TRANSNET
freight rail

A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT SPECIFICATION

25KV AC TRACTION SUBSTATIONS

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SECTION 1: SUBSTATION DESIGN INFORMATION

1.0 SCOPE

1.1 This specification covers Transnet Freight Rail's requirements for the design, manufacture, testing, installation and commissioning of 25kV 50Hertz AC single phase traction substations. Traction substations are required for feeding the overhead track equipment of the Transnet Freight Rail's AC traction system. Adjoining the Transnet Freight Rail 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 APPENDICES

2.1 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 Transnet Freight Rail.

3.0 STANDARDS

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

The following publications are referred to in this specification:

3.2 BRITISH STANDARDS INSTITUTION

BS 159:	High Voltage Busbars and Busbar Connections.
BS 50522:	Earthing of power installations exceeding 1kV A.C.
BS EN 10029:	Hot-rolled steel Plates 3mm thick or above Tolerances on Dimensions and Shape.

3.3 INTERNATIONAL ELECTROTECHNICAL COMMISIION

IEC 60051-1:	Direct acting indicating analogue electrical measuring instruments and their accessories - Part 1: Definitions and general requirements common to all parts.

3.4 SOUTH AFRICAN NATIONAL STANDARDS

SANS 121:	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods.
SANS 32:	Internal and/or external protective coatings for steel tubes - Specification for hot dip galvanized coatings applied in automatic plants.
SANS 156:	Moulded Case Circuit Breakers.
SANS 555:	Insulating Oil for Transformers and Switchgear.
SANS 780:	Distribution Transformers.
SANS 1019:	Standard Voltages, Currents and Insulation Levels for Electricity Supply.
SANS 1091:	National Colour Standards for Paint.

SANS 1507:	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V).
SANS 1574:	Electric flexible cables with solid extruded dielectric insulation.
SANS 10142:	The Wiring of Premises. Part 1: low–voltage installations.
SANS 10313:	Protection against lightning - Physical damage to structures and life hazard.
SANS 60099-4:	Surge arresters part 4: Metal oxide surge arresters without gaps for AC systems.
SANS 60137:	Insulated Bushings for Alternating Voltages above 1000 Volts.
SANS 60282-1:	High Voltage Fuses. Part 1: Current Limiting Fuses.
SANS 60529:	Degrees of protection provided by enclosures. (IP Code).
SANS 60730-2-6:	Automatic electrical controls for household and similar use Part 2-6: Particular requirements for automatic electrical pressure sensing controls including mechanical requirements.
SANS 61936-1:	Power installation exceeding 1kV AC – Part 1: Common rules.
SANS 62271-100:	High voltage switchgear and control gear. Part 100 - High Voltage Alternating Current Circuit Breakers.
SANS 62271-102:	High voltage switchgear and control gear. Part 102- Alternating Current Disconnectors and Earthing Switches.
SANS 62271-200:	AC metal enclosed switchgear and control gear for rated voltages above 1kV and up to and including 52kV.

3.5 TRANSNET FREIGHT RAIL

BBB0845:	Requirements for metal oxide surge arresters in accordance with SANS 60099-4.
BBB0937:	Requirements for Post Type Current Transformers for Traction and Distribution Substations.
BBB1267:	Specification for Outdoor High Voltage Alternating Current Circuit Breaker in Accordance with SANS 62271-100.
BBB4182:	Indoor, Medium voltage metal enclosed switchgear and control gear in accordance with IEC 62271 – 200.
BBB7842:	Outdoor, High Voltage, Alternating Current Disconnectors combined with earthing switch.
BBB8204:	Medium Voltage Distribution and Supply Transformers in accordance with SANS 780.
BBG2415:	25kV AC single phase 20MVA transformer.
BBG5003:	Distance protection relay for single phase AC systems.
BBG5882:	Voltage Transformers used for protection and metering.
CEE0040:	Manual or Motor Operated 25kV Track Sectioning Switches.
CEE0045:	Painting of Steel Components of Electrical Equipment.
CEE0085:	Self Contained Battery and Battery Charger Units.
CEE0224:	Drawings, Catalogues, Instruction Manuals and Spares.

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 cannot be closed until certain conditions return to normal. (Thermal protection, under-voltage 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 "Senior Engineer" is the person appointed by Transnet Freight Rail to manage and administer the contract works.

5.0 TENDERING PROCEDURE

5.1 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.

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

5.3 Equipment type test certificates shall be submitted with the tender. These shall be in English.

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

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

6.0 SERVICE CONDITIONS

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

6.1.1	Altitude:	0 to 1800m above sea level
6.1.2	Relative humidity:	10% to 90%
6.1.3	Ambient temperature range:	- 10°C to + 55°C
6.1.4	Level of pollution:	Heavily salted laden or polluted with smoke from industrial sources
6.1.5	Lightning conditions:	20 ground flashes/km^2/annum

7.0 GENERAL REQUIREMENTS

7.1 The primary supply voltage shall be as specified in the schedule of requirements (Appendix 2).

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

7.3 Equipment specification deviations require a written approval from Transnet Freight Rail's Technology Management.

7.4 Transnet Freight Rail 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.

7.5 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.

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

7.7 Acceptance by the Transnet Freight Rail – Senior Engineer of the equipment / installation offered in no way relieves the successful tenderer of his obligation to fulfil his statement of compliance with the specification.

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

7.9 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.

7.10 All electrical and electronic equipment shall have a fail to safety feature.

8.0 INSULATION LEVELS

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

8.2 Secondary equipment at 25 kV (phase to earth) shall have a rated insulation level based on an equivalent 3 phase system with a highest voltage for equipment of 52 kV r.m.s, i.e., a rated lightning impulse withstand voltage of 250 kV peak, and a rated power frequency withstand voltage of 95 kV 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 table 1:

Table 1: Insulation Levels.

Nominal system voltage	66 kV	88 kV	132 kV	220 kV
Highest voltage for equipment	72,5 kV	100 kV	145 kV	245 kV
Rated lightning impulse withstand voltage	350 kV	450 kV	550 kV	850 kV
Rated power-frequency withstand voltage	140 kV	185 kV	230 kV	360 kV

9.0 CLEARANCES

9.1 Table 2 indicates the minimum earth clearances which shall be maintained between any conductor or metal normally alive and earthed metal.

Table 2: Earth Clearances

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

9.2 Table 3 indicates minimum safety clearances which shall be maintained between any conductor or metal normally alive and ground surface level.

Table 3: Minimum Safety Clearances

Nominal system voltage	25 kV	66 kV	88 kV	132 kV	220 kV
Within security fence	3400mm	3270mm	3500mm	3950mm	4350mm
Outside security fence but within Transnet Freight Rail's reserve	5400mm	5700mm	5900mm	6300mm	6700mm
Outside Transnet Freight Rail'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 SANS 60137.

10.2 Secondary equipment at 25 kV (phase to earth) shall have Creepage distances based on an equivalent 3 phase system with a highest voltage of the system of 52 kV r.m.s, i.e. 1200mm and 1 488mm for normal (25mm) and heavy polluted (31mm) areas respectively.

10.3 Primary equipment (voltages phase to phase) shall have Creepage distances based on an equivalent 3 phase system in accordance with table 4.

Table 4: Creepage Distances

Nominal system voltage	66 kV	88 kV	132 kV	220 kV
Highest voltage for equipment	72,5 kV	100 kV	145 kV	245 kV
Normal or light pollution	1160mm	1600mm	2320mm	3920mm
Heavy Pollution	1812mm	2500mm	3625mm	6125mm

10.4 Unless an equipment specification specifies a Creepage distance, table 4 shall be used with the information provided in Appendix 1.

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 according to SANS 121 and SANS 32.

11.1.2 Steelwork for outdoor installation in coastal areas, i.e., within 20km of the sea, shall first be hot-dip galvanised to SANS 121, followed immediately at the galvanising plant by the application of the Sterling paint system in accordance with specification CEE0045.

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 CEE0045.

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 CEE0045 shall be applied.

11.3.3 The following table specifies the colours in accordance with SANS 1091 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

12.1 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.

12.2 PRIMARY DISCONNECTOR

12.2.1 It shall not be possible to operate the primary disconnector unless the primary circuit breaker is open.

12.2.2 It shall not be possible to earth the load side of the primary disconnector before the isolator blades are completely open.

12.2.3 With the disconnector in the open position it shall be possible to operate the primary circuit breaker for test purposes.

12.3 PRIMARY CIRCUIT BREAKERS

12.3.1 The primary circuit breaker shall trip and remain open for the following events:

12.3.1.1 Inverse Definite Minimum time operation (Primary).

12.3.1.2 Instantaneous overcurrent operation.

12.3.1.3 Transformer winding and oil temperature (85^0C and 95^0C).

12.3.1.4 Phase Under voltage and Overvoltage.

12.3.1.5 Utility No-Volt protection.

12.3.2 The primary circuit breaker shall trip and lockout for the following events:

12.3.2.1 When the SF6 gas pressure falls to the first warning pressure value (before it reaches the safe operational threshold) and circuit breaker or Circuit breaker health operation.

12.3.2.2 Transformer Buccholz first operation.

12.3.2.3 Transformer restricted earth fault.

12.3.2.4 Transformer biased differential.

12.4 SECONDARY DISCONNECTOR (25kV)

12.4.1 It shall not be possible to operate the secondary disconnector unless the 25kV Incomer circuit breaker is open.

12.4.2 With the disconnector in the open position it shall be possible to operate 25kV Incomer circuit breaker for test purposes.

12.5 SECONDARY CIRCUIT BREAKERS (25kV)

12.5.1 **INCOMER CIRCUIT BREAKER**

12.5.2 The 25kV Incomer shall trip and remain open for the following events:

12.5.2.1 Circuit breaker health failure.

12.5.2.2 Inverse Definite Minimum time operation (Secondary overcurrent).

12.5.2.3 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.

12.5.2.4 The incomer will trip and remain open, in the event of reverse current flow operation.

12.5.3 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.

12.5.4 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.

12.5.5 **TRACK FEEDER CIRCUIT BREAKERS**

12.5.6 The track feeder circuit breakers shall trip and remain open for the following events:

12.5.6.1 Circuit breaker health failure.

12.5.6.2 Operation of the thermal overload relay. The breaker shall trip and remain open (operational inhibit) until the relay resets.

12.5.6.3 Impedance distance protection operation. The breaker shall trip and the two shots 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)

12.5.6.4 When local operation of a circuit breaker is selected any auto reclose feature provided shall be rendered inoperative.

12.5.6.5 The health of the feeder protection relay shall trip and lockout the circuit breaker.

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 EN 10029.

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 SANS 121.

13.5 A lattice type steel gantry (25 kV gantry) shall be provided on which for secondary circuit breakers of the outdoor structure mounted type the following items of equipment shall be mounted:

- 25 kV disconnector
- 25 kV 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 (500mm^2 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 in drawing CEE TBB 109 (Appendix 3).

13.7 Support steel structures for the following equipment shall be provided:

- High voltage double pole disconnector.
- High voltage lightning arrestors.
- Primary circuit breaker.
- High voltage Current Transformer.

13.8 The manufacture of any steelwork shall not take place prior to the approval by the Technical Officer of the design drawings. All steelwork shall be approved by a structural Engineer.

13.9 Transnet Freight Rail shall inspect the steelwork at the manufacturers works prior to dispatch.

14.0 PRIMARY AND SECONDARY DISCONNECTORS

14.1 Disconnectors and earthing switches shall comply with the requirements of Transnet Freight Rail's specification BBB7842.

14.2 Disconnectors 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 disconnector shall be of the double pole type.

14.4 The secondary disconnector shall be of the single pole type.

14.5 Interlocking shall be provided on the primary disconnector to ensure that the disconnector can only be opened with the primary circuit breaker in the open position.

14.6 Interlocking shall be provided on the secondary disconnector to ensure that the disconnector can only be opened with the incomer circuit breaker in the open position.

14.7 The primary disconnector shall be provided with means to earth the load side of the disconnector when in the open position.

14.8 The disconnector shall be rated to suit the associated equipment.

14.9 Tenderers shall provide details of the disconnector offered and the proposed method of interlocking.

15.0 SURGE ARRESTERS

15.1 All surge arresters shall be of the substation class and shall comply with the requirements of Transnet Freight Rail's specification no. BBB0845.

15.2 All surge arresters shall have a long duration discharge, which shall be class 2.

15.3 Surge arresters shall be connected to each phase of the incoming primary supply. The supply system may be considered to be effectively earthed.

15.4 Surge arresters rated for 44kV r.m.s shall be provided for connection to each 25 kV circuit feeding the overhead track equipment.

15.5 All surge arresters earth lug shall be connected to the substation main earth mat by means of the specified conductor.

16.0 PRIMARY CIRCUIT BREAKERS

16.1 Primary circuit breakers shall be of the SF6, gas filled type. Circuit breakers shall comply with Transnet Freight Rail's specification no. BBB1267.

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 electrical substation equipment.

16.4 The rated short-circuit breaking current shall be at least 16 kA.

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.

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).

16.14.1 Provision shall be made that when the circuit breaker is switched to the local position, the protection trip circuitry from the control panels to the circuit breaker shall not in any way be disconnected

16.15 Mechanical operation shall be provided on the circuit breaker for any closing or trip release which is normally electrical 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 below 70% of the nominal value.

16.18 A counter shall be provided on the control panel to indicate the number of operations initiated by the protection scheme. In the event of Vacuum Circuit Breakers (VCB) the counter maybe part of the outdoor control equipment.

16.19 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 design shall be in accordance with Transnet Freight Rail's specification BBG2415.

17.1.2 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 tapings.
- Location of tapings.
- In addition to the above any information relating to reliability and in-service performance should be submitted in support of the above.

18.0 CURRENT TRANSFORMERS

18.1 Current transformers shall be of the bar-primary type and comply with Transnet Freight Rail's specification no. BBB0937. Ratings, ratios and class of accuracy shall be determined by the protection scheme as shown on drawing No. CEE-TBB-109. Current transformer shall have a protection and metering coils. A margin of 5 VA shall be provided for testing purposes.

18.2 If the primary supply voltage is 88 kV and below, then the current transformers for main transformer protection maybe installed in the transformer bushings. If the primary supply voltage exceeds 88 kV 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 25 kV 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 these purposes.

19.0 VOLTAGE TRANSFORMERS

19.1 Voltage transformers shall be single phase and have a ratio of 26,4kV/110V. They shall be in accordance with Transnet freight rail's specification BBG5882. Voltage transformer shall be suitable for the measuring and protection purposes.

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, 27500V/240V single phase transformers mounted on the substation portal structure shall be provided by the successful tenderer.

20.2 The transformers shall comply with Transnet Freight Rail's specification no. BBB8204.

20.3 The transformers and the connected equipment shall be capable of operating satisfactorily for a supply voltage varying between 27,5kV and 22,5kV. 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 25 kV 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 – Appendix 2.

21.2 For secondary circuit breakers of the outdoor structure mounted type, the busbar coupler shall be a motor operated 25 kV AC track sectioning switch supplied in accordance with specification CEE.0040.

21.3 The track sectioning switch shall be rated at 1500 A and the operating voltage of the switch mechanism shall be 110 V DC.

22.0 SECONDARY CIRCUIT BREAKERS

GENERAL REQUIREMENTS

22.1 Secondary Circuit breakers shall be of the vacuum type. Circuit breakers shall comply with Transnet Freight Rail's specification no. BBB4182.

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 44 kV, and the system frequency is 50Hz.

22.6 The rated continuous current shall be at least 1200 A.

22.7 The rated short-circuited breaking current shall be 12 kA at a nominal voltage of 25 kV. In addition the circuit breaker shall be capable of interrupting 6 kA at a recovery voltage of 44 kV in the case where a short circuit between phases occurs.

22.8 Fault making current shall be 30 kA peak and at least 12 kA for 3 seconds.

22.9 Opening time on low impedance track faults including relay operating time shall not exceed 0,1 second, 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 110 V 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 15 A, 220 V AC socket outlet in accordance with SANS 10142.

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 condition.

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 spring 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 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 6 kA.
- Breaking 1500 A.

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 requirement.

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 1 000mm high.
- Tele-control 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. Another door is required at the end of the building which shall only be opened from inside the building. It must be located at the left end of the building from the main entrance door. This door will be used for maintenance purposes.

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 Transnet Freight Rail.

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 under floor trunking)

23.20 HEATING AND VENTILATION

23.20.1 A ventilation fan shall be provided in the substation control equipment building. The fan shall be capable of providing 20 air changes per hour.

23.20.2 Ventilators shall not be installed on the roof of the building.

23.20.3 The fan shall draw air from inside the building and blow to the outside through automatically closing shutter louvers.

23.20.4 Thermostatically controlled heaters shall be provided to prevent condensation within the building. Thermostats shall comply with SANS 60730-2-6.

23.20.5 Heaters shall be robust with elements completely enclosed in a metal tube.

23.20.6 Heaters shall be positioned and mounted in such a manner that they are not subject to damage during normal maintenance activities.

23.20.7 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 SANS 10142.

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 withdrawal 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 Transnet Freight Rail will arrange for the supply from a second auxiliary transformer to be connected to one of the 80A MCB'S.

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 SANS 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 220V, 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.

24.10 LIGHTING – Eco Friendly Lighting

24.10.1 Lighting points shall be provided in each building to provide a general level of illumination of 20 lux. Light fittings shall be of the Eco friendly fluorescent type e.g. LEDs.

24.10.2 Two outdoor Eco friendly 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.

24.10.3 Outdoor Eco friendly fluorescent 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 Senior Engineer.

25.0 REQUIREMENTS FOR TELECONTROL

25.1 Tele-control and telemetering equipment will be provided by Transnet Freight Rail.

25.2 The Tele-control equipment cabinet, the size of which is approx. 1600x800x800 (hwd), will be housed in the substation control equipment building. Transnet Freight Rail 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 Tele-control 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 Tele-control functions required on one side of this terminal strip. The successful tenderer shall supply and install the cable required to connect the Tele-control equipment cabinet (supplied by Transnet Freight Rail) 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 Tele-control equipment cabinet for connection by others.

25.4 The relay contacts provided in the Tele-control cabinet for remote operation of switchgear will have a maximum rating of 0.5 A at 110 V DC.

25.5 Indication for Tele-control 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 Tele-control 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 Tele-control terminal strip.

25.9 Tenderers shall state the type and suppliers of the transducers they intend using.

25.10 Any additional Tele-control 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 Tele-control commands, indications and alarms shall be submitted for approval by the Senior Engineer.

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 SANS 60529.

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 SANS 62271-100. 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 SANS 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. Conductor's 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.

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

26.2.15 Each protective element that causes the circuit breakers to trip shall be catered for (Buchholz, overload, SF6 low gas, distance protection etc.). The visual alarm shall continue until the indication alarm is accepted and reset.

26.2.16 No anti condensation heaters are required inside the panels.

26.2.17 Each panel shall have and 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 IEC 60051-1 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 – 30 kV
- Ammeters 0 - 1 500 A

26.3.4 A voltmeter shall be provided to indicate the voltage of each section of the 25 kV 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 110 V.

27.4 The batteries shall be of the nickel cadmium sealed type. The capacity should therefore not be less than 10 Ampere hours.

28.0 PROTECTION

Drawing no. CEE-TBB-109 shows the principle 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 25 kV 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 re-closure 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 under voltage and overvoltage detection.

28.2.2.4 Instantaneous overcurrent.

28.2.2.5 Utility No-Volt protection.

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 re-closure from remote.

28.3.3 Incomer circuit breaker

28.3.3.1 Inverse Definite Minimum Time (IDMT) overcurrent relay.

28.3.3.2 Instantaneous overcurrent.

28.3.3.3 All units shall be equipped with a reverse power relay.

28.3.4 Track feeder circuit breaker

28.3.4.1 Single phase Distance Impedance relay shall be in accordance with TFR specification BBG 5003. 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.

28.3.4.2 The thermal overload relay shall be as specified in BBG5003.

28.3.4.3 Auto reclose relay with dead time and reclaim time independently adjustable as per relay operation. An operations counter shall be provided. The auto reclose sequence shall only be initiated by the impedance distance protection relay as per BBG5003.

28.3.4.4 Circuit breaker health detection.

28.4 AUXILIARY TRANSFORMER PROTECTION

28.4.1 Each 16 KVA 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.

Table 5: Electrical conductors

Primary (HT) Flying jumper	160 mm^2 Al (stranding 19/3.35)
Secondary (25kV) overhead conductors/jumpers	500 mm^2 Al (stranding 37/4.25)
Earth Mat	3x30 mm Cu strap (90 mm^2)
Steelwork earth mat connections cast in concrete foundations	95 mm^2 Cu equivalent ERICO cadstrap earth tails or Copper weld.
Earth connections from isolator earth blade to earth mat	95 mm^2 Cu equivalent ERICO cadstrap earth tails or Copper weld
Earth connections from all lightning arrestors to earth mat	150 mm^2 Al stranded insulated cable
Neutral return overhead conductor	500 mm^2 Al (stranded 37/4.25)
Auxiliary transformer and VT's neutral conductors	70 mm^2 stranded Cu unarmoured cable insulated for 3.3kV
Auxiliary transformer positive conductor	50 mm^2 stranded annealed Cu
Earthing harness	95 mm^2 stranded annealed insulated conductor

29.2 The 25 kV busbar shall be Aluminium and shall have a continuous rating of 1500 A. 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 SANS 1507.

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 terminations shall comply with SANS 10142 and SANS 61936-1. 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 2.5 mm^2 cross-section with stranded copper conductors. Wires connected to the current transformers shall have a minimum cross-section of 4 mm^2.

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 500 mm 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 in accordance with SAPEM – standards chapter 4.

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 Senior Engineer 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 Senior Engineer 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 weed killer to be approved by the Senior Engineer 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 weed killer, a 100mm layer of 25mm crusher stone shall be laid over the whole area of the Transnet Freight Rail yard (within the kerbing).

30.4.9 Access to the sites shall be by means of Transnet Freight Rail 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/her 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, an 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 Senior Engineer. Transnet Freight Rail reserves the right to undertake testing of concrete samples and the successful tenderer shall furnish test cubes if requested by the Senior Engineer.

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 100 mm 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 Senior Engineer.

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 (25 kV) 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 directly to the substation earth mat. 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. (25 kV gantry)

33.6.2 The live side of the primary winding shall be connected to the 25 kV 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 25 kV 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 disconnector shall be mounted on the 25 kV 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 25 kV 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 25 kV 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 25 kV gantry structure.

33.9 SECONDARY CIRCUIT BREAKERS

33.9.1 Secondary circuit breakers of the outdoor structure mounted type shall be mounted on the 25 kV gantry structure.

33.9.2 The outdoor switchgear shall be mounted on suitably designed horizontal steel beams forming part of the 25 kV 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 300 mm between the circuit breaker terminals and the 25 kV busbar should the jumper be removed.

33.10 SECONDARY LIGHTNING ARRESTORS

33.10.1 All secondary lightning arrestors shall be mounted on the 25 kV 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 25 kV BUSBAR

33.11.1 For secondary circuit breakers of the outdoor structure mounted type, the 25 kV aluminium busbar shall be mounted between the two vertical legs of the 25 kV gantry in such a manner as to allow for a isolating gap of 300 mm 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 25 kV gantry structure as per drawing no. CEE-TDB-41 sht 1. The two additional isolation MOD's on a bus coupler shall be interlocked.

33.12.2 The installation of the busbar coupler shall be done in accordance with specification CEE.0040.

33.12.3 The jumpers used to connect the busbar coupler switch to the two busbars shall be rated at 1500 A.

33.13 SUBSTATION BUILDING

33.13.1 The substation steel building shall be bolted to the foundation plinth and sealed to prevent the ingress of vermin.

33.13.2 The orientation of the building to the site will be shown on the substation layout drawings.

33.14 EQUIPMENT INSTALLED IN THE SUBSTATION BUILDING

33.14.1 The layout of the equipment installed within the building shall be in accordance with Drawing No. CEE-TEC-28.

33.14.2 All equipment installed within the substation building shall be attached to either the floor or the walls.

33.15 CABLES

33.15.1 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.

33.15.2 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.

33.15.3 Asbestos free-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.

33.15.4 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.

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

33.15.6 Armoured cables terminating on outdoor equipment shall have their armouring connected to earthed metal by means of a suitable gland.

33.15.7 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.

33.15.8 The cable trays shall be attached to the support steel in accordance with drawing No. CEE - TDC-10.

33.15.9 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)

33.15.10 Cable trays for indoor installation shall be galvanised type O-line PT38 or similar.

33.15.11 The cables shall be fixed to the cable trays using UV stabilised cable ties.

33.16 INTERCONNECTION OF EQUIPMENT

33.16.1 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.

33.16.2 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).

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

33.16.4 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).

33.16.5 All copper connections to steel (galvanised) shall be tinned.

33.16.6 The overhead neutral return conductor shall be insulated using disc insulators for 3,3 kV.

33.16.7 The overhead track feeder conductors shall be provided between the 25 kV gantry and the overhead track equipment portal structure.

33.16.8 The overhead track feeder conductors complete with insulation and fitted with suitable bi-metallic clamps for the connection of two 160mm^2 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.

33.17 FENCING AND KERBING

33.17.1 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 conductors stringing is complete.

33.17.2 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.

33.17.3 The security fence required shall be in accordance with the drawing as specified in Appendix 2.

33.17.4 Kerbing shall be installed in accordance with Drawing No. CEE-TEA-1.

33.18 "RETURN" CURRENT AND SUBSTATION EARTHING

33.18.1 RETURN CURRENT

33.18.1.1 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.

33.18.1.2 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 3,3 kV.

33.18.2 SUBSTATION EARTH

33.18.2.1 A main earth mat shall be installed in Transnet Freight Rail's substation yard in accordance with Drawing No. CEE-TBD-8.

33.18.2.2 The earth mat shall be a trench earth system consisting of copper conductor with a cross sectional area of 90 mm^2 buried in trenches at a depth of 700mm.

33.18.2.3 Should soil conditions be such that this depth cannot practically be achieved, the reduced depth shall be approved by the Senior Engineer. If the trench depth is below 600mm, precast concrete slabs shall be placed 100mm above the copper earth conductor in the trench and backfilled.

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

33.18.2.5 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.

33.18.2.6 The earth resistivity of the earth mat shall be less than 5 Ω (ohms).

33.18.2.7 A ring earth, not forming part of the floor, with a 90mm^2 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.

33.18.2.8 The fences bordering the Transnet Freight Rail substation yard shall be bonded to the substation main earth mat as shown on Drawing No. CEE-TBD-8.

33.18.2.9 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.

33.18.3 EARTHING DEVICES

33.18.3.1 Any device provided for earthing of equipment shall comprise PVC covered 65mm^2 Cu conductors, link stick clamps to fit 500mm^2 Al. Conductors similar to that at one end, and a clamp for clamping to the earth mat terminal at the other.

33.18.3.2 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.

33.18.3.3 Portable earth connections adequately designed for safety in application shall be supplied. All portable earth harnesses shall be approved by the Senior Engineer.

33.18.3.4 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.

33.18.3.5 In double unit substations two portable earthing harnesses as per the previous clause shall be provided.

33.19 NAMEPLATES AND LABELS

33.19.1 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.

33.19.2 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.

33.19.3 All nameplates and labels shall be in English.

33.19.4 Labels shall be attached by screws or rivets or by a method approved by the Senior Engineer.

33.19.5 All labels shall be made of composite sandwich type plastic material of the following colour combinations: -

33.19.6 Identification labels: White lettering on black background. Letters must be of sufficient size to be clearly legible.

33.19.7 Danger labels: White lettering on red background. Letters must be of sufficient size to be clearly legible.

- On (I)
- Off (O)
- Open (Verb.)
- Close (Verb.)
- Closed
- Open
- Trip
- Local
- Remote
- Do not operate link under load
- Open and earthed

33.19.9 Each circuit breaker and circuit breaker control panel shall be provided with labels to indicate the breaker designation and tele-control code. Transnet Freight Rail (Senior Engineer) will supply these designations and tele-control codes

33.19.10 The proposed labelling scheme must be submitted to the Senior Engineer 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 Transnet Freight Rail.

34.3 Delivery of equipment shall not commence before acceptance of type test certificates has been obtained from the Senior Engineer.

34.4 Primary circuit breakers shall be tested in accordance with SANS 62271-100.

34.5 Secondary circuit breakers shall be tested in accordance with SANS 62271-200.

34.6 Primary and secondary disconnects and earthing switches shall be tested in accordance with SANS 62271-102.

34.7 High voltage fuses for protection of auxiliary transformers shall be tested in accordance with SANS 60282-1.

34.8 Voltage transformers shall be tested in accordance with SANS 60186.

34.9 Auxiliary transformers shall be tested in accordance with SANS 780.

34.10 The transformer shall be tested in accordance with SANS 60076-4, including a test with lightning impulse chopped on the tail.

34.11 Transnet Freight Rail 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 Transnet Freight Rail's approval, but should this model be unacceptable short circuit tests will be required and shall be conducted in accordance with Transnet specification BBG2415. 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 tapings. 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 2 500 MVA.

34.14 The successful tenderer shall test all concrete used for the construction of the works and the results submitted to the Senior Engineer for approval.

34.15 The following equipment shall be inspected by Transnet Freight Rail 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 Senior Engineer at least six weeks before tests are due to commence at the first substation.

35.1.3 The successful tenderer shall arrange for the Senior Engineer 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 25 kV equipment at 57 kV for one minute.

- A power frequency voltage test on all small wiring at 2 kV for one minute.
- Millivolt-drop test on 25 kV circuits with a current of not less than 200 A.
- 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 Senior Engineer or his representative, shall either sign the test sheets (supplied by the successful tenderer) as having witnessed the satisfactory completion thereof, or hand to the successful tenderer a list of defects requiring rectification.

35.1.7 Upon rectification of defects the successful tenderer shall arrange for the Senior Engineer or his representative to certify satisfactory completion of on-site tests for that particular substation.

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

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 Senior Engineer 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 Transnet Freight Rail'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 Transnet Freight Rail will in no way absolve the successful tenderer from any of his responsibilities during the guarantee period. It is the successful tenderers responsibility to satisfy himself/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.

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 Transnet Freight Rail's electrification program and will be defined by the Transnet Freight Rail Senior Engineer.

36.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS

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

36.1 DRAWINGS

36.1.1 All drawings shall be supplied in electronic format (Microstation/CAD)

36.1.2 All drawings (paper prints) shall be submitted to Transnet Freight Rail Senior Engineer for approval. No construction or manufacturing activity will be allowed prior to the associated drawings having been approved by the Senior Engineer.

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.

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
- 25 kV secondary circuit breaker complete with operating mechanism
- 27,5 kV/240 V, 16 kVA auxiliary transformer
- 26,4 kV/110 V 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 Transnet Freight Rail 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 courses shall be arranged with the Senior Engineer.

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: -

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

39.2.2 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 Senior Engineer and at the cost of the successful tenderer.

39.4 If urgent repairs have to be carried out by Transnet Freight Rail 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 Transnet Freight Rail the cost of material and labour.

40.0 APPENDIX 1

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

Substation Site No.	Substation Name	X-Axis KM Position	Layout Plan Drawing No.
1	Antra	2.543km	CEE-TEB-177

40.1.1 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.

40.1.2 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.

40.1.3 GPS coordinates – specify the position of where the substation will be located.

41.0 APPENDIX 2

SCHEDULE OF REQUIREMENTS FOR AC TRACTION SUBSTATIONS

41.1 Number of substations required and their primary voltage must be specified.

41.1.1 The specific requirements for each traction substation must be specified e.g. number of breakers, what type of security fence is required, extent of security fencing and kerbing, any special design considerations etc.

41.1.2 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	1	1

Table 1: Substation equipment

Note:
- 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

42.0 APPENDIX 3

SCHEDULE OF DRAWINGS SUPPLIED BY TRANSNET FREIGHT RAIL

DRAWING NO.	TITLE
CEE-TA-196:	Sign warning, electric shock hazard 25kV AC traction substation
CEE-TBB-109:	Single line diagram and protection requirements 25kV AC traction substation
CEE-TBD-8:	Earthing arrangement 25kV AC traction Substation
CEE-TBK-27:	No volt coil for circuit breakers
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
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 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-PFB-30:	Typical mounting arrangement for Auxiliary transformer on track structures
CCE-FG-263:	Details of cables in Transnet Freight Rail's formation
CCE-TYPE 1-45:	Boundary / stock fencing.