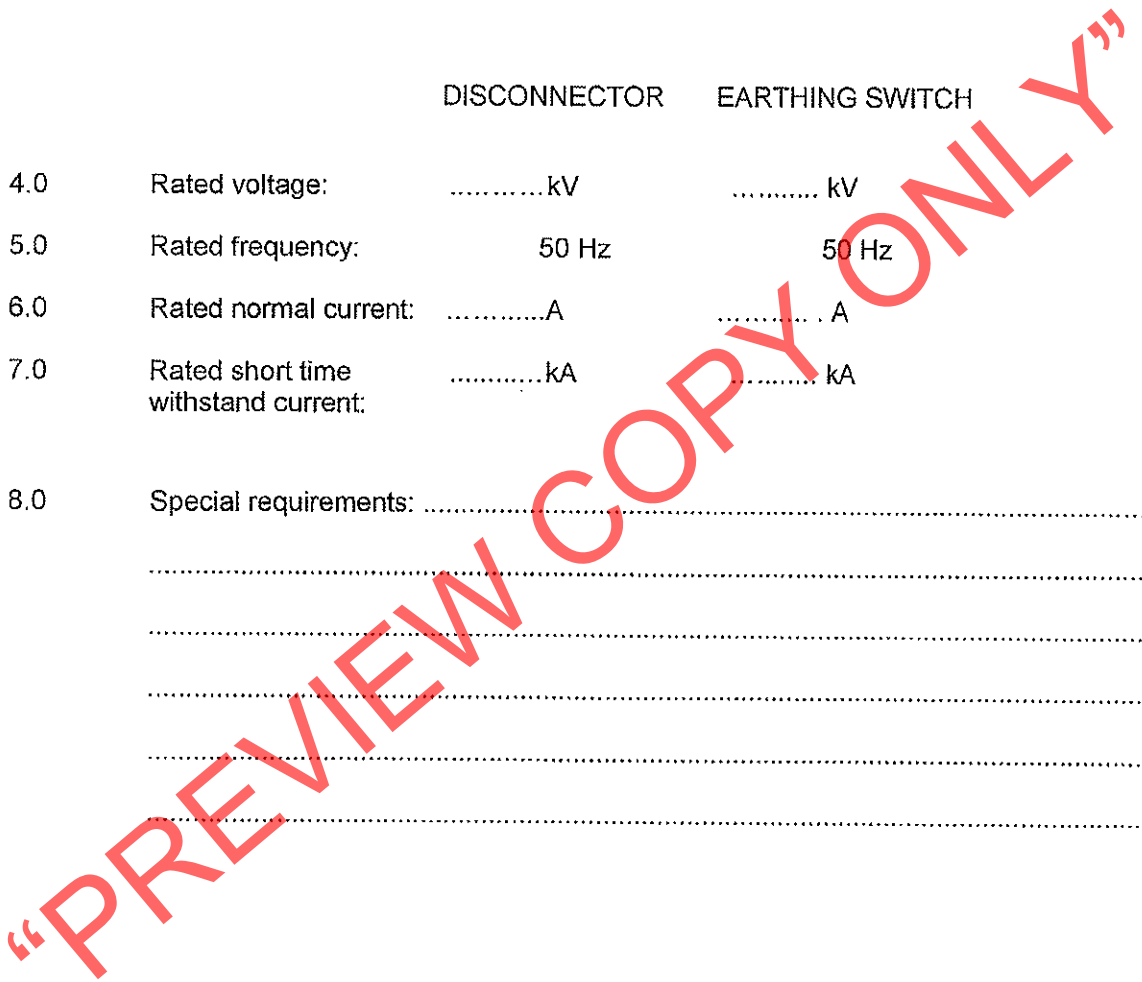
END

SCHEDULE OF REQUIREMENTS

- 1.0 Required for .....
- 2.0 Number of sets required .....
- 3.0 System of supply ..... kV, 50 Hz, 3 phase,.....neutral

DISCONNECTOR      EARTHING SWITCH

- 4.0 Rated voltage:      .....kV      ..... kV
- 5.0 Rated frequency:      50 Hz      50 Hz
- 6.0 Rated normal current: .....A      ..... A
- 7.0 Rated short time withstand current: .....kA      ..... kA
- 8.0 Special requirements: .....
- .....
- .....
- .....
- .....
- .....



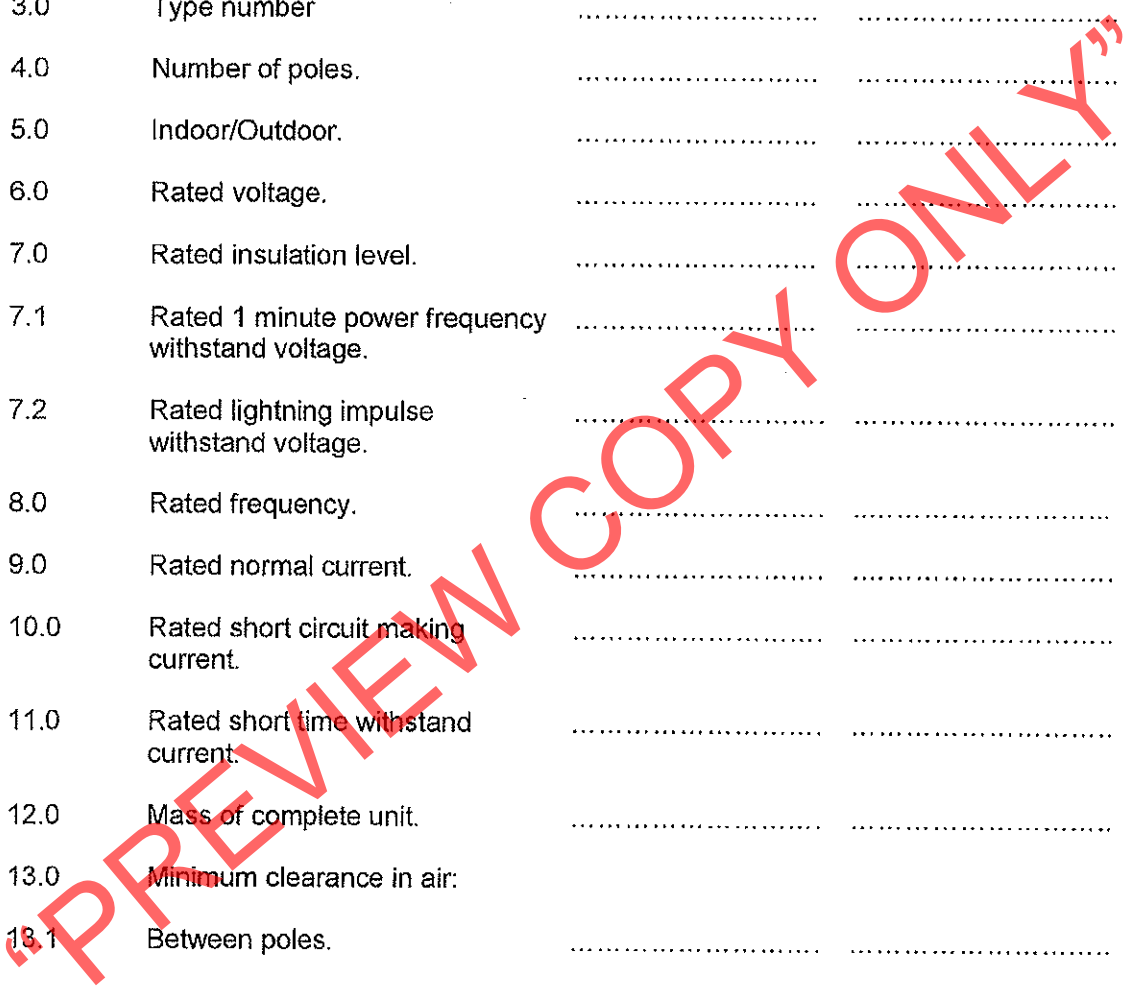
END



**TECHNICAL DATA SHEET**

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

1.0	Spoornet Tender number: .....		
		DISCONNECTOR	EARTHING SWITCH
2.0	Name of manufacturer.	.....	.....
3.0	Type number	.....	.....
4.0	Number of poles.	.....	.....
5.0	Indoor/Outdoor.	.....	.....
6.0	Rated voltage.	.....	.....
7.0	Rated insulation level.	.....	.....
7.1	Rated 1 minute power frequency withstand voltage.	.....	.....
7.2	Rated lightning impulse withstand voltage.	.....	.....
8.0	Rated frequency.	.....	.....
9.0	Rated normal current.	.....	.....
10.0	Rated short circuit making current.	.....	.....
11.0	Rated short time withstand current.	.....	.....
12.0	Mass of complete unit.	.....	.....
13.0	Minimum clearance in air:		
13.1	Between poles.	.....	.....
13.2	To earth.	.....	.....
13.3	For isolating distance.	.....	.....
14.0	Type of closing mechanism.	.....	.....
15.0	Height above ground of lowest HV connection.	.....	.....

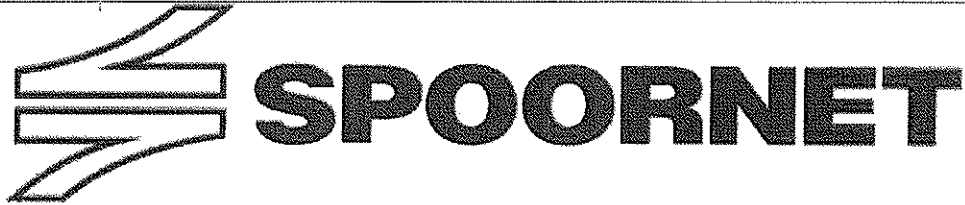


ANNEXURE 2

		DISCONNECTOR	EARTHING SWITCH
16.0	Length of insulator (taut string measurement)	.....	.....
17.0	Type test certificate	.....	.....
17.1	Testing authority	.....	.....
17.2	Test number	.....	.....
18.0	Insulators		
18.1	Type test certificate number	.....	.....
18.2	Testing authority	.....	.....

END

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**ENGINEERING AND TECHNOLOGY  
TECHNOLOGY MANAGEMENT**

**SPECIFICATION**

**REQUIREMENTS FOR THE SUPPLY OF ELECTRIC  
CABLES**

(Appendix to be filled in by client)

Authors: Engineering Technician (level 1)  
Section: Technology  
Management B.L. Ngobeni

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Section: Technology  
Management D.O. Schulz

Authorised: Senior Engineer  
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Date: 5 September 2005

Circulation restricted to:

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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-XLPE distribution 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 Spornet 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 Spornet 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 Spornet for inspections to be carried out before delivery of the equipment.

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**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<sup>2</sup>): .....

**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<sup>2</sup>): .....

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<sup>2</sup>): .....

END





**TRANSNET**  
freight rail

A Division of Transnet SOC Limited

## TECHNOLOGY MANAGEMENT

### SPECIFICATION

#### INSTALLATION OF LOW AND MEDIUM VOLTAGE CABLES

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Technology Management

S.E. Sibande

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31 May 2012

Circulation Restricted To:

Transnet Freight Rail

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## 1.0 SCOPE

- 1.1 This specification covers Transnet Freight Rail's requirements for the installation, laying, terminating, jointing, testing and commissioning of low and high voltage cables.

## 2.0 APPENDICES

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

- 2.1 Appendix 1 - "Scope of Work" - to be completed by Transnet Freight Rail (Client).  
 2.2 Appendix 2 - "Schedule of Requirements" – (to be completed by Tenderer).  
 2.3 Appendix 3 – "Normative SANS references"

## 3.0 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.

### 3.1 British Standards

- BS 5467: Electric cables – thermosetting insulated, armoured cables for voltages of 600/1000V and 1900/3300V.  
 BS 6480: impregnated paper – installed lead or lead alloy sheathed electric cables of rated voltages up to and including 33 000V

### 3.2 South African National Standards

- SANS 32: Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plants.  
 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 121: Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.  
 SANS 1339: Electric cables - Cross-linked polyethylene (XLPE) insulated cables for rated voltages 3,8/6,6 kV to 19/33 kV  
 SANS 10142-1: The wiring of premises Part 1: Low-voltage installations.  
 SANS 10142-2: The wiring of premises Part 2: Medium-voltage installations above 1 kV A.C not exceeding 22 kV A.C and up to and including 3 000 kW installed capacity

### 3.3 Transnet Freight Rail Instructions

- BBD 8210 - General work and works on, over, under or adjacent to a railway lines and near high voltage equipment  
 CEE.0012 - Method of Tendering  
 CEE.0045 - Painting of steel components of electrical equipment.  
 CEE.0089 - Drawings of electrical equipment supplied under electric light and power contracts.  
 Electrical Safety Instructions 2012 - High Voltage Electrical Equipment

### 3.4 Transnet Freight Rail Drawings

- CEE PA-0105 - Precast concrete slab cover for cable protection.  
 CEE-PK-14 - Electrical cable route marker.  
 CEE-MA-307 – Route marker electrical cables.  
 FG 263 - Accommodation of cables in Railway formations

### 3.5 Statutory Requirements

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

- 3.6 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.

#### 4.0 TENDERING METHODS

- 4.1 Tenderer 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 tenderer to elaborate on their response to a clause.
- 4.2 A statement of non-compliance shall be motivated by the tenderer.
- 4.3 Tenderer shall complete Appendix 2 – "Schedule of requirements".
- 4.4 Tenderer shall submit descriptive literature consisting of detailed technical specifications, general constructional details and principal dimensions, together with clear illustrations of the equipment offered.
- 4.5 Failure to comply with clauses 4.1, 4.2, 4.3 and 4.4 could preclude a tender from consideration.

#### 5.0 SERVICE CONDITIONS

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

Altitude:	0 to 1800m above sea level.
Ambient temperature:	-10°C to +55 °C.
Relative humidity:	10% to 90%
Lightning Conditions:	12 ground flashes per square kilometre per annum.
Pollution:	Heavily salt laden or polluted with smoke from industrial sources.

#### 6.0 GENERAL REQUIREMENTS

- 6.1 The tenderer shall submit all drawings in accordance with Transnet Freight Rails Specification CEE.0089
- 6.2 Where joints and terminations are to be done by others, the contractor shall submit detailed instructions regarding the procedure recommended by the cable manufacturer.
- 6.3 The electrical installation shall conform to the requirements of SANS 10142 part 1 and 2 and shall be to the satisfaction of Transnet Freight Rail.
- 6.4 Galvanising where specified shall be in accordance with SANS 32 and SANS 121.
- 6.5 Work on the high voltage equipment shall be carried out in accordance with the Transnet Freight Rail's Safety Instructions 2012 - High Voltage Electrical Equipment.
- 6.6 All work done must comply with the requirements of Occupational Health and Safety Act and Regulations, Act 85, 1993

#### SURVEYS

- 6.7 The Contractor shall within 30 days after being awarded the contract carry out a pre-installation route survey which shall include digging test holes and guided by the Transnet Freight Rail's drawings to determine a suitable route.
- 6.8 The contractor shall determine where cables are liable to be subjected to chemical, electrolytic, mechanical or other damage and shall submit his recommendation to the Depot Maintenance Manager (Electrical) for approval.
- 6.9 The Contractor shall submit in triplicate plans of the cable routes selected to the Depot Maintenance Manager (Electrical) for approval. Plans may be submitted in sections as the survey progresses.

- 6.10 No excavation of any section of the cable route shall commence before the Contractor is in possession of the relevant approved plans and the Depot Maintenance Manager (Electrical) has authorised the commencement of work on the section concerned.
- 6.11 After completion of all cable laying and jointing and before commissioning of any cable the Contractor shall carry out a final "as laid" survey of the cable routes and submit plans on transparencies suitable for reproduction.
- 6.12 The cable route plans shall include the following information:
- 6.12.1 Overall length, type, size and voltage of each cable.
- 6.12.2 Accurate indication of the position of each cable joint by indicating two distances to each joint from permanent structures.
- 6.12.3 Pipes and chambers provided.

## 7.0 EXCAVATIONS

- 7.1 Excavations shall be carried out in strict compliance with the specification BBD 8210 for general work and works on, over, under or adjacent to a railway lines and near high voltage equipment.
- 7.2 Trenching procedure shall be programmed in advance, approved by the Depot Maintenance Manager (Electrical) and shall not be departed from except with the consent of the Depot Maintenance Manager (Electrical).
- 7.3 The Contractor will be advised of any known buried services such as cables, pipes, etc. in the vicinity of the cable route.
- 7.3.1 When trenching the contractor shall take all necessary precautions to prevent damage to underground services.
- 7.3.2 On encountering any uncharted service, the Contractor shall promptly advise the Depot Maintenance Manager (Electrical) who will give the necessary instructions. Additional excavations shall be paid for at scheduled rates.
- 7.4 Should any underground service, water mains, road pavement, drainage system, building or any other structure be damaged by the Contractor's staff, it shall be reported immediately to the Depot Maintenance Manager (Electrical), who shall arrange for the necessary repairs. The Contractor shall be responsible for the cost of repairs.
- 7.5 The removal of obstructions along the cable routes shall be subject to the approval of the Depot Maintenance Manager (Electrical) and shall be paid for at the agreed rates.
- 7.6 The Contractor shall not trench beneath any railway line without departmental supervision. Should the contractor wish to carry out such work, a minimum of 14 working days notice is required by the Depot Maintenance Manager (Electrical) to arrange for the necessary supervision. The cost of such supervision shall not be charged to the Contractor.
- 7.7 Excavations crossing oil pipe lines shall not commence until an authorised representative is present on site. The Depot Maintenance Manager (Electrical) shall be advised 14 days in advance when such excavations will take place.
- 7.7.1 Cable crossings of oil pipe lines shall only be at right angles.
- 7.8 Trenches across roads, access ways or foot-paths shall not be left open. If trenching, cable laying and backfilling cannot be done during the same shift, the portion of trench across the full width of the road, etc., must be temporarily backfilled and consolidated sufficiently to carry the traffic concerned without subsidence. Alternatively, adequately strong cover plates shall be laid across the trench.
- 7.9 Power driven mechanical excavators may be used for trenching operations. Transnet Freight Rail shall not be responsible for any damage to other Services in close proximity when using mechanical excavators.
- 7.10 The Contractor shall provide shuttering in places where the danger exists of the trench collapsing, and causing damage to formations or other nearby structures.
- 7.10.1 Shuttering shall be paid for at scheduled rates.

- 7.11 Trenches shall be as straight as possible and the bottom of each cable trench shall be firm and of smooth contour without sharp dips or rises which may cause tensile forces in the cable during backfilling.
- 7.11.1 Trenches shall have no sharp objects which may cause damage to the cable during laying or backfilling.
- 7.12 The unfinished depth of trenches unless otherwise stated shall be as follows:
- 7.12.1 HV cables and associated pilot cables = 1 000 mm.
- 7.12.2 LV cables and separate pilot cables = 750 mm.
- 7.13 The width of the trench unless otherwise stated shall be 500 mm for one or two HV cables and associated pilot cables, and shall increase by 300 mm for each additional HV cable and its associated pilot cable.
- 7.13.1 The width of the trench at any bend or places where cable slack is required, shall be such that the bending radius of the cables shall not be less than that specified for the particular cable as per specifications SANS 97 and SANS 1339.
- 7.13.2 Trenching in railway formations shall be in accordance with Transnet Freight Rail's drawing FG 263.
- 7.14 The material excavated from each trench shall be placed in such a manner as to prevent nuisance or damage to adjacent ditches, railway lines, drains, gateways and other properties and shall not interfere with traffic.
- 7.14.1 Where, owing to certain considerations, this is not possible the excavated materials shall be removed from site and be returned for refilling the trench on completion of laying.
- 7.15 When excavating close to railway tracks, the ballast must be covered by tarpaulins or other sheeting to prevent soiling.
- 7.16 Removal of accumulated water or other liquid from trenches shall be done by the Contractor at his expense. The Contractor shall provide all pumps and appliances required to carry out this operation. Water or any other liquid removed shall be disposed of without creating any nuisance or hazard.
- 7.17 Transnet Freight Rail reserves the right to alter any cable route or portion thereof prior to cable laying. Payment in respect of any additional work involved shall be at scheduled rates.

## **8.0 CABLE LAYING**

### **8.1 GENERAL**

- 8.1.1 All possible care shall be exercised in handling cables on site.
- 8.1.2 Any drum of cable showing signs of damage shall not be used.
- 8.1.3 The outer covering (insulation) of cables shall not be damaged in any way and cables shall not be bent at radii less than allowed by the manufacturer.
- 8.1.4 When cable is supplied by the contractor, the drums thereof remain the property of the Contractor and shall be removed from the site and disposed of by the contractor.
- 8.1.5 Cable pulling and laying shall be done manually unless otherwise approved by the Depot Maintenance Manager (Electrical). No cable shall be subjected to a tension exceeding that stipulated by the cable manufacturer.

### **8.2 IN TRENCHES**

- 8.2.1 High Voltage cables shall be spaced at a minimum of 300 mm apart (centre to centre).
- 8.2.2 Low Voltage cables shall be spaced at a minimum of 150 mm apart (centre to centre).
- 8.2.3 Pilot cables shall be laid beside the associated power cables.
- 8.2.4 High Voltage and Low Voltage cables (and pilot cables not associated with High Voltage cable) shall be spaced at a minimum of 300 mm apart.

- 8.2.5 Pilot cables, when they are routed separately from their associated power cables, may be run next to one another.
- 8.2.6 Single core low voltage cables to be clamped in trefoil formation.
- 8.2.7 Where the cable cannot be laid down at the specified depth, prior authority shall be obtained from the Depot Maintenance Manager (Electrical) by the Contractor to protect the cable by means of 150 mm diameter half round concrete pipes with 50 mm concrete slab coverings or other approved methods.
- 8.2.8 Where cables have to be drawn around corners well lubricated skid plates shall be used. The skid plates shall be securely fixed and constantly examined during cable laying operations.
- 8.2.9 Suitable rollers may be used during the laying of cables.
- 8.2.10 Cables shall be visually inspected for damage during and after laying. Any damage shall be reported immediately to the Depot Maintenance Manager (Electrical) who will issue the necessary instructions.
- 8.3 IN SLEEVE PIPES
- 8.3.1 All cables crossing beneath roads and pavements shall be enclosed in cement or PVC pipes with a minimum internal diameter of 150mm. The Depot Maintenance Manager (Electrical) shall be advised timeously of the locations and quantity of pipes to be laid and chambers to be provided by others. Separate lengths of pipe shall be properly jointed.
- 8.3.2 Pipes shall maintain or exceed the specified cable spacing.
- 8.3.3 Only one High Voltage cable shall be laid per pipe.
- 8.3.4 Pipes shall extend at least 1 m on either side of the road or pavement formations and shall maintain the specified cable depth. All pipes shall be graded for water drainage: the required grade is 1:400.
- 8.3.5 All cables crossings underneath railway tracks shall be in pipes in accordance with Transnet Freight Rail's drawing FG 263.
- 8.4 IN DUCTS AND BUILDINGS
- 8.4.1 Concrete ducts and pipes within buildings will be provided by others.
- 8.4.2 Before installing cables, the ducts are to be inspected to ensure that they are suitable and clean as not to damage the cables.
- 8.4.3 The cables are to be neatly positioned and cross overs are to be avoided.
- 8.4.4 Steel checker plates over ducts will be supplied by others. The tenderer will however be required to cut all the slots for emerging cables. These slots are to be neatly cut and smoothed to avoid damage to the cable.
- 8.4.5 The Contractor shall supply all cable trays, racks, wooden cleats or other supports required to adequately support cables not laid in ducts.
- 8.4.6 Cable trays or racks shall be of reinforced glass fibre or steel suitably treated to prevent corrosion, Steel trays, racks and other supports shall be galvanised in accordance with SANS 32 and SANS 121 when used within 50 km of the sea or inland exposed conditions.
- 8.4.7 Where cable enters buildings sufficient measures shall be installed to ensure no moisture/water is digressing into the ducts. A sealing system based rubber modules from multi removable layers may be used.
- 8.5 UNDER BRIDGES AND IN TUNNELS
- 8.5.1 Where a cable route can only be against the concrete wall of a bridge or tunnel the cable shall be supported on:
- 8.5.1.1 Suitable brackets at 750 mm intervals or.

- 8.5.1.2 Straining wire secured at maximum 1 200 mm intervals.
- 8.5.2 Brackets shall be of robust design and shall be galvanised and painted in accordance with Transnet Freight Rail's specification CEE.0045.
- 8.5.3 The height of the cable route on the brackets or strain wire shall be determined and agreed upon on site.
- 8.5.4 The brackets or strain wire shall be supplied and installed by the contractor.
- 8.6 CROSSING OF PIPELINES AND OTHER CABLES
- 8.6.1 Cables shall pass beneath pipelines with a 300 mm minimum clearance between the top of any cable and the bottom of any oil pipe.
- 8.6.1.1 The level of any cable at an oil pipeline crossing shall be maintained for not less than 3 m on either side of the centre line of the pipeline or on either side of the centre line of the outermost pipelines where there is more than one pipeline on the same route.
- 8.6.2 Where cables cross communication or signal cables, at least 300 mm of fill shall be provided between the two cables. In addition a concrete slab in accordance with Transnet Freight Rail's drawing CEE PA-0105 shall be placed between the two cables parallel to the lower cable.
- 8.7 IN RAILWAY FORMATIONS
- 8.7.1 Cables to be accommodated in railway formations shall be laid in accordance with Transnet Freight Rail's drawing FG 263.
- 8.8 SECURED TO POLES
- 8.8.1 Cables to be terminated at disconnectors (isolators) mounted on wood, concrete or steel poles, shall be clamped onto such structures by means of stainless steel straps applied at such a tension that the cable or cable sheath is not damaged. Straps shall be located at intervals of not more than 1,2 m.
- 8.8.2 Cables shall be protected by a pipe or boxed section of galvanised steel or other approved material for a distance of 250 mm below and 600 mm above ground level, strapped or screwed to the pole at a minimum of two points and connected to the earth connection, if of steel construction.
- 8.8.3 Straps and pipes shall be supplied and installed by the Contractor.
- 8.9 EXPOSED CONDITIONS
- 8.9.1 Whenever cables enter buildings or tunnels, or where excavations are not permitted down banks or cuts, the exposed portion shall be suitably protected by means of concrete slabs, or suitable steel pipes or boxed sections which shall be galvanised in accordance with SANS 32 and SANS 121.
- 8.9.2 These pipes or boxed sections shall be firmly secured to the bank or cut, at regular intervals.
- 8.9.3 All such material shall be supplied and installed by the Contractor.
- 8.9.4 Stake routes shall only be supplied when specifically called for in Appendix 1.
- 9.0 CABLE TERMINATIONS**
- 9.1 GENERAL
- 9.1.1 All cables shall be terminated and connected to the respective equipment, whether provided by the Contractor or by others.
- 9.1.2 Jumpers between cable end boxes and disconnectors shall either be short enough to be rigidly self supporting, or shall be supported on suitably placed pin insulators.
- 9.1.3 Termination of cables on outdoor equipment shall not be done during inclement weather conditions.



- 9.1.4 Both ends of each cable shall be identified by means of embossed stainless steel strips clamped around the cables. The characters shall have a minimum height of 6 mm.
- 9.1.5 All materials necessary for cable termination shall be provided by the Contractor.
- 9.1.6 The contractor shall ensure that correct phase rotation is maintained throughout.
- 9.1.7 Glands of cables terminating on equipment provided with frame leakage protection shall be insulated from the frame by high grade non-deteriorating, non-hygroscopic insulation, at least 2 mm thick, capable of withstanding a test voltage of 4 kV DC for one minute.
- 9.2 HV Cables
- 9.2.1 The cable armouring shall be bonded with an approved copper bond to the cable end box at one end of the cable only as directed by the Depot Maintenance Manager (Electrical). This bond shall be easily removable for testing purposes.
- 9.2.2 Where for any reason a cable cannot be terminated, sufficient length of cable shall be left to reach the cable end box position. The cable shall be coiled and buried or otherwise protected. The cable end of paper insulated cables shall be capped immediately with a plumbed lead seal. Other cables shall be sealed with suitable tape.
- 9.3 LV Cables (and Pilot Cables)
- 9.3.1 All cut ends of cables are to be sealed with suitable tape, or other approved means until they are ready to be terminated.
- 9.3.2 The cables shall terminate in compression type glands, brass or bronze, suitable for PVC SWA ECC cables.
- 9.3.2.1 The glands shall be fitted with neoprene shrouds or corrosion guard to prevent the ingress of moisture and dust at the point of cable entry.
- 10.0 CABLE JOINTS**
- 10.1 General
- 10.1.1 Jointing shall be carried out strictly in accordance with the manufacturer's jointing instructions and by artisans thoroughly experienced and competent in jointing the classes of cables used. They shall be adequately supervised to ensure the highest quality of workmanship.
- 10.1.2 Jointing shall not be carried out during inclement weather.
- 10.1.3 The cores of cables shall be jointed number to number or colour to colour.
- 10.1.4 The joints shall not impair the anti-electrolysis characteristics of the cables.
- 10.1.5 The conductor bridging the armouring shall be adequate to carry the prospective earth fault current.
- 10.1.6 A through joint shall only be permitted after every full drum length of cable.
- 10.1.7 Each cable joint shall be identified by a non-corrodible label fixed securely to the top of the joint. Each label shall have stamped on it, in characters having a minimum height of 10 mm, the identification of equipment at each end of the cable concerned.
- 10.1.8 Transnet Freight Rail reserves the right to be present during jointing operations to familiarise themselves with any special techniques.
- 10.1.9 No joint shall be situated inside a cable pipe.
- 11.0 COVERING, BACKFILLING AND REINSTATEMENT**
- 11.1 Filling of trenches shall not commence before the Depot Maintenance Manager (Electrical) or his authorised representative has inspected and approved the cables and cable joints in situ in the section of trench concerned.

- 11.2 Trenches in railway formations shall be backfilled and reinstated in accordance with Transnet Freight Rail's drawing FG 263.
- 11.3 All other trenches shall be backfilled and reinstated as follows:
- 11.3.1 Two 75 mm thick layers of soil sifted through a 6 mm mesh shall be laid directly under and over the cables respectively and consolidated by hand ramming only.
- 11.3.1.1 Only soil with a thermal resistivity of 1,5 degrees C.m/watt, or lower may be used for this purpose.
- 11.3.1.2 When necessary imported fill shall be arranged by the Contractor and paid for at scheduled rates.
- 11.3.1.3 The backfill material shall be free from rubble/stones or foreign material.
- 11.3.2 HV cables shall, where likely to be mechanically damaged as decided by the Depot Maintenance Manager (Electrical), be protected by concrete slabs (to Drawing CEE PA-0105) to be supplied and laid by the Contractor on top of the sifted soil. These slabs shall be laid close-butted, convex end to concave end, directly above each HV cable throughout the underground portion except where otherwise protected as by pipes, etc. Only unbroken cable protection slabs may be used, and only slabs actually laid will be paid for.
- 11.3.3 Reinforced resin protection trench covers might also be used instead of concrete slabs. These covers shall be made of material which is flame retardant, non toxic and corrosion resistant.
- 11.3.4 The minimum dry densities of backfilling after compaction shall be not less than 1600 kg/cubic metre.
- 11.3.5 All excavations made (whether for the purpose of cable laying, joint bays or trial holes) shall be back-filled in 150 mm layers, the earth in each layer being well rammed and consolidated and sufficient allowance being made for settlement. The back-filling shall be completed to the satisfaction of the Depot Maintenance Manager (Electrical). If necessary, water shall be used to obtain the specified compacted density. Any cable damaged during backfilling shall be replaced by the Contractor at his own expense.
- 11.3.5.1 Backfilling at pipe entries shall be such as not to stress or damage the cable during compaction from the top.
- 11.3.6 A continuous plastic cable warning tape, to drawing CEE-MA-307 shall be laid directly above each HV cable, 150 mm below the normal surface level and run for the full length of the cable before completing the back-filling.
- 11.4 The back filled trench shall be maintained in a thoroughly safe condition by the contractor for the duration of the contract.
- 11.5 All back filling of road crossings shall be mechanically rammed.
- 11.6 Final surfacing of roads shall be restored by others unless called for under "Scope of Work", Appendix 1.
- 11.7 Concrete cable route markers shall be provided and installed by the contractor in accordance with drawing CEE-PK-14.
- 11.8 Pipes shall be filled with a sand/water mixture to also have a thermal resistivity of 1,5 degrees C.m/watt or lower when dry. The sand used in the mixture shall be chemically tested not to be harmful to the cable outer sheath.
- 12.0 MEASUREMENTS**
- 12.1 All measurements for payment purposes shall be made jointly by representatives of the Contractor and Transnet Freight Rail and shall be agreed upon by both parties. The Contractor shall be responsible for obtaining the Depot Maintenance Manager (Electrical)'s signed approval of such measurements.

- 12.2 Measurements of cable length shall be made from centre to centre of cable joints and to the cable ends and will exclude any wastage due to jointing and terminating.
- 12.3 When cable is drawn through pipes, only the portion remaining in the pipe will be paid for at the rates quoted for "as installed in pipes".
- 12.4 Determination of trench volume for measurement purposes shall be based on measured length and specified width and depth. No allowance shall be made where trenches have to be widened at the bottom to accommodate cables, cable joints and protection slabs.
- 12.5 The classification of different types of ground for measurement purposes shall be as follows:
- 12.5.1 Soft rock will be taken as broken or friable rock which can be removed by pick or mechanical excavator or paving breaker. This includes hard clay.
- 12.5.2 Hard rock will be taken as rock which cannot be removed by a mechanical excavator and requires drilling and blasting or splitting. This includes reinforced or plain concrete.

### 13.0 TESTS

- 13.1 The costs of all post-installation tests shall be borne by the Contractor.
- 13.2 The Contractor shall be responsible for remedial work necessary due to damages caused during tests.
- 13.3 Transnet Freight Rail reserves the right to carry out any further tests deemed necessary, using either the Contractor's instruments and equipment or its own, or both. The costs of such tests will not be charged to the Contractor.
- 13.4 Test instruments shall be of the accuracy class. Calibration certificates from a recognised testing authority shall be available for inspection and shall not be older than one year.
- 13.5 Time measurements shall be carried out using an approved digital timer.
- 13.6 The final commissioning site tests will be carried out by Transnet Freight Rail.
- 13.6.1 A suitably qualified staff member of the Contractor shall assist Transnet Freight Rail during the tests and shall carry out any remedial work where necessary.
- 13.7 The contractor shall notify the Depot Maintenance Manager (Electrical) in writing 4 weeks before the commissioning date and shall have carried out the following site tests before such date:
- 13.7.1 Prove the continuity and insulation resistance of the multicore pilot cables.
- 13.7.2 Verify that the insulation level between frame and earth of switchboards fitted with frame leakage protection is not reduced by the installation of the cables.
- 13.7.3 The following voltages withstand tests on each completed cable run:
- 13.7.3.1 Paper insulated cables:
- (i) Rating up to 12,7/22 kV shall be tested in accordance to SANS 97.
- (ii) Rating 19/33 kV shall be tested in accordance to BS 6480.
- The extruded PVC impermeable serving shall withstand a test voltage of 10 kV DC between armouring and earth for 1 minute.
- The insulation between armouring and lead sheath shall withstand a test voltage of 4 kV DC for 1 minute.

### 13.7.3.2 XLPE Insulated Cables:

All cables rated up to 19/33 kV shall be tested in accordance to SANS 1339, and cables rated up to 1,9/3,3 kV shall be tested in accordance to BS 5467.

Where a new XLPE cable is to be joined to an existing XLPE Cable, the test shall differ, in that a 4 kV DC test voltage shall be applied for one minute between the brass screens of the cores and the armouring. The outer sheath shall withstand a test voltage of 10 kV DC for 1 minute between the armouring and earth.

- 13.7.4 The Contractor shall submit three copies of certified test reports to the Depot Maintenance Manager (Electrical) within three weeks after completion of the tests.

## 14.0 GUARANTEE

- 14.1 All work undertaken by the Contractor shall be subject to a guarantee for a period of one year against faulty and/or inferior workmanship and material.
- 14.2 The guarantee period shall commence the day the installation is formally handed over to and accepted by Transnet Freight Rail.
- 14.3 The Contractor shall undertake to repair all faults or defects due to bad workmanship and/or faulty materials, and to replace all defective equipment or materials during the guarantee period.
- 14.4 Any defects that may become apparent during the guarantee period shall be rectified to the satisfaction of, and free of cost to Transnet Freight Rail.
- 14.5 The Contractor shall undertake work on the rectification of any defects that may arise during the guarantee period within 7 days of his being notified by Transnet Freight Rail of such defects.
- 14.6 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 replacement, including the labour costs incurred in replacing defective material.

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15.0 APPENDIX 1

**SCOPE OF WORK**  
(To be filled by the client)

1.0 Site inspection required (Yes/No).....

Date : .....

Time : .....

Client's Signature: .....

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## 16.0 APPENDIX 2

## SCHEDULE OF REQUIREMENTS

(To be filled by Tenderer)

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT RATE	TOTAL
1.0	Route surveys		complete		
2.0	Excavations in				
a)	Hard rock		/cubic metre		
b)	Soft rock		/cubic metre		
c)	Soil		/cubic metre		
3.0	Transportation of soil		/cubic metre		
4.0	Shuttering		/m		
5.0	Concrete slabs supplied and installed		each		
6.0	Plastic cable warning tape supplied and installed		/m		
7.0	150 mm dia. half round concrete pipes supplied and installed		/m		
8.0	150 mm dia. Cement or PVC pipes supplied and installed		/m		
9.0	Cutting of checker Plates		/m cut		
10.0	Backfilling of trenches with soil		/cubic metre		
11.0	Backfilling of trenches with 10:1 soil/cement mix		/cubic metre		
12.0	Importation of soil		/cubic metre		
13.0	Concrete cable route markers		each		
14.0	Reinstate tarred Surface		/cubic metre		
15.0	Reinstate concrete Surface		/cubic metre		

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT RATE	TOTAL
16.0	Installation of cables				
16.1	Installed in trenches				
16.1.1	High Voltage Cables		/m		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				
16.1.2	Low Voltage Cables		/m		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core		mm sq		
16.2	Installed in sleeve pipes				
16.2.1	High Voltage Cables		/m		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				
16.2.2	Low Voltage Cables		/m		
	..... Core.....		mm sq		
	..... Core.....		mm sq		
	..... Core.....		mm sq		
	..... Core.....		mm sq		
16.3	Installed in ducts				
16.3.1	High Voltage Cables		/m		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT RATE	TOTAL
16.3.2	Low Voltage Cables		/m		
	..... Core.....		mm sq		
	..... Core.....		mm sq		
	..... Core.....		mm sq		
	..... Core.....		mm sq		
17.0	Installation of cables (Special conditions)				
17.1	Cable supports				
17.1.1	High Voltage Cables		/m		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				
17.1.2	Low Voltage Cables		/m		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		
17.2	Securing cables to poles				
17.2.1	High Voltage Cables		/m		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				
17.2.2	Low Voltage Cables		/m		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		



ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT RATE	TOTAL
17.3	Securing cables to concrete/tunnel walls				
17.3.1	High Voltage Cables		/m		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				
17.3.2	Low Voltage Cables		/m		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		
17.4	Installation of cables in track formations				
17.4.1	High Voltage Cables		/m		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				
17.4.2	Low Voltage Cables		/m		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		
18.0	Cable terminations complete (Supply material, terminate and connect up).				

ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT RATE	TOTAL
18.1	XLPE cable				
18.1.1	High Voltage terminations		each		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				
18.1.2	Low Voltage terminations		each		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		
18.2	PILC SWA cable				
18.2.1	High Voltage terminations		each		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				
18.2.2	Low Voltage terminations		each		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		
	..... core.....		mm sq		

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ITEM NO.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT RATE	TOTAL
19.0	Cable joints complete (Supply material, terminate and connect up)				
19.1	PVC to PVC		each		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				
19.2	XLPE to XLPE		each		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				
19.3	PILC to PILC		each		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				
19.4	XLPE to PILC		each		
	240 mm sq				
	185 mm sq				
	120 mm sq				
	95 mm sq				
	16 mm sq				
	Other sizes				

TENDERER'S SIGNATURE.....

DATE.....

**17.0 APPENDIX 3**

- SANS 1411 – 1: Materials of insulated electric cables and flexible cords Part 1: Conductors.
- SANS 1411 – 2: Materials of insulated electric cables and flexible cords Part 2: Polyvinyl chloride (PVC).
- SANS 1411 – 3: Materials of insulated electric cables and flexible cords Part 3: Elastomers.
- SANS 1411 – 4: Materials of insulated electric cables and flexible cords Part 4: Cross-linked polyethylene (XLPE).
- SANS 1411 – 5: Materials of insulated electric cables and flexible cords Part 5: Halogen-free, flame-retardant materials.
- SANS 1411 – 6: Materials of insulated electric cables and flexible cords Part 6: Armour.
- SANS 1411 – 7: Materials of insulated electric cables and flexible cords Part 7: Polyethylene (PE).
- SANS 1507 – 1: Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 1: General.
- SANS 1507 – 2: Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 2: Wiring cables.
- SANS 1507 – 3: Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 3: PVC Distribution cables
- SANS 1507 – 4: Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 4: XLPE Distribution cables
- SANS 1507 – 5: Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V) Part 5: Halogen-free distribution cables.
- SANS 10198 – 1: The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 1: Definitions and statutory requirements.
- SANS 10198 – 2: The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 2: Selection of cable type and methods of installation.
- SANS 10198 – 3: The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 3: Earthing systems - General provisions.
- SANS 10198 – 4: The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 4: Current ratings.
- SANS 10198 – 5: The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 5: Determination of thermal and electrical resistivity of soil.
- SANS 10198 – 6: The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 6: Transportation and storage.
- SANS 10198 – 7: The selection, handling and installation of electric power cables of rating not exceeding 33 kV Part 7: Safety precautions.

**SPOORNET**  
**(INFRASTRUCTURE)(ELECTRICAL)**

THIS ISSUE CANCELS  
SPECIFICATION NO.  
CEE.0111.84

**SPECIFICATION FOR 25KV AC TRACTION SUBSTATIONS**

This specification covers SpoorNet's requirements for the design, manufacture, testing, installation and commissioning of 25kV AC single phase substations for an electric traction system.

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## SECTION 1 - SUBSTATION DESIGN INFORMATION

### 1.0 SCOPE

- 1.1 This specification covers Spoornet's requirements for the design, manufacture, testing, installation and commissioning of 25kV 50 hertz AC single phase traction substations for feeding the overhead track equipment of the Spoornet's AC traction system. Adjoining the Spoornet substation yard will be an Eskom yard. The equipment in the Eskom yard, including the earth mat will be provided and installed by others.

### 2.0 STANDARDS

- 2.1 Unless otherwise specified all materials and equipment supplied shall comply with the current edition of the relevant SABS, BS, IEC or Spoornet publication where applicable.

The following publications are referred to in this specification:

#### 2.2 South African Bureau of Standards

- SABS 03-1985 - The Protection of Structures against Lightning  
 SABS 150 - PVC Insulated Electric Cables and Flexible Cords  
 SABS 156 - Moulded Case Circuit Breakers  
 SABS 555 - Insulating Oil for Transformers and Switchgear (uninhibited)  
 SABS 763 - Hot-dip Galvanised Zinc Coatings  
 SABS 780 - Distribution Transformers  
 SABS1019 - Standard Voltages, Currents and Insulation Levels for Electricity Supply  
 SABS1035 - Insulated Bushings  
 SABS1091 - National Colour Standards for Paint  
 SABS1222 - Enclosures for Electrical Equipment  
 SABS1299 - Direct Acting Indicating Electrical Measuring Instruments and their Accessories  
 SABS0142 - The Wiring of Premises

#### 2.3 International Electrotechnical Commission

- IEC 56 - High Voltage Alternating Current Circuit Breakers  
 IEC 76 - Power Transformers  
 IEC 129 - Alternating Current Disconnectors and Earthing Switches  
 IEC 354 - Loading Guide for Oil Immersed Transformers

#### 2.4 British Standards Institution

- BS 159 - Busbars and Busbar Connections  
 BS 162 - Electric Power Switchgear and Associated Apparatus  
 BS2692 - Fuses for Voltages Exceeding 1000V AC  
 BS2914 - Surge Diverters for Alternating Current Systems  
 BS3938 - Current Transformers  
 BS3955 - Electrical Controls for Domestic Appliances  
 BS4360 - Specification for Weldable Structural Steels  
 BS5311 - AC Circuit Breakers of Rated Voltage above 1kV

#### 2.5 Spoornet

- CEE.0224.94 - Drawings, Catalogues, Instruction Manuals and Spares  
 CEE 0040.83 - Manual or Motor Operated 25kV Track Sectioning Switches  
 CEE.0045.96 - Painting of Steel Components of Electrical Equipment  
 CEE.0085.84 - Self Contained Battery and Battery Charger Units

- 2.6 Any items offered in accordance with other standards will be considered at the sole discretion of Spoornet. 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 APPENDICES**

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

APPENDIX 1 : Substation sites (names and locations) and degree of pollution.

APPENDIX 2 : Schedule of requirements for AC traction substations.

APPENDIX 3 : Schedule of drawings supplied by Spoornet.

**4.0 DEFINITIONS**

4.1 "Single unit substation" refers to a substation to be provided with one traction transformer.

4.2 "Double unit substation " refers to a substation to be provided with two traction transformers, a busbar coupler and associated equipment.

4.3 "Substation" refers to a traction substation

4.4 "Local" operation refers to a condition in which a circuit breaker can only be switched by operating the breaker controls provided in the substation.

4.5 "Remote" operation refers to a condition in which a circuit breaker can only be switched by operation of a control system from a location remote from the substation

4.6 Breaker "remain open" refers to a breaker that trips and stays in the open position and can be closed from local or remote.

4.7 A circuit breaker that is open and has an "operational inhibit" refers to a condition in which the breaker can not be closed until certain conditions return to normal. (thermal protection, undervoltage protection etc.)

4.8 "Lockout" of a circuit breaker refers to a condition where local manual reset of the control circuit is required before any attempt to close the circuit breaker can be made.

4.9 "Technical Officer" Is the person appointed by Spoornet to manage and administer the contract works.

**5.0 TENDERING PROCEDURE**

5.1 Tenderers shall submit a main offer in duplicate, complete in every respect in compliance with the specification.

5.2 Tenderers shall indicate clause by clause compliance or non 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.

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

5.4 Equipment type test certificates as specified shall be submitted with the tender. These shall be in English or a certified translation.

5.5 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 GENERAL REQUIREMENTS**

6.1 The primary supply voltage shall be as specified in the schedule of requirements.

6.2 The locations of the substations to be provided, as well as the differing requirements to suit any particular substation are given in Appendices 1 and 2.

- 6.3 Equipment / Installations supplied shall be in terms of this specification. Deviations from the specification will not be allowed without the written consent of the Technical Officer.
- 6.4 Spoornet reserves the right to subject material and equipment offered to test or inspection to check compliance with the clauses of this specification prior to adjudication or at any stage during manufacture.
- 6.5 The onus to prove compliance to the specification shall rest with the tenderer during the tender stage and with the successful tenderer once the contract has been awarded.
- 6.7 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.
- 6.8 Acceptance by the Technical Officer of the equipment / installation offered in no way relieves the successful tenderer of his obligation to fulfil his statement of compliance with the specification.
- 6.9 All equipment shall be adequately earthed, insulated, enclosed and interlocked to ensure the safety of staff (operators) as well as equipment.
- 6.10 Any portion of the equipment which may be likely to cause injury to staff or fire by being overloaded or failing, or by an arc set up by the equipment in operation, shall be so arranged as to prevent the possibility of injury to staff as well as preventing damage to other equipment.

**7.0 SERVICE CONDITIONS**

7.1 The equipment shall be designed and rated for operation under the following service conditions :-

Altitude	: 0 to 1 800m above sea level
Ambient temperature range	: Minus 5 °C to plus 50 °C
Relative humidity	: 10% to 90%
Wind pressure on equivalent projected area normal to direction of wind	: 750Pa
Lightning conditions	: 5,5 Flashes/km <sup>2</sup> /annum

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**8.0 INSULATION LEVELS**

- 8.1 Insulation levels for high voltage equipment shall be in accordance with the recommendations of SABS 1019.
- 8.2 Secondary equipment at 25kV (phase to earth) shall have a rated insulation level based on an equivalent 3 phase system with a highest voltage for equipment of 52kV r.m.s, i.e., a rated lightning impulse withstand voltage of 250kV peak, and a rated power frequency withstand voltage of 95kV r.m.s.
- 8.3 Primary equipment (voltages phase to phase r.m.s) shall have a rated insulation level based on an equivalent 3 phase system as indicated in the following table:

Nominal system voltage	<u>66kV</u>	<u>88kV</u>	<u>132kV</u>	<u>220kV</u>
Highest voltage for equipment	72,5kV	100kV	145kV	245kV
Rated lightning impulse withstand voltage	350kV	380kV	550kV	850kV
Rated power-frequency withstand voltage	140kV	150kV	230kV	360kV

**9.0 CLEARANCES**

- 9.1 The following minimum earth clearances shall be maintained between any conductor or metal normally alive and earthed metal :-

Nominal System Voltage	<u>25kV</u>	<u>66kV</u>	<u>88kV</u>	<u>132kV</u>	<u>220kV</u>
Outdoor	540mm	770mm	1000mm	1450mm	1850mm
Indoor	300mm	-	-	-	-

- 9.2 The following minimum safety clearances shall be maintained between any conductor or metal normally alive and ground surface level:-

Nominal system voltage	<u>25kV</u>	<u>66kV</u>	<u>88kV</u>	<u>132kV</u>	<u>220kV</u>
Within security fence	3400mm	3270mm	3500mm	3950mm	4350mm
Outside security fence but within Spoornet's reserve	5400mm	5700mm	5900mm	6300mm	6700mm
Outside Spoornet's reserve	5400mm	5700mm	5900mm	6300mm	6700mm

**10.0 CREEPAGE DISTANCES**

- 10.1 The insulators or bushings provided on all high voltage AC disconnecting switches, circuit breakers and transformers shall comply with the requirements of SABS 1035.
- 10.2 Secondary equipment at 25kV (phase to earth) shall have creepage distances based on an equivalent 3 phase system with a highest voltage of the system of 48kV r.m.s, i.e. 960mm and 1200mm for normal and extremely polluted areas respectively.
- 10.3 Primary equipment (voltages phase to phase) shall have creepage distances based on an equivalent 3 phase system in accordance with the following table:

Nominal system voltage	<u>66kV</u>	<u>88kV</u>	<u>132kV</u>	<u>220kV</u>
Highest voltage for equipment	72,5kV	100kV	145kV	245kV
Normal or light pollution	1150mm	1600mm	2320mm	3920mm
Heavy Pollution	1660mm	2300mm	3340mm	5640mm

**11.0 PREVENTION OF CORROSION**

**11.1 Preparation of outdoor structural steelwork.**

- 11.1.1 Steelwork for outdoor installation in inland areas, i.e, at a distance greater than 20km from the coast, shall be hot-dip galvanised to SABS 763.
- 11.1.2 Steelwork for outdoor installation in coastal areas, i.e, within 20km of the sea, shall first be hot-dip galvanised to SABS 763, followed immediately at the galvanising plant by the application of the Sterling paint system in accordance with specification CEE.0045.

**11.2 Preparation of steel buildings.**

Where it is impractical to galvanise large areas of sheet steel, surfaces for outdoor exposure in both inland and coastal areas shall be prepared in accordance with specification CEE.0045.

**11.3 Handling and final treatment of painted steelwork.**

- 11.3.1 Painted steel shall be handled with care and/or suitably packed to avoid damage during transport and installation.
- 11.3.2 Any damage to painted surfaces shall be repaired, after installation after which a final finish coat of the paint specified in specification CEE.0045. shall be applied.
- 11.3.3 The following table specifies the colours to be used:

◆ Coastal structural support steel	Tower Grey
◆ Traction transformer tank	Navy light Grey (G35)
◆ Traction transformer conservator tank	White
◆ Substation building	White
◆ Interior of building and all outdoor enclosures	White
◆ Indoor equipment/control panels	Navy light Grey (G35)

**12.0 SUBSTATION OPERATIONAL PROTOCOLS**

All traction substation circuit breakers shall trip and remain open (operational inhibit) should the circuit breakers tripping power supply (110V DC) be lost completely or fall below 70% of nominal battery voltage. It shall only be possible to close the circuit breakers when the supply voltage reaches 85% of the nominal value.

**12.1 PRIMARY ISOLATOR**

- 12.1.1 It shall not be possible to operate the primary isolator unless the primary circuit breaker is open.
- 12.1.2 It shall not be possible to earth the load side of the primary isolator before the isolator blades are completely open.
- 12.1.3 With the isolator in the open position it shall be possible to operate the primary circuit breaker for test purposes.

**12.2 PRIMARY CIRCUIT BREAKERS**

- 12.2.1 The primary circuit breaker shall trip and remain open for the following events:
  - 12.2.1.1 Inverse Definite Minimum time operation. (primary)
  - 12.2.1.2 Transformer winding and or oil temperature.
- 12.2.2 The primary circuit breaker shall trip and lockout for the following events:
  - 12.2.2.1 When the SF6 gas pressure falls to the first warning pressure value (before it reaches the safe operational threshold)
  - 12.2.2.2 Transformer Bucholtz operation
  - 12.2.2.3 Transformer restricted earth fault
  - 12.2.2.4 Transformer biased differential

**12.3 SECONDARY ISOLATOR (25kV)**

- 12.3.1 It shall not be possible to operate the secondary isolator unless the 25kV Incomer circuit breaker is open.
- 12.3.2 With the isolator in the open position it shall be possible to operate 25kV Incomer circuit breaker for test purposes.

**12.4 SECONDARY CIRCUIT BREAKERS (25kV)**

- 12.4.1 **Incomer circuit breaker**
  - 12.4.2 The 25kV Incomer shall trip and remain open for the following events:
    - 12.4.2.1 When the SF6 gas pressure falls to the first warning pressure value.
    - 12.4.2.2 Inverse Definite Minimum time operation. (secondary overcurrent)
    - 12.4.2.3 Intertripping with the primary circuit breaker. If the primary circuit breaker is tripped by any of the transformer protection relays, then the incomer circuit breaker shall trip and shall not be able to close until the primary circuit breaker is closed.
    - 12.4.2.4 In the case of substations connected in parallel (will be specified in the schedule of requirements), the incomer will trip and remain open, in the event of reverse current flow.
  - 12.4.3 It shall not be possible to parallel incoming 25kV supplies through a substation busbar coupler in double unit substations. (it must not be possible to close both Incomer circuit breakers with the Busbar coupler in the closed position) Where a busbar coupler is required in a single unit substation, this feature shall be provided for future use when the incoming supply is doubled.

- 12.4.4 The operation of the Busbar coupler (opening or closing) shall only be possible if all the Secondary Circuit Breakers (Incomers and Track feeders) are in the open position.
- 12.4.5 **Track feeder circuit breakers**
- 12.4.6 The track feeder circuit breakers shall trip and remain open for the following events:
  - 12.4.6.1 When the SF6 gas pressure falls to the first warning pressure value.
  - 12.4.6.2 Operation of the thermal overload relay. The breaker shall trip and remain open (operational inhibit) until the relay resets. The auto reclose function shall not be initiated by this relay.
  - 12.4.6.3 Impedance distance protection operation. The breaker shall trip and the single shot auto reclose sequence will be initiated. Should the breaker trip again after the auto reclose sequence, it shall remain open. (no lockout or auto reclose)
  - 12.4.6.4 When local operation of a circuit breaker is selected any auto reclose feature provided shall be rendered inoperative.
  - 12.4.6.5 When closing any circuit breaker from remote any auto reclose feature provided shall be rendered inoperative for a period of 30 seconds.

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**SECTION 2: - TRACTION SUBSTATION EQUIPMENT****13.0 STEELWORK**

- 13.1 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.
- 13.2 Structural steel shall comply with BS 4360.
- 13.3 All welded joints shall be seal welded with no gaps or blow holes.
- 13.4 All steelwork shall be hot-dip Galvanised to SABS 763.
- 13.5 A lattice type steel gantry (25kV gantry) shall be provided on which for secondary circuit breakers of the outdoor structure mounted type the following items of equipment shall be mounted:
- ◆ 25kV Isolator
  - ◆ 25kV Busbar
  - ◆ Lightning arrestors (for each feeder circuit)
  - ◆ Auxiliary transformer
  - ◆ Voltage transformer
  - ◆ All Secondary Circuit Breakers (Incomer as well as the track feeders)
  - ◆ All track feeder overhead feeders (500 mm<sup>2</sup> Aluminium) shall be made off on this structure with the span length being the distance to the Overhead track equipment switch structure which will be provided by others.
- 13.6 A typical layout of the above arrangement is shown on Drawings No's CEE-TDB-41 sht's 1&2 which form part of this specification.
- 13.7 Support steel structures for the following equipment shall be provided:
- ◆ High voltage double pole isolator.
  - ◆ High voltage lightning arrestors. (structure shall be similar to that shown on Sketch No. 1 in Appendix No.3)
  - ◆ Primary circuit breaker
  - ◆ High voltage Current Transformer. (structure shall be similar to that shown on Sketch No 1 in Appendix No.3)
- 13.8 The manufacture of any steelwork shall not take place prior to the approval by the Technical Officer of the design drawings.
- 13.9 Spoonnet shall inspect the steelwork at the manufacturers works prior to dispatch.

**14.0 PRIMARY AND SECONDARY ISOLATORS**

- 14.1 Isolators and earthing switches shall comply with the requirements specified in IEC 129.
- 14.2 Isolators and earthing switches shall be of the air break type suitable for outdoor installation and be designed for manual operation from ground level.
- 14.3 The primary isolator shall be of the double pole type.
- 14.4 The secondary isolator shall be of the single pole type.
- 14.5 Interlocking shall be provided on the primary isolator to ensure that the isolator can only be opened with the primary circuit breaker in the open position.

- 14.6 Interlocking shall be provided on the secondary isolator to ensure that the isolator can only be opened with the incomer circuit breaker in the open position.
- 14.7 The primary isolator shall be provided with means to earth the load side of the isolator when in the open position.
- 14.8 The isolators shall be rated to suit the associated equipment.
- 14.9 Tenderers shall provide details of the isolators offered and the proposed method of interlocking.
- 15.0 **LIGHTNING ARRESTERS**
- 15.1 Lightning arresters shall comply with the requirements of BS 2914.
- 15.2 Heavy duty station class arresters shall be provided.
- 15.3 Lightning arresters shall be connected to each phase of the incoming primary supply. The supply system may be considered to be effectively earthed.
- 15.4 Lightning arresters rated for 39kV rms shall be provided for connection to each 25kV circuit feeding the overhead track equipment.
- 15.5 Lightning arresters rated for 3,3kV rms shall be provided for connection to the main transformer return current bushing.
- 15.6 All lightning arresters earth lug shall be connected to the substation main earth mat by means of the specified conductor.

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**16.0 PRIMARY CIRCUIT BREAKERS**

- 16.1 Primary circuit breakers shall be of the SF6, gas filled type. Circuit breakers shall comply with IEC 56 in so far as that specification is applicable to the type of circuit breaker offered.
- 16.2 The circuit breaker shall be of the double pole type for outdoor operation.
- 16.3 The circuit breaker shall be suitably rated for the substation equipment's electrical rating as specified in the schedule of requirements.
- 16.4 The rated short-circuit breaking current shall be at least 16kA .
- 16.5 The operating mechanism shall be provided with shunt release for both opening and closing.
- 16.6 The circuit breakers shall be designed for electrical operation at 110V DC from the substation battery supply.
- 16.7 Tension springs shall not be used for either closing or tripping mechanisms.
- 16.8 The circuit breaker shall be of the trip-free type.
- 16.9 A visual mechanical indicating device shall be provided to show whether the circuit breaker is closed or open.
- 16.10 The operating mechanism shall be constructed of non-ferrous material or cadmium plated steel.
- 16.11 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.
- 16.12 The circuit breaker shall be provided with a control panel in the substation building on which are mounted the protection relays, control switches and associated equipment.
- 16.13 Circuit breaker control switches shall be provided on the control panel as well as 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.
- 16.14 Local/Remote selector switches shall be provided on the control panel in the substation building as well as on the circuit breaker mechanism and shall be of the two-position type (no "off" or "neutral" position).
- 16.15 Mechanical operation shall be provided on the circuit breaker for any closing or trip release which is normally electrically operated.
- 16.16 The circuit breaker shall be provided with a no volt coil which will trip and lock out the breaker when the coil is de-energised. Drawing No. CEE-TBK-27 forming part of this specification, details control circuitry.
- 16.17 It shall be possible to close the circuit breaker only when the control voltage is above 85% of the nominal value, and the circuit breaker shall trip automatically when the control voltage falls to 70% of the nominal value.
- 16.18 A counter shall be provided on the circuit breaker to indicate the total number of operations of the breaker.
- 16.19 A counter shall be provided on the control panel to indicate the number of trips initiated by the protection scheme.
- 16.20 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.

**17.0 TRACTION TRANSFORMER**

**17.1 GENERAL**

17.1.1 The transformer shall comply with IEC 76.

17.1.2 The transformer shall be suitable for providing supplies to a single phase railway traction system and as such will be subjected to cyclic overloads up to 2 per unit (maximum duration 2 minutes). For thermal considerations the overall loading requirements of IEC 354 will not be exceeded. In addition the possibility exists that a high incidence of short-circuit faults will be applied to the transformer secondary terminals. Tenderers must comment on the ability of transformers offered to meet these requirements and provide this comment and the following details of transformers previously built for traction supplies with the tender :-

- ◆ User.
- ◆ Where installed.
- ◆ Date installed.
- ◆ Quantity supplied.
- ◆ MVA rating.
- ◆ Voltage ratio.
- ◆ BIL of Primary and secondary windings.
- ◆ Range of tapplings.
- ◆ Location of tapplings.
- ◆ In addition to the above any information relating to reliability and in-service performance should be submitted in support of the above.

**17.2 TECHNICAL REQUIREMENTS.**

17.2.1 The following are the technical requirements of the required transformer:

Frequency	50Hz
Type	OUTDOOR
Cooling	ONAN
Rated power	20MVA
Rated voltages	As specified in schedule of requirements
Tap changer	OFF LOAD
Tapped winding	Secondary
Tapping range in 6 equal steps.	Minus 0 % Plus 15 %
Winding connections	Primary Phase to phase. Secondary Phase to earth.
Insulation	Primary and secondary fully insulated

	Impedance	Limits on any tapping at 75 °C and at rated frequency expressed in percent of <u>(Nominal Voltage)<sup>2</sup></u> MVA	Max 12% Min 10%
17.2.2	Protection current transformers on the primary side shall be fitted on the transformer primary bushings for primary voltages of 88kV and less. For voltages above 88kV the primary protection current transformers will be separate units. All protection current transformers on the secondary side (25kV) shall be fitted on the transformer secondary bushings.		
17.2.3	Transformer oil shall conform to SABS 555.		
17.3	<b>ANCILLARY EQUIPMENT</b>		
	The following shall be provided :-		
17.3.1	A conservator tank which shall be painted white, fitted with a silica gel dehydrating breather and an oil-level gauge and drain cock.		
17.3.2	The connecting pipe to the conservator shall extend at least 50mm into the tank to form a sediment trap. All pipe connections shall have flange joints.		
17.3.3	A weather-proof dial type thermometer graded in °C for registering "top oil" temperature. The instrument shall be fitted with a resettable maximum temperature indicator. Adjustable trip and alarm contacts shall be fitted to the thermometer. The contacts shall normally be set to operate at a temperature of 90 °C.		
17.3.4	A single-float Buchholz relay to provide tripping facilities.		
17.3.5	A thermal type overload relay to protect the transformer windings against sustained overloads. This relay shall have a load-temperature characteristic approximately the same as the transformer winding hot spot. Suitable means of compensation for variation of ambient air temperature shall be provided.		
17.3.6	The relay shall be provided with trip and alarm contacts. The contacts shall normally be set to operate at 100 °C.		
17.3.7	A oil drain cock, oil sampling cock and thermometer pockets on the main tank. The sampling cock shall be so arranged that a oil sampling bottle may be easily filled.		
17.3.8	Two cocks, one on top and one at the lowest point on opposite sides of the main tank shall be provided, for connecting up to an oil filtering system. The cocks shall be screwed 50mm gas or metric equivalent female thread. If desired, the cock at the lowest point of the tank may be combined with the drain cock required above by the addition of a suitable fitting having a 50mm gas or metric equivalent female thread.		
17.3.9	A suitable explosion vent may be provided on the main tank if considered necessary by the manufacturer, but the provision of such a vent shall not effect the efficiency of the Buchholz relay in the event of a transformer fault.		
17.3.10	Bushing stems and terminals of a size to ensure sufficient mechanical strength for attaching and supporting external connections, which shall not in any case be smaller than 26mm diameter (primary and secondary). At least two earthing terminals on opposite sides of the transformer shall be fitted on the outside of the transformer tank to facilitate connection to the substation main earth mat.		
17.3.11	All pipe joints and inspection covers shall be sealed using O-ring gaskets.		
17.3.12	Pockets for the temperature indication probes shall be located in areas where the oil is freely circulating, thus avoiding the possibility of incorrect oil temperature measurement.		

- 17.3.13 A separate quote for the optional supply of the following on the transformer is required:
- ◆ A "Bagged conservator" (A bag installed in the conservator tank which prevents air from coming into contact with the transformer oil)
  - ◆ A Chainings UAU transformer filter system
  - ◆ A on load tap changer
- 17.4 TANK AND COOLING RADIATORS**
- 17.4.1 The transformer tank and its associated components shall have adequate mechanical strength and rigidity to permit the complete transformer minus cooling radiators but filled with oil, to be lifted, jacked and skidded in any direction. Welded seams shall not be covered by stiffeners.
- 17.4.2 The transformer tank shall have a welded top cover.
- 17.4.3 Transformers shall not be fitted with rollers, but shall be provided with a substantial base that is rectangular (has no protruding lugs or protrusions) and is so constructed that it can be supported on a flat concrete plinth that has a raised portion the same size as the transformer base, to prevent the possibility of water standing in contact with the transformer base. Provision shall be made on the transformer for the attachment of a tackle for the purpose of skidding. Jacking lugs shall be provided for lifting the transformer complete with oil.
- 17.4.4 The transformers shall be fitted with removable cooling radiators which shall be hot-dip galvanised externally. Suitable valves shall be provided so that the radiators can be removed without having to drain the oil from the transformer tank.
- 17.5 RATING PLATES**
- 17.5.1 A non-corrosive metal plate shall be fixed to each transformer tank (not cooling tubes).
- 17.5.2 Comprehensive information shall be provided on the rating plate in respect of both electrical and mechanical aspects.
- 17.5.3 Details must be submitted to Spoornet for approval prior to construction.
- 17.6 TESTING**
- 17.6.1 The transformer shall be tested in accordance with IEC 76, including a test with lightning impulse chopped on the tail.
- 17.6.2 Spoornet will conduct an out of tank inspection of the transformer prior to the transformer being tanked as well as witnessing all the routine manufacturers tests carried out at the works. The co-ordination of manufacturers testing shall be the responsibility of the successful tenderer.
- 17.6.3 Type test certificates of the transformer design offered shall be submitted with the tender. Should type test certificates not be available, the required tests shall be carried out, the cost of which must be included in the tender price quoted as a separate item.
- 17.6.4 Should the transformer offered not have a short circuit type test certificate available, a simulated computer model of this test may be submitted for Spoornet's approval, but should this model be unacceptable short circuit tests will be required and shall be conducted in accordance with IEC 76 Part 5 . An out of tank inspection shall be carried out after completion of the tests. The tests shall comprise two short circuits on each of the extreme and centre tapplings. The short circuits on each tapping shall be of opposite asymmetry. Short circuit duration shall not be less than 0,5 seconds. Short circuit current shall not be less than that calculated for a fault on the secondary terminals of the transformer with rated voltage on the primary terminals from a supply of not less than 2 500MVA .
- 18.0 CURRENT TRANSFORMERS**
- 18.1 Current transformers shall be of the bar-primary type and comply with BS 3938. Ratings, ratios and class of accuracy shall be determined by the protection scheme as shown on Drawing No. CEE-TBB-109. A margin of 5VA shall be provided for testing purposes.

- 18.2 If the primary supply voltage is 88kV and below, then the current transformers for main transformer protection shall be installed in the transformer bushings. If the primary supply voltage exceeds 88kV then only the current transformers on the secondary side of the main transformer shall be mounted in the transformer bushings, with the primary side's current transformers being of the post type.
- 18.3 Secondary protection current transformers shall be mounted in the transformer bushings.
- 18.4 Current transformers shall be installed on the load side of the associated circuit breaker. It shall be possible to remove the current transformers with the minimum of disturbance to other equipment.
- 18.5 Separate current transformers shall be provided for main and back-up protection on all 25kV track feeder circuit breakers.
- 18.6 Since the accurate measurement of harmonics in the traction supply will be necessary from time to time, current transformers offered shall be suitable for this purpose.

**19.0 VOLTAGE TRANSFORMERS**

- 19.1 Voltage transformers shall be single phase and have a ratio of 26,4kV/110V . They shall comply with the requirements of BS 3941 and be class E for protection.
- 19.2 Voltage transformers shall be outdoor structure mounted, oil filled type.
- 19.3 The return side of the primary winding shall have a bushing insulated for 3,3kV and must not be connected to the Voltage Transformer's tank.
- 19.4 The secondary winding shall be terminated in a cable box.

**20.0 AUXILIARY POWER TRANSFORMERS**

- 20.1 Unless otherwise stated two 16kVA 27 500V/240V single phase transformers mounted on the substation portal structure shall be provided by the successful tenderer.
- 20.2 The transformers shall comply with SABS 780.
- 20.3 The transformers and the connected equipment shall be capable of operating satisfactorily for a supply voltage varying between 27,5kV and 22,0kV. Main transformer secondary voltage under traction no-load conditions will normally be 27,5kV and auxiliary equipment shall be capable of operating continuously at this voltage.
- 20.4 Each transformer shall be provided with a suitably rated drop-out fuse link provided in the high voltage supply conductor.

**21.0 BUSBAR COUPLER**

- 21.1 The 25kV busbars of each unit at all double unit traction substations shall be connected together by means of a busbar coupler. A busbar coupler shall be provided in single unit substations where specified in the Schedule of Requirements.
- 21.2 For secondary circuit breakers of the outdoor structure mounted type, the busbar coupler shall be a motor operated 25kV AC track sectioning switch supplied in accordance with specification CEE.0040.83.
- 21.3 The track sectioning switch shall be rated at 1500A and the operating voltage of the switch mechanism shall be 110V DC.

**22.0 SECONDARY CIRCUIT BREAKERS**

**GENERAL REQUIREMENTS**

- 22.1 Secondary Circuit breakers shall be of the vacuum type. Circuit breakers shall comply with BS 5311 in so far as that specification is applicable to the type of circuit breaker offered.
- 22.2 Circuit breakers of a service proven design are required and full-supporting details in this respect shall be furnished with tenders. The circuit breakers shall be single pole.

- 22.3 Circuit breakers shall be of the outdoor structure mounted type and shall be mounted on a suitably designed structure, in the manner indicated on Drawing No's CEE-TDB-41 sht's 1 & 2
- 22.4 The mounting method of the circuit breaker and the operating mechanism shall be adjustable to allow for alignment.
- 22.5 The circuit breakers shall have a rated voltage of 44kV, and the system frequency is 50Hz.
- 22.6 The rated continuous current shall be at least 1 200A.
- 22.7 The rated short-circuited breaking current shall be 12kA at a nominal voltage of 25kV . In addition the circuit breaker shall be capable of interrupting 6kA at a recovery voltage of 44kV in the case where a short circuit between phases occurs.
- 22.8 Fault making current shall be 30kA peak and at least 12kA for 3 seconds.
- 22.9 Opening time on low impedance track faults including relay operating time shall not exceed 0,1 seconds, for track feeder circuit breakers.
- 22.10 Tenderers shall advise the capability of circuit breakers offered to interrupt :-
- ◆ Capacitive currents.
  - ◆ Currents with a high harmonic content.
- 22.11 Tenderers shall advise the chopping current levels of the circuit breaker offered and what steps are taken to keep these values to a minimum.
- 22.12 Tenderers shall also advise whether special precautions are required to limit the effects of chopped current and to give details.
- 22.13 The operating mechanism shall be constructed of non-ferrous material or cadmium plated steel.
- 22.14 The operating voltage shall be 110V DC.
- 22.15 The circuit breaker operating mechanism shall be housed in a weatherproof enclosure, and shall be accessible by means of a lockable door.
- 22.16 The following shall be provided within the enclosure:
- ◆ A thermostatically controlled anti-condensation heater.
  - ◆ A fluorescent light operated by a door switch.
  - ◆ A 15A, 220V AC socket outlet in accordance with SABS 0142.
- 22.17 The circuit breaker mechanism shall be of the spring operated type with shunt release for both opening and closing. The closing operation shall charge the tripping spring.
- 22.18 It shall not be possible for the circuit breakers to close while the spring is being charged.
- 22.19 The spring shall be fully charged before it can be released to close the circuit breaker.
- 22.20 It shall be possible to charge the spring when the circuit breaker is closed and if the spring can be, and is released, the circuit breaker shall not open.
- 22.21 There shall not be any danger of a fully charged spring being released by vibration caused by the opening of the circuit breaker under any conditions.
- 22.22 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.
- 22.23 Means shall be provided for charging the spring by hand.
- 22.24 Means shall be provided for discharging the spring when the circuit breaker is in the "open" position without the circuit breaker attempting to close.
- 22.25 Facilities shall be provided for locking of the local manual release of the closing spring mechanism.

- 22.26 The closing springs shall recharge automatically after the completion of a closing operation.
- 22.27 Tension springs shall not be used for either closing or tripping mechanisms.
- 22.28 Facilities shall be provided to permit manual slow closing of the circuit breaker for maintenance purposes.
- 22.29 The mechanism shall be trip-free. The contacts shall make before the breaker starts to open.
- 22.30 If the circuit breaker fails to latch on closing it shall trip before any significant damage can occur.
- 22.31 A visual mechanical indicating device shall be provided to indicate whether the circuit breaker is closed or open.
- 22.32 Unless the design of the circuit breaker mechanism is such that compensation for interrupter contact wear is provided automatically, a visible indication shall be provided to show when adjustment is needed. In the case of circuit breakers incorporating more than one interrupter it shall be possible to make such adjustments individually to suit the requirements of each interrupter.
- 22.33 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.
- 22.34 Local/Remote selector switches on the circuit breaker equipment shall be of the two-position type (no "off" or "neutral" position).
- 22.35 Circuit breaker control switches shall be arranged to return automatically to the neutral position when the handle is released after being turned to either the "close" or "trip" positions.
- 22.36 A counter shall be provided on each circuit breaker to indicate the total number of operations of the breaker.
- 22.37 A counter shall be provided on each track feeder circuit breaker control panel to indicate operations (trips) initiated by any of the track feeder protection relays.
- 22.38 Tenderers shall advise the number of circuit breaker operations under the following conditions, after which maintenance and/or measurement of contact wear is recommended :-
- ◆ Rated breaking capacity.
  - ◆ Breaking 6kA.
  - ◆ Breaking 1500A.

- 23.0** TRACTION substation building
- 23.1 The building to be provided shall be of the prefabricated steel modular type. It shall be robust, waterproof, vermin proof and of sufficiently strong construction to resist all weather conditions encountered in South Africa.
- 23.2 Details of a suggested design are shown on Drawing No. CEE-TEC-28. This design or variations thereof may be used but tenderers are free to offer alternatives that comply with this specifications requirements.
- 23.3 When a single unit substation is required, the building design shall facilitate extension to accommodate equipment for a double unit substation in the future.
- 23.4 Steelwork shall be treated in accordance with the prevention of corrosion requirements specified in clause 11.
- 23.5 The building shall have a "double-skinned" roof construction to allow a free circulation of air between the skins.
- 23.6 The outer skin shall be of flat sheet steel of the same thickness as the building.
- 23.7 The inside walls shall be thermally insulated to the equivalent of 40mm of glass-fibre. The tenderer shall give full details of the material he intends to use as well as the fixing method of the material to the walls (Glue is not acceptable). Protection against mechanical damage to the insulation shall be provided.
- 23.8 The building shall be large enough to accommodate all equipment that will be contained within the building with enough space for comfortable maintenance of the equipment. The following major items of equipment as called for in this specification must be accommodated within the building:
- ◆ An aluminium self-supporting ladder with a height of 1.2m.
  - ◆ A wall mounted metal key box with a lid and provision for at least 20 keys as shown on Drawing CEE-TCA-92.
  - ◆ Suitable brackets and/or storage for ladder, special tools and earthing apparatus.
  - ◆ Suitable bracket on the wall immediately adjacent to the annex door for mounting of a fire extinguisher. (Fire extinguisher will be provided by others).
  - ◆ Suitable brackets for mounting of a control selector telephone and telecommunications distribution board.
  - ◆ A complete set of wiring and circuit diagrams for the substation.
  - ◆ A steel cabinet / desk combination approximately 1150mm wide, 600mm deep and 1000mm high. 1
  - ◆ Telecontrol cabinets (provided by others).
  - ◆ Battery tripping unit.
  - ◆ Primary Circuit Breaker control panels.
  - ◆ Secondary Circuit Breaker control panels.
  - ◆ Low voltage distribution board.
- 23.9 One door is required for entrance into the building. The door shall be situated in the narrow wall opposite that which contains the ventilation fan.
- 23.10 It shall be possible to remove, without dismantling, any equipment contained within the building through the door provided.



- 23.11 The door shall be fitted with a robust locking mechanism capable of being locked by means of a stout padlock provided by Spornet.
- 23.12 Door hinges shall be robust with hardened steel pins. Doors shall be fitted with a suitable stay to hold them in the open position.
- 23.13 A foundation and plinth of concrete for the support of the building and its equipment and for the maintenance and handling of all indoor equipment shall be provided.
- 23.14 The plinth shall be so designed as to eliminate the possibility of water standing in contact with the base of the building.
- 23.15 Tenderers shall give details of the measures they propose taking to seal the base of the building to the concrete plinth.
- 23.16 The finished level of the plinth shall not be less than 250mm above ground level .
- 23.17 The floor surfaces shall be durable non-slip and of pleasing appearance and shall not be subject to damage or marking by normal maintenance activities. In the case of a concrete floor it shall be coated with "Solidkote" or similar.
- 23.18 Provision shall be made for the entry of cables from the outdoor yard into the building.
- 23.19 The building design shall be such as to provide the necessary trunking for cable entry to all equipment which will be top entry. (no underfloor trunking)

HEATING AND VENTILATION

- 23.20 A ventilation fan shall be provided in the substation control equipment building. The fan shall be capable of providing 20 air changes per hour.
- 23.21 Whirlybird or similar ventilators suitable to ventilate the building shall be provided and installed on the roof.
- 23.22 The fan shall draw air from inside the building and blow to the outside through automatically closing shutter louvers.
- 23.23 Thermostatically controlled heaters shall be provided to prevent condensation within the building. Thermostats shall comply with BS 3955 part 2 section 2F and be to category A.
- 23.24 Heaters shall be robust with elements completely enclosed in a metal tube.
- 23.25 Heaters shall be positioned and mounted in such a manner that they are not subject to damage during normal maintenance activities.
- 23.26 Details of the type and rating of heaters must be supplied by tenderers.

**24.0 AUXILIARY POWER SUPPLIES**

- 24.1 All low voltage power and lighting circuits shall comply with the requirements of SABS 0142.
- 24.2 Under traction load conditions the substation supply voltage will have a high harmonic content and equipment supplied from the auxiliary transformer shall be capable of satisfactory operation under these conditions.
- 24.3 A low voltage distribution board shall be provided in the substation building. The output of the auxiliary transformers shall be connected to two 80A double pole miniature circuit breakers (MCB's) on the distribution board. The MCB's shall be withdrawable or lockable.
- 24.4 The output from the auxiliary transformers shall be connected to an automatic change-over contactor which must not allow the supplies to be paralleled under any circumstances.
- 24.5 Where only one auxiliary transformer is called for Spoornet will arrange for the supply from a second auxiliary transformer to be connected to one of the 80A MCB'S called for above.
- 24.6 The distribution board shall be provided with MCB'S to protect and control all lighting, heating, ventilation, socket outlets, control circuits, and supplies to the Eskom equipment. MCB'S shall comply with SABS 156.
- 24.7 Provision shall be made for six single MCB spare cut-outs for future additions.
- 24.8 The distribution board must provide for a 110V 10A DC supply and a 220 V 20A AC supply to be cabled to the Eskom equipment in the Eskom yard. AC and DC circuits shall be physically separated either by means of a partition or separate distribution boards.
- 24.9 At least two 15A 220V 3 pin socket outlets shall be provided in the building as well as one outlet mounted in the control panels.

**LIGHTING**

- 24.10 Lighting points shall be provided in each building to provide a general level of illumination of 20 lux. Light fittings shall be of the fluorescent type.
- 24.11 Two outdoor fluorescent lights shall be provided on the outside of the control equipment building. One shall be mounted above the buildings door and the other shall be mounted on the long side of the building facing the track. These lights shall be controlled by light sensitive switch.
- 24.12 Outdoor lighting shall be provided in at least two positions to provide a general level of illumination of 20 lux in the substation yard. These lights shall be controlled from within the control equipment building. Care shall be taken to avoid glare in the eyes of train drivers and the layout must be approved by the Technical Officer.

25.0 **REQUIREMENTS FOR TELECONTROL**

- 25.1 Telecontrol and telemetering equipment will be provided by Spornet.
- 25.2 The telecontrol equipment cabinet, the size of which is approx 1600x800x800 (hwd), will be housed in the substation control equipment building. Spornet will deliver this cabinet to site, with the installation thereof being the responsibility of the successful tenderer.
- 25.3 A "Klippon" or similar terminal strip with 250 terminals shall be provided to act as the interface between the substation equipment and the telecontrol equipment. This terminal strip can be housed in one of the switchgear control panels (space permitting) or housed in a dedicated enclosure. The successful tenderer shall terminate all conductors for the telecontrol functions required on one side of this terminal strip. The successful tenderer shall supply and install the cable required to connect the telecontrol equipment cabinet (supplied by Spornet) to the terminal strip. One side of this cable will be connected to the terminal strip with the other side being made off in the telecontrol equipment cabinet for connection by others.
- 25.4 The relay contacts provided in the telecontrol cabinet for remote operation of switchgear will have a maximum rating of 0,5A at 110V DC.
- 25.5 Indication for telecontrol purposes shall be provided by means of voltage free open and closed contacts on the switchgear.
- 25.6 Provision shall be made for the following principal telecontrol operations indications and alarms: -
- ◆ Open and close command function for all circuit breakers.
  - ◆ Open and close indication for all circuit breakers.
  - ◆ Lockout indication for all circuit breakers.
  - ◆ Indication of failure of voltage transformer output (protection reference voltage).
  - ◆ Indication of failure of distance protection relay supply voltage. Detection must take place at each relay.
  - ◆ Indication of charger failure for DC control batteries.
  - ◆ Indication of transformer pressure relief device operation.
  - ◆ Indication of low gas (SF6 breakers, Primary and Secondary).
- 25.7 The following transducers capable of measuring true RMS values of distorted waveforms shall be provided :-
- 25.7.1 A current transducer to monitor each main transformer secondary current.
- 25.7.2 A voltage transducer to monitor each secondary busbar voltage.
- 25.8 The output of these transducers shall be wired to the telecontrol terminal strip.
- 25.9 Tenderers shall state the type and suppliers of the transducers they intend using.
- 25.10 Any additional telecontrol functions that might be necessary due to the supply and installation of any specialised equipment offered shall be provided.
- 25.11 A detailed list of telecontrol commands, indications and alarms shall be submitted for approval by the Technical Officer.

**26.0 CONTROL PANELS**

A control panel shall be provided for each Primary and Secondary circuit breaker provided in the substation. These control panels shall contain all the protective relays and circuit control equipment required for the operation of the associated breaker.

**26.1 PANEL CONSTRUCTION**

26.1.1 The panels shall be constructed of steel sheeting of not less than 2mm thickness. The panel shall be of rigid construction with facilities for lifting.

26.1.2 The panels shall of the swing frame type (access to the panel being via the front swing frame and having no rear access).

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

26.1.4 The panel shall be supplied with a gland plate which allows for cable entry from the top. The installation contractor shall punch all required holes into the gland plate on site.

**26.2 EQUIPMENT INSTALLED IN THE PANELS**

26.2.1 All contactors and relays shall be of liberal rating and design and of the sturdiest construction, they shall not be affected by vibration and shall be silent when energised. Contacts shall be made of silver or other approved metal to minimise damage through oxidation and shall be designed to maintain good contact under all operating conditions.

26.2.2 Relays shall be completely sealed against the ingress of dust and dirt by means of non-inflammable covers which are easily removable. The relays shall have a protection rating of IP34 as defined in SABS 1222.

26.2.3 All protection relays shall be housed in withdrawable pattern cases and shall be so designed and mounted as to make them free from equipment vibration problems.

26.2.4 All relays, contactors, links, MCB's and test terminals shall be readily accessible so that routine examination, maintenance and testing may be carried out without the need to remove bolted panels.

26.2.5 The control equipment provided shall be capable of correct operation within the voltage limits specified in BS 5311 : Part 3 : 1976. In addition the coils of all devices operated from the substation auxiliary transformer AC supply shall be capable of satisfactorily operating under the harmonic voltage conditions encountered in an AC traction system.

26.2.6 All low voltage circuits in the panel which require protection shall be suitably protected by miniature moulded case circuit breakers which comply with SABS 156. The circuit breakers shall be B-curve design.

26.2.7 All electrical conductors shall be routed in plastic channel trunking with a removable cover. This trunking must be of sufficient size to easily hold the conductors. Should trunking not be feasible, a metal rod can be brazed onto the panel onto which the conductor bundle can be attached by cable ties or some other suitable method. Conductors supports that are attached by adhesive are not acceptable.

26.2.8 Panel bus wires shall be fully insulated and shall be run separately along the panel. MCB's shall be provided to enable independent circuits to be isolated from the bus wires. Separate troughs or ducts shall be provided for the building wiring and control wiring.

26.2.9 Protection circuits shall be provided with PK2 type test blocks to enable the temporary connection of instruments, meters or test equipment without interfering with fixed wiring.

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

- 26.2.11 All cables shall be marked at both ends with markings the same as that which appears on the wiring schematics and diagrams.
- 26.2.12 All relays, cables, terminal strips, switches, lamps, push buttons etc. which are mounted on panels, shall be labelled to clearly indicate their function.
- 26.2.13 An annunciator indicating panel giving visual (LED display) indication of the reason for the circuit breaker's trip shall be provided on the circuit breaker control panel.

A counter shall be provided on the control panel of each circuit breaker to indicate the number of trips initiated by the protection scheme.

- 26.2.14 Each protective element that causes the circuit breakers to trip shall be catered for (Bucholtz, overload, SF6 low gas, distance protection etc.). The visual alarm shall continue until the indication alarm is accepted and reset.
- 26.2.15 No anti condensation heaters are required inside the panels.
- 26.2.16 Each panel shall have an interior fluorescent lamp which will be switched by a door switch.

**26.3 INDICATING INSTRUMENTS**

- 26.3.1 All indicating instruments shall be designed, manufactured and tested in accordance with SABS 1299, and shall be flush mounted.
- 26.3.2 The dials of instruments shall be marked with the ratio of the associated instrument transformers.
- 26.3.3 The full-scale deflection of instruments shall be not less than 85mm and the scales shall be:
  - ◆ Voltmeters 0 - 30kV
  - ◆ Ammeters 0 - 1 500A
- 26.3.4 A voltmeter shall be provided to indicate the voltage of each section of the 25kV busbar.
- 26.3.5 An ammeter shall be provided to indicate the primary and secondary current.

**27.0 DC BATTERY AND CHARGER**

- 27.1 The DC control battery and charger shall comply with specification No.CEE.0085 except where special arrangements are necessary to suit the design of equipment offered. The Tenderer shall complete appendix No.2 of that specification.
- 27.2 The rating of the battery and charger to be installed in each substation shall be based on the burden of the equipment to be supplied.
- 27.3 The nominal voltage of the battery shall be 110V.
- 27.4 The batteries shall be of the nickel cadmium sealed type and shall comply with the requirements of CKS 455 if the capacity thereof is lower than 10 ampere hours otherwise they shall be of the non-sealed vented type.

**28.0 PROTECTION**

Drawing No. CEE-TBB-109 shows the principal protection requirements for a substation and must be read in conjunction with the following specific requirements.

28.1 Separate current transformers shall be provided for main and back-up protection on all 25kV track feeder circuit breakers.

**28.2 PRIMARY CIRCUIT BREAKER TRIPPING**

28.2.1 The following protection relays shall be provided and when operated shall cause the primary circuit breaker to trip and lockout: -

28.2.1.1 Buchholz.

28.2.1.2 Restricted earth fault on both primary and secondary windings.

28.2.1.3 Transformer percentage biased differential.

28.2.1.4 Primary circuit breakers SF6 low gas.

28.2.1.5 Traction transformer pressure relief valve.

28.2.2 The following protection relays shall be provided and when operated shall cause the primary circuit breaker to trip only, allowing reclosure from remote.

28.2.2.1 Transformer winding and oil temperature.

28.2.2.2 Inverse Definite Minimum Time (IDMT) operated from transformer primary current.

28.2.2.3 Circuit breaker tripping supply undervoltage detection.

**28.3 SECONDARY CIRCUIT BREAKER TRIPPING**

28.3.1 Secondary circuit breaker protection relays shall be circuit specific:

28.3.2 The following protection relays shall be provided and when operated shall cause the secondary circuit breaker to trip only, allowing reclosure from remote.

**28.3.3 Incomer circuit breaker**

28.3.3.1 Inverse Definite Minimum Time (IDMT) overcurrent relay.

28.3.3.2 In the case of double unit substations feeding parallel fed sections, a reverse power relay which will operate in the event of the reverse flow of power.

**28.3.4 Track feeder circuit breaker**

28.3.4.1 Distance Impedance relay with directional mho characteristics suitable for electrified railway systems (GEC Alsthom Optimho relay). A track feeder circuit breaker will normally be the only feed into a section of railway line and will therefore not be required to discriminate with other track feeder circuit breakers. The relay shall provide for instantaneous tripping up to a relay setting equivalent to an overhead equipment impedance of 64 ohms at an angle of 65°. The relay characteristic shall be designed to discriminate between load and fault current conditions at high impedance settings.

28.3.4.2 Thermal overload relay to match the thermal characteristics of the overhead equipment which permits a continuous current of 780A, 950A for 5 minutes and 1 720A for 1 minute.

28.3.4.3 Single shot auto reclose relay with dead time and reclaim time independently adjustable from 5 to a total of 25 seconds. An operations counter shall be provided. The auto reclose sequence shall only be initiated by the impedance distance protection relay

28.3.4.4 Low SF6 Gas pressure detection.

**28.4 AUXILIARY TRANSFORMER PROTECTION**

Each 16KVA auxiliary transformer shall be provided with a 1 Amp dropout fuse in the primary supply conductor.

**28.5 RELAYS AND CIRCUITRY PROTECTION**

- 28.5.1 All circuits supplied by the auxiliary transformers shall be protected by an earth leakage relay.
- 28.5.2 All circuits, regardless of source of supply shall be protected by suitably rated miniature circuit breakers. (MCB's)
- 28.5.3 Due to the susceptibility of protection relays to damage due to poor quality of supply as well as lightning surges, the tenderer must state what measures will be implemented to safeguard this equipment.

**29.0 CONDUCTORS, CABLES, AND SMALL WIRING**

29.1 The following electrical conductors shall be used in the construction of a substation:

- |  |   |
|--|---|
| ◆ Primary (HT) flying busbar/jumper                            | 160 mm <sup>2</sup> Al (stranding 19/3.35)                          |
| ◆ Secondary (25kV) overhead conductors/jumpers                 | 500 mm <sup>2</sup> Al(stranding 37/4.25)                           |
| ◆ Earth mat  | 3x30 mm Cu strap (90 mm <sup>2</sup> )                              |
| ◆ Steelwork earth mat connections cast in concrete foundations | 95 mm <sup>2</sup> Cu equivalent ERICO cadstrap earth tails         |
| ◆ Earth connections from isolator earth blade to earth mat     | 95 mm <sup>2</sup> Cu equivalent ERICO cadstrap earth tails         |
| ◆ Earth connections from all lightning arresters to earth mat  | 150 mm <sup>2</sup> Al stranded insulated cable                     |
| ◆ Neutral return overhead conductor                            | 500 mm <sup>2</sup> Al (stranding 37/4.25)                          |
| ◆ Auxiliary transformer and VT neutral conductors              | 70 mm <sup>2</sup> stranded Cu unarmoured cable insulated for 3,3kV |
| ◆ Auxiliary transformer positive conductor                     | 50 mm <sup>2</sup> stranded annealed Cu                             |
| ◆ Earthing harness   | 95 mm <sup>2</sup> stranded annealed insulated conductor            |

29.2 The 25kV busbar shall be Aluminium and shall have a continuous rating of 1500A. Busbars shall comply with BS 159.

29.3 Outdoor high voltage conductors shall be of all aluminium composition. ACSR conductors are not acceptable.

29.4 All low voltage cables shall be 600/1 000 Volt PVC insulated sheathed in terms of specification SABS 150.

29.5 Cables for indoor use only may be unarmoured. Cables for outdoor use shall be armoured, and suitable for laying direct in the ground.

29.6 Small wiring and termination's shall comply with BS 162. The current ratings for the various sizes of conductors shall not be exceeded.

29.7 All instrument and control wiring shall be a minimum size of 2,5mm<sup>2</sup> cross-section with stranded copper conductors. Wires connected to the current transformers shall have a minimum cross-section of 4mm<sup>2</sup>.

**SECTION 3: - INSTALLATION OF EQUIPMENT****30.0 SUBSTATION SITES**

Details of substation site sizes and positions (orientation to track) are shown on substation layout drawings listed in Appendix 1.

**30.1 SITE PREPARATION**

All substation sites will be cleared i.e. shrubs, bush, stumps and debris shall be completely removed from the site. Trees shall be uprooted and removed.

**30.2 SITE LEVELS**

30.2.1 The site level shall be raised 500mm above the natural ground level.

30.2.2 The final level of the earthworks on site shall be at a cross fall of not less than 2% parallel to the shortest rectangular dimension of the site. The fall must be in the same direction as the prevailing fall of the natural ground level parallel to the shortest rectangular dimension.

30.2.3 The site must be flat.

**30.3 MATERIAL**

30.3.1 The in situ material may be used for the bottom layer in a cut to fill operation if the material can be compacted as per compaction requirements. Should this not be the case the material may not be used.

30.3.2 Material of quality G5 must be used for earthworks.

**30.4 COMPACTION**

30.4.1 The material shall be deposited in layers, not exceeding 300mm prior to compaction. Material shall be compacted to 95% Mod. AASHTO at OMC.

30.4.2 All substation sites shall be inspected and signed off by the Technical Officer prior to any construction taking place.

30.4.3 Each substation site shall be fenced by a stock/boundary fence as well as by a security fence in accordance with the fence lines shown on the substation layout drawings listed in Appendix No. 1.

30.4.4 The extent of kerbing to be installed at each substation site is shown on the substation layout drawings listed in Appendix No. 1.

30.4.5 The security fence and kerbing shall be installed in accordance with the drawing specified in Appendix 2 and shall not be installed prior to the installation of all steelwork and equipment and the making off of all overhead conductors. The technical Officer shall authorise the installation of the fencing and kerbing.

30.4.6 The stock/boundary fence shall be installed in accordance with Drawing No CCE Type 1-45. This installation shall occur simultaneously with the security fencing.

30.4.7 After completion of construction a suitable weedkiller to be approved by the Technical Officer shall be applied throughout the site within the boundaries of the small stock/boundary fence, in accordance with the manufacturers instructions. The successful tenderer shall exercise the greatest care to avoid contaminating private property.

30.4.8 After treatment with the weedkiller, a 100mm layer of 25mm crusher stone shall be laid over the whole area of the Spoornet yard (within the kerbing).



- 30.4.9 Access to the sites shall be by means of Spoornet maintenance roads. Should the tenderer feel that these roads are not adequate, a separate quotation for any work deemed necessary shall be submitted with the tender.
- 31.0 **FOUNDATIONS**
- 31.1 The successful tenderer shall be responsible for the design and installation of foundations for all the structures, equipment and buildings within the substation yard.
- 31.2 The successful tenderer shall carry out his own survey in regard to soil types and their load bearing capabilities.
- 31.3 Tenderers must ensure that provision (financial as well as time) for excavations in a range of soil types is allowed for in their tenders.
- 31.4 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.
- 31.5 All foundations edges shall be bevelled, and the surfaces must be float finished.
- 31.6 All support foundations shall be at the same level.
- 31.7 An earth mat conductor shall be cast in the concrete foundation for the connection of support steelwork to the earth mat. This shall be done in accordance with Drawing No. CEE-TEE-173 sht's 1-3.
- 31.8 This earth conductor shall be electrically connected to the foundation bolt group such that in the event of the visible earth connection being removed, a earth connection via the bolt group is maintained. This shall be done in accordance with Drawing No CEE-TEE-173 sht's 1-3.
- 31.9 A plastic pipe shall be cast into all concrete foundations for earth/control cabling to be taken up the structure and shall be done in accordance with Drawing No CEE-TEE-173 sht's 1-3.
- 31.10 If the foundation for the main traction transformer is larger than the transformer base plate, then a portion of the foundation the exact size of the base plate must be raised at least 50mm to prevent the possibility of standing water against the transformers base plate.
- 32.0 **CONCRETE**
- 32.1 The 28-day strength of all concrete used shall be a minimum of 20Mpa.
- 32.2 The successful tenderer shall arrange for sampling and testing of all concrete used, and shall submit full records to the Technical Officer. Spoornet reserves the right to undertake testing of concrete samples and the successful tenderer shall furnish test cubes if requested by the Technical Officer.
- 32.3 Hand mixed concrete is not acceptable, it must be mechanically mixed.
- 32.4 The addition of water to a concrete mix reduces the strength of that concrete very significantly and on no account shall water be added to a mix after test cubes have been taken.
- 32.5 There shall be a minimum of 100mm concrete cover for all steel reinforcing.

**33.0 INSTALLATION OF SUBSTATION EQUIPMENT**

33.1 The installation of the equipment required for the construction of the required substations will be carried out in accordance with the substation layout drawings listed in Appendix 1. These drawings will indicate the particular requirements for each substation.

33.3 All fasteners (nuts & bolts) shall be secured using flat as well as lock washers.

Requirements for the installation of substation equipment are as follows:

**33.4 PRIMARY ISOLATOR**

33.4.1 The primary supply conductors will be made off by the supply authority on a terminal structure which shall be supplied and installed by the successful tenderer. Tails and clamps for the connection of the primary supply to the primary isolator will be provided by the successful tenderer. These tails will probably be Wolf conductors, which must be confirmed by the Technical Officer.

33.4.2 The earth connection of the earthing blades shall be connected to the substation earth mat.

**33.5 MAIN TRANSFORMER**

33.5.1 The interface between the traction transformer plinth and the steel tank must be sealed using an outdoor UV resistant silicone sealer.

33.5.2 A 150mm diameter PVC pipe shall be cast into the transformer plinth to allow for the routing of control and protection cables. This pipe shall be installed based on the principles indicated on Drawing No. CEE-TEE-174 sht's 1-3. This pipe shall be positioned such that the cables enter the transformer control cable terminal box vertically.

33.5.3 The earth conductors connecting the transformer tank to the earth mat at two places shall be cast into the transformer plinth such that a minimum of the conductor is exposed, based on the principles indicated on Drawing No. CEE-TEE-174 sht's 1-3. This conductor must be cast into the plinth in such a manner as to prevent the conductor being damaged during the installation of the transformer.

33.5.4 The secondary transformer bushing that will be designated as the positive (25kV) bushing is the bushing on the left side of the transformer looking at the transformer from the secondary side.

33.5.5 The negative secondary bushing shall be connected to the substation earth mat via a lightning arrester rated at 3,3kV. The lightning arrester must be mounted on the transformer tank in close proximity to the negative bushing. The conductor to be used for this connection to the earth mat shall be similar to that specified for the earth connection of the primary isolator.

**33.6 VOLTAGE TRANSFORMER**

33.6.1 For secondary circuit breakers of the outdoor structure mounted type, the voltage transformers shall be mounted outdoors on the secondary switchgear gantry. (25kV gantry)

33.6.2 The live side of the primary winding shall be connected to the 25kV busbar.

33.6.3 The neutral side of the primary winding of each voltage transformer shall be connected to the overhead neutral return current conductor.

33.6.4 The secondary winding shall be connected to the appropriate circuits through MCB's.

**33.7 AUXILIARY TRANSFORMER**

- 33.7.1 The primary positive pole of the auxiliary transformer shall be connected on the traction transformer side of the secondary isolator and should a second auxiliary transformer connected to the 25kV supply be required, its primary positive pole shall be connected to the overhead track equipment on the load side of the track feeder switch (see Drawing No. CEE -TBB -109).
- 33.7.2 The auxiliary transformer connected to the main transformer side of the isolator shall be mounted on the 25kV gantry. It shall be mounted in such a manner as to allow space for the drop out fuse to be mounted and to function safely, above the auxiliary transformer.
- 33.7.3 The second 25kV auxiliary transformer (see schedule of requirements) shall be mounted on one leg of the overhead track equipment track switch structure. (see Drawing No. CEE-PFB-30 for typical mounting details)
- 33.7.4 The neutral of the primary winding of each 25kV Auxiliary transformer shall be connected to the overhead neutral return current conductor.
- 33.7.6 The secondary output of the auxiliary transformers shall be cabled to a distribution board in the substation building.

**33.8 SECONDARY ISOLATOR**

- 33.8.1 The secondary isolator shall be mounted on the 25kV gantry structure.

**33.9 SECONDARY CIRCUIT BREAKERS**

- 33.9.1 Secondary circuit breakers of the outdoor structure mounted type shall be mounted on the 25kV gantry structure.
- 33.9.2 The outdoor switchgear shall be mounted on suitably designed horizontal steel beams forming part of the 25kV gantry structure (see Drawing No's CEE-TDB-41 sht's 1 & 2 )
- 33.9.3 The outdoor switchgear mounting arrangement shall allow for lateral and vertical adjustment to enable proper alignment of switchgear to take place.
- 33.9.4 The switchgear shall be mounted in such a manner as to allow an isolating gap of not less than 300mm between the circuit breaker terminals and the 25kV busbar should the jumper be removed.

**33.10 SECONDARY LIGHTNING ARRESTORS**

- 33.10.1 All secondary lightning arrestors shall be mounted on the 25kV gantry and shall be connected in the circuit in accordance with Drawing No. CEE-TBB-109.
- 33.10.2 The earth connection of all the secondary lightning arrestors shall be connected to the substation earth mat by means of the specified earthing conductor.

**33.11 25kV BUSBAR**

- 33.11.1 For secondary circuit breakers of the outdoor structure mounted type, the 25kV aluminium busbar shall be mounted between the two vertical legs of the 25kV gantry in such a manner as to allow for a isolating gap of 300mm between the busbar and the terminals of the secondary circuit breakers should the jumper be removed.

**33.12 BUSBAR COUPLER (DOUBLE UNIT TRACTION SUBSTATIONS)**

- 33.12.1 For secondary circuit breakers of the outdoor structure mounted type the busbar coupler shall be mounted on the 25kV gantry structure as shown on Drawing No. CEE-TDB-41 sht 2.
- 33.12.2 The installation of the busbar coupler shall be done in accordance with specification No. CEE.0040.83.
- 33.12.3 The jumpers used to connect the busbar coupler switch to the two busbars shall be rated at 1500A.

**33.12 SUBSTATION BUILDING**

- 33.12.1 The substation steel building shall be bolted to the foundation plinth and sealed to prevent the ingress of vermin.
- 33.12.2 The orientation of the building to the site will be shown on the substation layout drawings.

**33.13 EQUIPMENT INSTALLED IN THE SUBSTATION BUILDING**

- 33.13.1 The layout of the equipment installed within the building shall be in accordance with Drawing No. CEE-TEC-28.
- 33.13.2 All equipment installed within the substation building shall be attached to either the floor or the walls.

**33.14 CABLES**

- 33.14.1 Cable trenches shall have a minimum depth of 500mm measured from ground level. All trenches shall be backfilled and compacted in layers to the compaction of the surrounding yard.
- 33.14.2 The exact position and size of each cable in the yard shall be shown on the cable layout plan. These drawings shall be submitted for approval prior to installation.
- 33.14.3 Asbestos-cement cable pipes shall be installed beneath any roadway, where the crossing of a roadway by cables is required. These pipes shall be not less than 150mm in diameter and shall protrude at least 500mm on either side of the roadway. The pipes shall be graded 1:400 for water drainage.
- 33.14.4 All cables entering the control equipment building shall be block jointed (50mm of armouring to be removed) above the ground. The block jointing shall be done before the cables are installed into the control equipment building. The block joint shall be covered by a heatshrink sleeve.
- 33.14.5 All cables shall terminate in compression type glands. These glands shall be fitted with neoprene shrouds.
- 33.14.6 Armoured cables terminating on outdoor equipment shall have their armouring connected to earthed metal by means of a suitable gland.
- 33.14.7 Cables and earthing conductors connected to equipment installed on steel support structures shall be supported on the steel structure vertically and horizontally by means of a cable tray. This cable tray shall be of the O-Line GS50 Gridspan Wire Mesh type or similar with the wire mesh having a diameter of 4mm and a hot dip galvanised finish.
- 33.14.8 The cable trays shall be attached to the support steel in accordance with Drawing No. CEE-TDC-10.
- 33.14.9 Should the cable termination box of an item of equipment overhang the vertical steel support structure, the cable can be installed directly from the cable trench to the terminal box provided a hot dip galvanised steel cable support is provided. This support must either be securely attached to the terminal box or be concreted into the ground. (see Drawing No. CEE-TDC-10)
- 33.14.10 Cable trays for indoor installation shall be galvanised type O-line PT38 or similar.
- 33.14.11 The cables shall be fixed to the cable trays using UV stabilised cable ties.

**33.15 INTERCONNECTION OF EQUIPMENT**

- 33.15.1 Conductors between separately mounted outdoor equipment shall incorporate a degree of flexibility to avoid any stressing of these connections due to foundation movement or conductor expansion/contraction and to facilitate alignment of equipment.
- 33.15.2 All connections to the overhead conductors shall be made using clamps that are specifically designed and manufactured to make that particular connection (ad hoc fabricated clamps are not acceptable).
- 33.15.3 High conductive silicon grease shall be liberally applied to all connections.
- 33.15.4 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).
- 33.15.5 All copper connections to steel (galvanised) shall be tinned.
- 33.15.6 The overhead neutral return conductor shall be insulated using disc insulators for 3,3kV.
- 33.15.7 The overhead track feeder conductors shall be provided between the 25kV gantry and the overhead track equipment portal structure.
- 33.15.8 The overhead track feeder conductors complete with insulation and fitted with suitable bi-metallic clamps for the connection of two 160 mm<sup>2</sup> Cu conductors (provided by others), shall be supplied and made off on the track switch portal by the contractor. Others shall do the connection of these conductors to the track switches. This forms the substation / overhead track equipment contract boundary.
- 33.16 **FENCING AND KERBING**
- 33.16.1 The boundary/stock fence, security fence and concrete kerbing shall only be installed once all major items of equipment and steelwork have been delivered and installed and all overhead conductor stringing is complete.
- 33.16.2 The extent of Boundary/stock fencing, security fencing as well as kerbing for each substation site is shown on the substation layout drawings listed in Appendix No. 1.
- 33.16.3 The security fence required shall be in accordance with the drawing as specified in Appendix 2.
- 33.16.4 Kerbing shall be installed in accordance with Drawing No. CEE-TEA-1.

**33.17 "RETURN" CURRENT AND SUBSTATION EARTHING****33.17.1 RETURN CURRENT**

33.17.1.1 It is required that the return current from the traction system shall not return to the main transformer via the substation earth. Therefore the principles set out below and indicated on Drawing No.CEE-TBD-8 shall be adhered to and adapted to suit the particular equipment offered.

33.17.1.2 An overhead return conductor shall be provided between one terminal of the main transformer secondary winding (negative bushing) and the overhead track equipment switch structure, where it will be connected to the overhead track equipment's return circuit by others. This conductor shall be insulated for at least 3,3kV.

**33.17.2 SUBSTATION EARTH**

33.17.2.1 A main earth mat shall be installed in Spornet's substation yard in accordance with Drawing No. CEE-TBD-8.

33.17.2.2 The earth mat shall be a trench earth system consisting of copper conductor with a cross sectional area of 90mm<sup>2</sup> buried in trenches at a depth of 700mm.

33.17.2.3 Should soil conditions be such that this depth can not practically be achieved, the reduced depth shall be approved by the Technical Officer. If the trench depth is below 600mm, precast concrete slabs shall be placed 100mm above the copper earth conductor in the trench and backfilled.

33.17.2.4 All earth mat joints shall be brazed or exothermically welded.

33.17.2.5 The earth mat connections to structural support steel as called for on drawing No. CEE-TBD-8 shall be made via the copper earth connection cast into the associated foundations. The earth mat shall be brazed to the tails protruding from the support foundations at a depth of 600mm.

33.17.2.6 The earth resistivity of the earth mat shall be less than 5 ohms.

33.17.2.7 A ring earth, not forming part of the floor, with a 90mm<sup>2</sup> copper cross-sectional area shall be provided in the substation building. This ring earth shall electrically connect all steel modules, which the building consists of.

33.17.2.8 The fences bordering the Spornet substation yard shall be bonded to the substation main earth mat as shown on Drawing No. CEE-TBD-8.

33.17.2.9 Substation equipment shall be connected to the earth mat in accordance with the requirements shown on Drawing No. CEE-TBD-8. The following connections shall also be connected to earth mat:-

- ◆ The earth connection of all lightning arresters
- ◆ The earth connections of the earth blades on the high voltage isolator.
- ◆ A suitable terminal to allow for the connection of the secondary switchgear earthing harness's to the earth mat.

33.17.2.10 A mast air terminal lightning protection system, hazard class A3, with an earth electrode separate from the substation earth mat shall be provided and positioned in accordance with SABS 03-1985 to provide lightning protection for the complete traction substation installation.

**33.17.3 EARTHING DEVICES**

- 33.17.3.1 Any device provided for earthing of equipment shall comprise PVC covered 65 sq. mm Cu conductors, link stick clamps to fit 500 sq. mm Al. Conductors similar to that shown on Sketch No. 2 at one end, and a clamp for clamping to the earth mat terminal at the other.
- 33.17.3.2 The clamps for the connection of the overhead feeder to the load side of the secondary switchgear, shall be designed such that a suitable attachment for the earthing harness is provided.
- 33.17.3.3 Portable earth connections adequately designed for safety in application shall be supplied. All portable earth harnesses shall be approved by the Technical officer.
- 33.17.3.4 In a single unit substation a portable earthing harness shall be provided for connecting all secondary switchgear outdoor bushing terminals simultaneously to the substation main earth mat.
- 33.17.3.5 In double unit substations two portable earthing harnesses as per the previous clause shall be provided.

**33.18 NAMEPLATES AND LABELS**

- 33.18.1 A substation nameplate shall be provided. The names of the substations shall be as specified in Appendix No. 1. The nameplate shall be manufactured in accordance with Drawing No. CEE-TEA-2.
- 33.18.2 Danger warning notices as per Drawing CEE TA-196 shall be supplied and fitted to the substation building access door, on each half of the substation gate, one notice on the narrow side substation fence and two notices on the long side substation fence.
- 33.18.3 All nameplates and labels shall be in English.
- 33.18.4 Labels shall be attached by screws or rivets or by a method approved by the Technical Officer.
- 33.18.5 All labels shall be made of composite sandwich type plastic material of the following colour combinations :-
- 33.18.6 Identification labels : White lettering on black background. Letters must be of sufficient size to be clearly legible.
- 33.18.7 Danger labels : White lettering on red background. Letters must be of sufficient size to be clearly legible.
- 33.18.8 The following is a list of approved labels.
  - ◆ On (I)
  - ◆ Off (O)
  - ◆ Open (Verb.)
  - ◆ Close (Verb.)
  - ◆ Closed
  - ◆ Open
  - ◆ Trip
  - ◆ Local
  - ◆ Remote
  - ◆ Do not operate link under load
  - ◆ Open and earthed
- 33.18.9 Each circuit breaker and circuit breaker control panel shall be provided with labels to indicate the breaker designation and telecontrol code. Spornet (Technical Officer) will supply these designations and telecontrol codes
- 33.18.10 The proposed labelling scheme must be submitted to the Technical Officer for approval prior to the manufacture of the labels.

**SECTION 4: - TESTING AND COMMISSIONING****34.0 TYPE AND ROUTINE TESTING REQUIREMENTS**

- 34.1 Type and routine tests shall be conducted on the equipment to be supplied. These tests shall be carried out at the successful tenderers expense.
- 34.2 Test certificates in respect of type tests conducted on identical equipment may be accepted in lieu of type tests at the discretion of Spornet.
- 34.3 Delivery of equipment shall not commence before acceptance of type test certificates has been obtained from the Technical Officer.
- 34.4 Primary circuit breakers shall be tested in accordance with BS 5311.
- 34.5 Secondary circuit breakers shall be tested in accordance with BS 5311.
- 34.6 Primary and secondary isolators and earthing switches shall be tested in accordance with IEC 129.
- 34.7 High voltage fuses for protection of auxiliary transformers shall be tested in accordance with BS 2692.
- 34.8 Voltage transformers shall be tested in accordance with BS 3941.
- 34.9 Auxiliary transformers shall be tested in accordance with SABS 780.
- 34.10 The transformer shall be tested in accordance with IEC 76, including a test with lightning impulse chopped on the tail.
- 34.11 Spornet staff will conduct an out of tank inspection of the transformer prior to the transformer being tanked as well as witnessing all the routine manufacturers tests carried out at the works. The co-ordination of manufacturers testing shall be the responsibility of the successful tenderer.
- 34.12 Type test certificates of the transformer design offered shall be submitted with the tender. Should type test certificates not be available, the required tests shall be carried out, the cost of which must be included in the tender price quoted as a separate item.
- 34.13 Should the transformer offered not have a short circuit type test certificate available, a simulated computer model of this test may be submitted for Spornet's approval, but should this model be unacceptable short circuit tests will be required and shall be conducted in accordance with IEC 76 Part 5 . An out of tank inspection shall be carried out after completion of the tests. The tests shall comprise two short circuits on each of the extreme and centre tapplings. The short circuits on each tapping shall be of opposite asymmetry. Short circuit duration shall not be less than 0,5 seconds. Short circuit current shall not be less than that calculated for a fault on the secondary terminals of the transformer with rated voltage on the primary terminals from a supply of not less than 2 500MVA
- 34.14 The successful tenderer shall test all concrete used for the construction of the works and the results submitted to the Technical Officer for approval.
- 34.15 The following equipment shall be inspected by Spornet staff at the place of manufacture prior to delivery to the successful tenderers works or to site:
- ◆ All structural steelwork
  - ◆ The substation building
  - ◆ Battery tripping unit
  - ◆ All control panels

**35.0 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.



**35.1 ON-SITE TESTS**

- 35.1.1 Functional on-site tests shall be conducted on all items of equipment and circuitry to prove the proper functioning and installation thereof.
- 35.1.2 The successful tenderer shall submit a detailed list of on-site tests for the approval of the Technical Officer at least six weeks before tests are due to commence at the first substation.
- 35.1.3 The successful tenderer shall arrange for the Technical Officer or his representative to be present to witness the on-site tests at each substation.
- 35.1.4 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 substation equipment will not be allowed to take place in a construction site environment.
- 35.1.5 On-site tests shall include the following ;
- ◆ Polarity tests on all VT's and CT's
  - ◆ Ratio tests on all VT's and 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.
  - ◆ A power frequency voltage test on all 25kV equipment at 57kV for one minute.
  - ◆ A power frequency voltage test on all small wiring at 2kV for one minute.
  - ◆ A millivolt-drop test on 25kV circuits with a current of not less than 200A.
  - ◆ A proof of vacuum test on vacuum circuit breakers.
  - ◆ Tests on primary circuit breakers and other primary equipment in accordance with manufacturer's instructions.
- 35.1.6 At the completion of the on-site tests the Technical Officer 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.
- 35.1.7 Upon rectification of defects the successful tenderer shall arrange for the Technical Officer or his representative to certify satisfactory completion of on-site tests for that particular substation.
- 35.1.8 Acceptance by the Technical Officer 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.

**35.2 COMMISSIONING OF EQUIPMENT**

- 35.2.1 Commissioning will include the energising of equipment from the primary isolator to the track feeder circuits. The successful tenderer must prove the satisfactory operation of all equipment under live conditions .
- 35.2.2 On completion of commissioning the successful tenderer will hand the substation over to the Technical Officer in terms of the relevant instructions.
- 35.2.3 Tenderers shall allow a period of at least three days per substation between satisfactory completion of on-site tests and commissioning of equipment.
- 35.2.4 During this period the Spoornet's Test staff will test the operation of all protective relays and circuits and set the protection relays at each substation.
- 35.2.5 The successful tenderer installation staff shall be present during the testing and setting of the protection to rectify any faults found.
- 35.2.6 On-site testing of the first substation must therefore commence ahead of the contract completion date, by a period not shorter than a total of three days per substation.
- 35.2.7 The commissioning of the protection equipment by Spoornet 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.
- 35.2.8 The commissioning dates for the substations will be dependent on the availability of power supplies from the supply utility as well as Spoornet's electrification program and will be defined by the Technical Officer.

**36.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS**

Drawings, instruction manuals and spare parts catalogues shall be supplied in accordance with Spoornet specification CEE.0224.94

**36.1 DRAWINGS**

- 36.1.1 All as built drawings shall be supplied in electronic format. (Microstation/Acad)
- 36.1.2 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.
- 36.1.3 The following drawings are required for approval prior to construction and submission in as built form at the completion of the works:
- ◆ Electrical schematic diagrams
  - ◆ Detailed electrical wiring diagrams
  - ◆ Foundation design drawings (for all foundations)
  - ◆ Structural support steelwork design drawings
  - ◆ Site equipment layout plan showing equipment and conductor profiles.
  - ◆ Earth mat layout plan showing position of buried conductors.
  - ◆ Buried cable layout plan showing position of buried cables.
  - ◆ Substation control equipment building plans.
- 36.1.4 A complete set (paper copies bound in book form) of the electrical schematic and detailed wiring diagrams shall be provided for each substation and shall be in the substation at the commissioning stage.

**36.2 INSTRUCTION MANUALS**

The tenderer shall supply three copies of an instruction/maintenance manual for each unique installation. (if a number of substations are of the same design only three copies of the manual will be required with the names of all the substations to which the manual applies to clearly indicated on the cover)

**36.3 SPARES LISTS**

36.3.1 The successful tenderer shall submit details of spares required in accordance with specification No. CEE.0224.94

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

36.3.3 Tenderers shall however include in their offers, separate quotes for the supply of certain major items of equipment as strategic spares. Individual prices shall be given for one of each of the following items:

- ◆ 20MVA traction transformer complete
- ◆ HT traction transformer bushing
- ◆ LT traction transformer bushing
- ◆ HT primary circuit breaker complete with operating mechanism
- ◆ 25kV secondary circuit breaker complete with operating mechanism
- ◆ 27,5kV/240V 16kVA auxiliary transformer
- ◆ 26,4kV/110V Voltage Transformer

**37.0 SPECIAL TOOLS AND/OR SERVICING AIDS**

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

37.2 The tenderer shall quote for the supply of SF6 gas filling equipment as well as a distance impedance relay test set.

37.3 Tenderers shall submit detailed offers for special tools and servicing aids including all specialised equipment required for the servicing and maintenance of SF6 and vacuum circuit breakers, distance impedance relay calibration and testing equipment.

**38.0 TRAINING**

The tenderer shall submit details with the tender of the training courses which will be conducted by the successful tenderer for the training of Spoornet maintenance staff in the operation and maintenance of the substation equipment with emphasis on the protection scheme. The courses shall include theoretical as well as practical tuition. The dates and venue of these training course shall be arranged with the Technical Officer.

**39.0 GUARANTEE AND DEFECTS**

39.1 The successful tenderer shall guarantee the satisfactory operation of the complete electrical installation supplied and erected by him and accept liability for makers defects which may appear in design, materials and workmanship.

- 39.2 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 substation is handed over to Spoornet whichever is the later, or
  - ◆ A period of 12 months commencing on the date of commissioning of the last substation, whichever is the later date.
- 39.3 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 Technical Officer and at the cost of the successful tenderer.
- 39.4 If urgent repairs have to be carried out by Spoornet staff to maintain supply during the guarantee period the successful tenderer shall inspect such repairs to ensure that the guarantee period is not affected and should such repairs be covered by the guarantee, reimburse Spoornet the cost of material and labour.

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## APPENDIX 1

## SUBSTATION SITES (NAMES AND LOCATIONS) AND DEGREE OF POLLUTION

<u>SUBSTATION SITE NO.</u>	<u>SUBSTATION NAME</u>	<u>X-AXIS KM POSITION</u>	<u>LAYOUT PLAN DRAWING No.</u>
1	ANTRA	2.543km	CEE-TEB-177

Degree of pollution - Specify the pollution level applicable to each site. Most sites will have the same degree of pollution (average polluted area), with traction substations at the coast or in industrial areas being defined as severely polluted areas.

The X-axis km position is the position on the track to which the X-axis indicated on the layout drawing for a traction substation site must be aligned to.

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## SCHEDULE OF REQUIREMENTS FOR AC TRACTION SUBSTATIONS

- 1.0 The Number of substations required and their Primary voltage must be specified.
- 1.1 The specific requirements for each traction substation must be specified eg. (No. of breakers, what type of security fence is required, extent of security fencing and kerbing, any special design considerations etc.)
- 1.2 The following table must be completed quantifying the major items of equipment required at each traction substation.

P.I.	P.C.B.	M.T.	S.I.	I.F.	T.F.	B.C.	A.T.	V.T.
1	1	1	1	1	2	0	2	1

NOTE 1:

- P.I. Primary isolator.  
P.C.B. Primary circuit breaker.  
M.T. Main transformer.  
S.I. Secondary isolator.  
I.F. Incoming feeder.  
T.F. Track feeder.  
B.C. Bus coupler.  
A.T. Auxiliary transformer.  
V.T. Voltage transformer.

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## SCHEDULE OF DRAWINGS SUPPLIED BY SPOORNET

<u>DRAWING No.</u>	<u>TITLE</u>
CEE-TCA-92	Key box 25kV AC traction substation
CEE-TDB-41 sht 1	Double unit switch gantry 25kV AC traction substation
CEE-TDB-41 sht 2	Single unit switch gantry 25kV AC traction substation
CEE-TDC-10	Cable tray details in yard 25kV AC traction substation
CEE-TDF-15 sht 1	Substation security fence detail 25kV AC traction substation
CEE-TDF-15 sht 2	Gate detail for security fence 25kV AC traction substation
CEE-TDF-16	Substation Palisade fencing detail 25kV AC traction substation
CCE-TYPE 1-45	Boundary / stock fencing
CEE-TEA-1	Kerbing for substation 25kV AC traction substation
CEE-TEA-2	Traction substation nameboard
CEE-TEB-177	Antra substation yard layout - 25kV AC traction substation
CEE-TEB-178	Intshamanzi substation yard layout - 25kV AC traction substation
CEE-TEB-179	Nseleni substation yard layout - 25kV AC traction substation
CEE-TEB-180	Ekupheleni substation yard layout - 25kV AC traction substation
CEE-TEE-173 sht 1	Pipe and earth details in small foundation 25kV AC traction substation
CEE-TEE-173 sht 2	Pipe and earth details in large foundation 25kV AC traction substation
CEE-TEE-173 sht 3	Pipe and earth details for transformer plinth 25kV AC traction substation
CEE-TEC-28	Substation building detail and layout 25kV AC traction substation
CEE-TBK-27	No volt coil for circuit breakers
CEE-TBB-109	Single line diagram and protection requirements 25kV AC traction substation
CEE-TBD-8	Earthing arrangement 25kV AC traction substation
CEE-TA-196	Sign warning, electric shock hazard 25kV AC traction substation
CEE-PFB-30	Typical mounting arrangement for Aux transformer on track structures
CCE-FG-263	Details of cables in Spoornet's formation

**SKETCHES**

The following sketches are part of this appendix and are referred to in the specification:

SKETCH No. 1	Structural steel support for CT's and LA's
SKETCH No. 2	Earth harness clamp