

# ANNEXURE A

Project specification: Upgrade of 11 kv Switch gear (VCB)

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**A DIVISION OF TRANSNET LIMITED**

**RAIL NETWORK**

**REQUEST FOR SERVICE**

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**SUPPLY AND INSTALL 11KV SWITCH GEAR  
FOR POLOKWANE DEPOT**

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## 1. SCOPE

This specification cover's TFR's requirements remove old 11kV RMU, supply and install of indoor three phase medium voltage metal enclosed switchgear and control gear.

The Contractor shall:

- 1.1.1. Dismantle, remove and transport old equipment from site to Polokwane Infra depot.
- 1.1.2. Supply and installed 11kV Switchgear
- 1.1.3. Testing and commissioning
- 1.1.4. Provide Catalogues, manuals and drawings.

## 2. EMPLOYERS OBJECTIVE

The Employer's current objective is to....

- 2.1 Perform switching for the contractor to work. No work shall be done in any substation without the presence of a Transnet representative
- 2.2. Supervision during the course of the project
- 2.3 Opening gates at the substations
- 2.4 To conduct alco blow testing every shift
- 2.5 Conducting an induction for the contractor before start
- 2.6 The contractor shall confirm the isolation and earthing applied as well as the work limits.

## 3. ACCESS TO THE AFFECTED PROPERTY

Site access certificate will be given by Technician

## 4. PROVISIONS

- 4.1. The *Contractor* provides: Contractor to come with their own tools or personnel.
- 4.2. The Contractor shall attend all site meetings convened by the Project Manager / Project Managers Deputy. Such meetings will be for the purpose of discussing progress, delays, Conditions, specifications, etc. The meeting will be held under the chairmanship of the Project Manager / Project Managers Deputy.

## 5. ENGINEERING AND DESIGN

### 5.1. CONTRACTOR'S DESIGN

The *Consultant's* design for the service is: Not applicable.

### 5.2. The *Contractor* supplies the following:

- Services Information.
- Technical specifications or reference thereto; **Refer to technical specification document.**
- Engineering Drawings appended herewith. **Refer to technical specification document.**

### 5.3. PARTS OF THE SERVICE WHICH THE *CONTRACTOR* IS TO DESIGN

The *Contractor* shall design 11kV Switchgear

## **6. PROCEDURE FOR THE SUBMISSION AND ACCEPTANCE OF CONTRACTOR'S DESIGN**

6.1. The *Contractor* shall address the following procedures:

- The *Contractor* submits, to the *Service Manager*, a drawing of the switch gear
- The *Contractor* submits detailed drawings to the *Service Manager*, indicating the height, length and width

6.2. The *Contractor* undertakes design safety as per standard, and best practice codes of Engineering.

### **6.3. REVIEW AND ACCEPTANCE OF CONTRACTOR'S DESIGN**

The *Contractor* submits documentation as the Service Information requires to the *Service Manager* for review and acceptance.

## **7. SERVICE**

TEMPORARY SERVICE, AFFECTED PROPERTY & CONSTRAINTS ON HOW THE *CONTRACTOR* PROVIDES THE SERVICE

### **7.1. AFFECTED PROPERTY ENTRY AND SECURITY CONTROL, PERMITS, AND AFFECTED PROPERTY REGULATIONS**

The *Contractor* complies with the Employer's Affected Property entry and security control, permits and Affected Property regulations.

- Work permits will be issued during the course of the project.
- A technician/electrician from Transnet Freight Rail will provide site access to the substations and will issue applicable work/ test permits to isolate and earth all equipment before handing it over to the contractor for installation and testing purposes.

**NB:** The *contractor* shall confirm the isolation and earthing applied, as well as the work permit limits.

7.2. No work shall be done in any substation without the presence of a Transnet Freight Rail representative

### **7.3. RESTRICTIONS TO ACCESS ON AFFECTED PROPERTY, ROADS, WALKWAYS AND BARRICADES:**

- 7.3.1.** The *contractor* is specifically excluded from entering the employer's operational areas which are adjacent to the affected property. the *contractor* plans and organises his work in such a manner so as to cause the least possible disruption to the employer's operations.
- 7.3.2.** The *contractor* ensures safe passage of his team, to traffic and around the affected property working areas at all times which includes providing flagmen.
- 7.3.3.** The *Contractor* ensures that any of his staff, labour and Equipment moving outside of his allocated Affected Property and Service Areas does not obstruct the operations of the..... To this end, access routes are allocated and coordinated by the *Service Manager*.
- 7.3.4.** All sites will be accessed through service roads; a 30km/h speed must be maintained on the service roads his allocated and fenced off working Area.
- 7.3.5.** All *Contractor's* staff and labour working within..... complies with Transnet Freight Rail (TFR) operational safety requirements and are equipped with all necessary personnel protective equipment (PPE).
- 7.3.6.** All sites will be accessed through service roads; a 30km/h speed must be maintained on the service

**7.4. People restrictions on Affected Property; hours of work, conduct and records:**

- The *Contractor* keeps daily records of his people engaged on the Affected Property with access to such daily records available for inspection by the *Service Manager* at all reasonable times.
- No one will be allowed on site without safety induction certificate.
- Working hours are from 08:00 to 15:30, Monday to Friday excluding public holidays.
- Alcohol/ substance abuse records will be kept in the safety file on site.
- No littering will be allowed on site

**7.4.1. The *Contractor* complies with the following requirements of the *Employer*:**

- Access to site will depend on the results of alcohol/ substance abuse test results.
- Access to site will depend on the relevant PPE for the service.
- No weapons will be allowed on site, Transnet Freight Rail reserves the right to search anyone/vehicle entering or leaving the site.
- No poaching will be allowed on site.
- No open fires will be allowed on site.
- No smoking will be allowed where work is performed.

**7.4.2. The *Contractor* complies with the following hours of work for his people (including Subcontractors) employed on the Site:**

- Working hours are from 08:00 to 15:30, Monday to Friday excluding public holidays.

**7.4.3. The *Contractor* shall keep daily records of his people engaged on the Site and Working Areas (including Subcontractors) with access to such daily records available for inspection by the *Project Manager* at all reasonable times.**

**7.5. Health and safety facilities on Site**

- The *Contractor* shall report all incidents in writing to the *Project Manager*. Any incident resulting in the death of or injury to any person on service shall be reported within 24 hours of its occurrence and any other incident shall be reported within 48 hours of its occurrence.
- The *Contractor* shall make necessary arrangements for a valid first aid kit, sanitation, water, and electricity at these relevant sites during the installation of the equipment.
- The *Contractor's* Health and Safety Programme shall be subject to agreement by the Transnet Freight Rail Nelspruit Safety Office, 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.
- 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 *Project Manager*.
- The *Contractor* shall comply with the current Specification for Service On, Over, Under or Adjacent to Railway Lines and near High Voltage Equipment – E7/2 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.

**7.6. Environmental controls, fauna & flora, dealing with objects of historical interest**

- No poaching will be allowed on site.
- No open fires will be allowed on site.
- No littering will be allowed on site.

**7.7. Title to Materials from demolition and excavation**

The *Contractor* does not advertise the contract or the project to any third party, nor communicate directly with the media (in any jurisdiction) whatsoever without the express written notification and consent of the *Project Manager*

**7.8. Contractor's Equipment**

The *contractor* shall be fully responsible for his or hired equipment, and No security will be provided to safeguard the equipment's. Therefore, the *contractor* must take all necessary equipment to a place of safety daily. And the contractor must be able to work within Transnet 11kV AC substation fixed equipment without causing any damages to the existing assets.

7.9. The *Contractor* keeps daily records of his Equipment used on Site and the Working Areas (distinguishing between owned and hired Equipment) with access to such daily records available for inspection by the *Project Manager* at all reasonable times.

7.10. The *Contractor* complies with the following permissions and restrictions in the use of Equipment as required by the *Employer*:

- Only authorised personnel must operate the equipment.
- Installation and dismantling must be done or supervised by qualified personnel

7.11. The *Employer* provides the following Equipment on the Site for the *Contractor's* use:

- Transnet Freight Rail will provide no equipment for *Contractor's* use.
- The *Contractor* shall make necessary arrangements for sanitation, water, waste disposal and electricity at these relevant sites during the process of the installation of the 11kV Switchgear
- *Contractor* shall provide everything else necessary for providing the Service.
- Site access certificate will be issued to the *contractor*, after safety induction.
- No TFR facilities will be given to the contractor for use.

7.12. Wherever the *Employer* provides facilities (including, *inter alia*, temporary power, water, waste disposal, telecommunications etc) for the *Contractor's* use within the Working Areas and the *Contractor* adapts such facilities for use, then the *Contractor* makes good and provides full reinstatement to the land (including all apparatus of the *Employer* and Others in, on or under the land) and surrounding areas to its original standard upon dismantling of such facilities and hand-back to the *Employer*.

**7.13. Facilities provided by the Contractor:**

- The *Contractor* shall make necessary arrangements for electricity at these relevant sites during the installation as well as for testing of equipment's/substation.
- No camps will be allowed within or next to TFR properties.

- 7.13.1. Wherever the *Contractor* provides facilities (either for his own or for the *Project Manager* and/or *Supervisor*) and all items of Equipment, involving, *inter alia*, offices, accommodation, laboratories, Materials storage, compound areas etc, within the Working Areas, then the *Contractor* must provide full reinstatement to the land (including all apparatus of the *Employer* and Others in, on or under the land) and surrounding areas to its original standard, upon dismantling of such facilities and items of Equipment.
- 7.13.2. Unless expressly stated as a responsibility of the *Employer* as stated under 5.1.11 Site services and facilities, all residual requirements for the provision of facilities and all items of Equipment necessary for the *Contractor* to Provide the *service* remains the responsibility of the *Contractor*.

**7.14. Excavations and associated water control**

- No deep excavations will be required on the sites

**7.15. Underground services, other existing services, cable and pipe trenches and covers**

- Control and earthing cables are located underground.

**7.16. Where the *Contractor* encounters existing, the *Contractor* undertakes the following:**

- No digging shall be done in the absence of TFR representative.

**7.17. Control of noise, dust, water and waste**

- Proper PPE shall always be worn on site.
- Refuse bags shall always be on site.

**7.18. The *Contractor* complies with the following:**

- Contractor shall issue the employees with correct PPE.
- Contractor shall issue refuse bags (No littering is allowed).

**7.19. Giving notice of work to be covered up through Site diary.**

7.19.1. The *Contractor* shall notify the *Supervisor* of the following elements of the *service* which are to be covered up:

- 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 *Project Manager* or *Supervisor* must countersign such delays. Other delays such as non-availability of equipment from 3rd party suppliers must be communicated to the *Project Manager* or *Supervisor* in writing

## 8. TECHNICAL SPECIFICATION

### 8.1. Technical data

**Panel type:** 1x2      **Switchgear:** VCB  
**System:** 11000 volts, 3 Phase, 50HZ, NEC/R Earthed  
**Fault level:** 20kA.  
**Phase sequence:** R-W-B Anticlockwise  
**Impulse level:** 95kVip  
**Insulation level:** 28kV.  
**Secondary wiring:** PVC coloured. **Labels:** W-B-W.  
**Finish:** Exterior- Housing & INSTR. **PNL.'s:** Light orange.  
**Shade:** B26. **Interior:** White- chassis  
**Finish:** Exterior- Doors & C.B Covers: Light orange. **Shade:** B26

### 8.2. Loose equipment to be included on the control panel (Switchgear).

- Touch-up paint
- Operating handle
- Racking handle
- Wear gauge
- 800A test probes
- 800A Earth device
- Carriage Ramp
- Tool Rack
- Insulation materials
- Frame leakage insulation
- 5m- Scafe pushbutton station

### 8.3. Switchgear foundations

- Floor to be level to within +/- 1mm over each m<sup>2</sup> the switchboard occupies and to within -2mm for C.B withdrawal.
- Commence installation from the centre panel, working outwards, each panel being aligned and levelled using shims, then bolted down and together.
- Alignment and levelling to apply to both axes, along the switchboard and from front to rear.
- As each panel is installed, the C.B should be racked into the housing to check for even clearances all round, and if not adjust the shims.
- Failure to comply with the above procedures could affect C.B operation and may invalidate the guarantee.



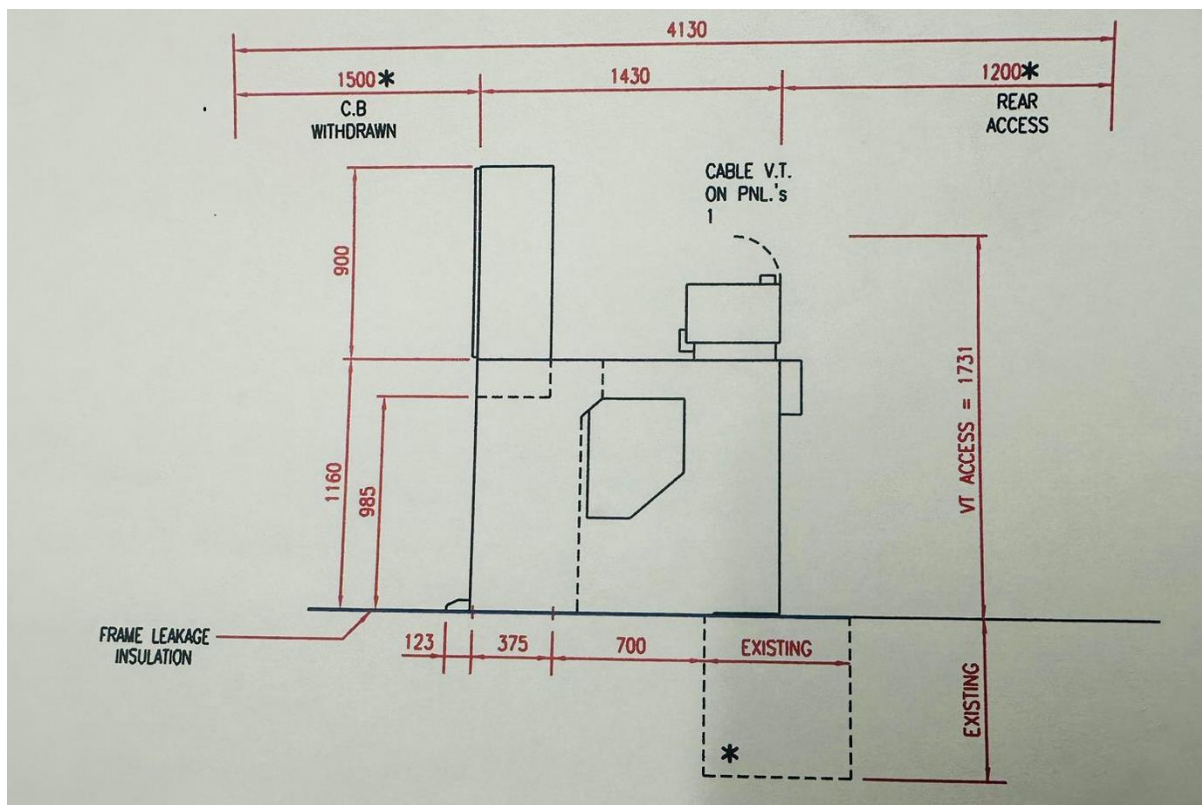
#### 8.4. Main board label

- Main board to be label-----Polokwane Stations, and Loco 11kV substation.
- Panel Reference-----Stations (8 &10), Loco (11 & 14)
- Circuit label----- All breakers (2+4+ transmission line)
- Panel function----- Transmission
- Busbar rating----- 800A (38 X 13 Cu)
- Circuit breaker rating----- 800A
- Mechanism type-----110V DC MWS
- Closing-----110V DC
- Tripping- shunt-----110V DC
- Integral earthing-----Cable
- Current transformer-----

Ratio (Protection+10A Test winding) Burden + Accuracy	3X20/5A
	15VA 10P10
Ratio (Metering+10A Test winding) Burden + Accuracy	3X20/5A
	10VA Class3

- Ammeter scale----- 3 x 0-20/24A
- Cable entry----- Bottom Entry
- Main cables details-----1x50mm<sup>2</sup> 3c XLPE
- Main cable termination----- Wood clamp
- Provide schematic diagram number.

## 9. SCHEMATIC DIAGRAM OF SWITCH GEAR



## 10. STANDARDS AND PUBLICATIONS

The latest version of the following publications and standards are referred herein.

### 10.1. INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

(The \* means, also SANS available)

IEC 60044-1\* Instrument transformer Part 1: Current Transformer

IEC 60044-2\* Instrument transformer Part 2: Inductive voltage transformer

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

IEC 60243-1 Electrical strength of insulating materials – Test methods – Part 1 Tests at power frequencies.

IEC 60255-5 Electrical Relays: Part 5: Insulation coordination for measuring relays and protection equipment – Requirements and tests

IEC 60282-1\* High-voltage – Current limiting fuses

IEC 60529\* Degrees of Protection provided by enclosures (IP code)

IEC 60947-5-1\* Low-voltage switchgear and control gear Part 5-1. Control circuit devices and switching elements. Electromechanical control circuit devices.

IEC 61000-4 Electromagnetic compatibility Part 4: - Testing and measuring techniques

IEC 62053-21 Electricity metering. Part 21

IEC 62271-100\* High Voltage alternating current (AC) circuit breaker.

IEC 62271-102\* Alternating current disconnectors and earthing switches.

IEC 62271-105\* Alternating current (AC) switch-fuse combinations.

IEC 62271-200\* AC metal enclosed switchgear and controlgear for rated voltages above 1kV and up to and including 52kV.

## 10.2. SOUTH AFRICAN SATNDARDS (SANS)

SANS 156 Moulded-case circuit breaker

SANS 1091 National colour standards for paint.

SANS 1274 Coatings applied by powder for paint.

SANS 1507 Electrical cables with extruded solid dielectric insulation for fixed installations. (300V/550V-1,900V/3,300V) Part 1: General

## 11. APPENDICES

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

11.1. Appendix 1: "Schedule of requirements" - to be filled in by Transnet Freight Rail (Client).

11.2. Appendix 2: "Technical Data Sheet" – to be furnish by tenders.

11.3. Appendix 3: "Tests conducted on the switchgear"

## 12. TENDERING PROCEDURE

12.1. Tenderers shall indicate clause by clause compliance with this specification. This shall take the form of a separate document listings all the specification clause numbers the individual statement of compliance or non-compliance.

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

12.3. Tenderers shall complete Appendix 2. "Technical Data Sheet".

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

12.5. Failure to comply with **clauses 6.1, 6.2, 6.3 and 6.4** could preclude a tender from consideration.

## 13. Service conditions

### 13.1. Atmospheric conditions

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

<b>Altitude</b>	: 0 to 1,8m above sea level
<b>Ambient temperature</b>	: -5°C to +55°C
<b>Relative Humidity</b>	: 10% to 90%
<b>Lightning Conditions</b>	: Up to 20 ground flashes per square kilometre per annum
<b>Pollution</b>	: Heavily salt laden or polluted with smoke from industrial sources.

## 14. Electrical conditions

The nominal operational conditions are specified in clauses 1.3, 4.1 and 6.0 of Appendix 1.

## 15. Mechanical conditions

The switchgear is installed in close proximity to railway tracks and be subjected to vibration.

## **16 General requirements of switchgear**

- 16.1. The switchgear and control gear shall be designed, manufactured and tested in accordance with IEC 622171-200.
- 16.2. The design of the equipment shall make provision for the safety of the persons concerned in the normal operation and maintenance of the equipment.
- 16.3. The equipment shall be capable to operate under full load and fault conditions.
- 16.4. It shall not be possible to manually operate the circuit breaker unless it is in the "service" or "earthed" position.
- 16.5. The switchgear and control gear shall be of the following:
  - Withdrawable vacuum interrupted switchgear and control gear.

## **17 Withdrawable vacuum interrupted switchgear**

- 17.1. It shall not be possible to rack in the circuit breaker unless the truck is properly located in the correct position.
- 17.2. Position indication shall be provided to mechanically / manually indicate the position of the withdrawable circuit breakers, disconnectors and earthing devices, and fuse combinations, i.e. racked-in, racked-out (isolated), earthed, on/off. The indication shall be readily visible from the front of each panel.
- 17.3. Shutters from free fall design shall be provided to cover the "Busbar" and "Circuit" high-voltage sockets into which the contacts of the circuit breaker engage. These shutters shall automatically cover the sockets with a positive action when the switchgear is withdrawn.
- 17.4. Facilities of independently padlocking each shutter in the closed position shall be provided.
- 17.5. Busbar shutters shall be red (colour A11 in SANS 1091) and shall be clearly marked "Busbars". The "Circuit"
- 17.6. The withdrawable circuit breaker shall be mounted on a transporting truck device, and fitted with wheels.
- 17.7. Flexible test rigs/cables shall be provided for testing the operation of the circuit breaker when fully withdrawn from the panels.

## **18. Switching devices: withdrawable**

### **18.1. General**

Switching device shall be ganged triple-pole construction.

- 18.1.1. Motors used for spring charging or other applications shall be protected by thermal overload and low voltage circuit protection.
- 18.1.2. Where motor driven operation is supplied, interlocking shall be provided to prevent three position switch-disconnectors from being switched from the closed position directly to the earthed position.
- 18.1.3. It shall be possible to manually charge the spring-operated mechanism.
- 18.1.4. A mechanical operated device shall indicate whether the spring is charged or free and this shall be visible without opening the operating cubicle doors.
- 18.1.5. The spring release coil shall be suitable for operation from the substation battery supply, which can vary from 80% to 120% of the stated nominal voltage.
- 18.1.6. It shall be possible to control the spring close/open mechanism from local/remote source depending on the position of the "local/remote" selector switch.
- 18.1.7. Tripping shall be by means of shunt trip coils.
- 18.1.8. A minimum of two normally open normally closed auxiliary contacts shall be provided on each switching device. The spare contacts shall be wired to a terminal strip in the panel. For withdrawable switchgear and control gear auxiliary plugs and sockets shall be used.
- 18.1.9. Each individual switching device panel shall be fitted with "close" and "open" controls.
- 18.1.10. Where "close" and "open" pushbuttons protrude to the outside of the panel they shall be shrouded.

### **18.2. Circuit breaker**

- 18.2.1. The circuit breaker shall be designed, manufactured and tested in accordance with IEC 62271-100.
- 18.2.2. Only Vacuum interrupters shall be used.

- 18.2.3. Circuit breakers shall be equipped with trip-free closing mechanisms. An electrical manual closing mechanism shall be provided for maintenance purposes.
- 18.2.4. Prestriking and chopping current shall be kept to a minimum. The tenderer shall give full details regarding these characteristics at the time of tendering.
- 18.2.5. The first pole clear factor shall be 1.5.
- 18.2.6. The making time shall not be greater than 100 milliseconds.
- 18.2.7. The breaking time shall not be greater than 40 milliseconds.
- 18.2.8. If a direct means of indicating contact wear and the necessity for replacement is not provided in withdrawable switchgear, a concise description of how this can be determined shall be provided on a label permanently fixed to the switchgear or switch panel.
- 18.2.9. Where remote pendant control system for the opening and closing of the circuit breaker is required, the design of the system shall be in conjunction with TFR staff.

### **18.3. Disconnectors (isolators) and earthing switches**

- 18.3.1. Disconnectors and earthing switches shall be designed, manufactured and tested in accordance with IEC 602271-102.
- 18.3.2. Earthing switches shall be of the fault make type.
- 18.3.3. The operation mechanism shall be positioned on the front of the panel and lockable in all switching positions.
- 18.3.4. The operation of the disconnectors shall be manually operated.
- 18.3.5. Reliable mechanical indication of these positions shall be visible from the front of the panel.
- 18.3.6. A notice with the following inscription shall be provided adjacent to the operating mechanism: -  
**“DO NOT OPERATE UNDER LOAD CONDITION”**

### **19.0. Protection system**

- 19.1. The protection relays shall be designed, manufactured and tested in accordance with IEC 602555.
- 19.2. The contractor shall be responsible for the design, supply and installation of the protection system. In the event of any discrepancies or disputes concerning the protection, Transnet freight Rail (TFR) reserves the right to final decision. TRF will provide the settings for the protection system.
- 19.3. The protection system shall be submitted to Transnet Freight Rail for approval.
- 19.4. Protection relays shall be supplied as specified in Appendix 1. (Protection schedule).
- 19.5. The protection relays shall be flush mounted and shall be contained in a dust-proof metal case. The degree of protection of the relay enclosure shall be IP 34 in accordance with IEC 60529.
- 19.6. The protection relays shall be capable of being reset without the necessity for opening the case.
- 19.7. It shall not be possible to operate any relay by hand to trip without opening the case.
- 19.8. The protection relays shall unless otherwise approved be provided with double contacts independent of each other, for controlling duplicate tripping circuits if necessary.
- 19.9. High speed tripping relays shall be self-latching and unless otherwise specified, the coil circuit shall be broken by self-contained contacts.
- 19.10. Relays used for master tripping shall be of the electromechanical type which can only be reset manually.
- 19.11. Protection relays used shall be continuously rated for the rated current setting.
- 19.12. The protection relays shall have reset flag indication on each element, save for fuse switch combination protective systems.
- 19.13. The relays shall have an additional set of normally open contacts for remote indication of the relay operation. These contacts shall be capable of handling 50W in the range of 24 to 110V DC and shall be wired to a terminal strip at the back of the panel.
- 19.14. The protection settings of the relays shall be menu driven and it shall be possible to manually program the protection relays from the front of the panel and by means of computer equipment if required.
- 19.15. Suitable surge protection shall be provided across the relay supply voltage to protect the electronic relays from incoming voltage transients. The surge protection shall be in accordance with BBD 7524.
- 19.16. Where multi-function, micro-processor protection relays are supplied they shall provide protection, measuring, supervisory and basic control functions.

19.17. It shall be possible to configure the relays for applications specific for TRF protection systems.

19.18. The relays shall comply with IEC 61000-4 for electrostatic discharge tests.

#### **User interface**

19.19. The user interface and menu shall be in English.

19.20. A display shall be provided for input data maintenance information and reporting functions.

19.21. Alarm indication shall be provided on the front cover of the relay.

#### **Data communication**

19.22. Where specified, data communication shall be possible between the protection relay(s) and remote transmission or supervisory equipment. SCADA (Supervisory and Data Acquisition) equipment.

19.23. Transnet Freight Rail shall be consulted for a decision on the compatibility of the protocol offered with the existing telecontrol system in the substations.

#### **Protection relays functionality**

The clauses below cover the requirements for multifunction or individual relays.

19.24. The protection relays shall function with one-Ampere or five-Ampere secondary (1:5) windings of current transformer or with Rogowski coil sensor in accordance with BBD 8946.

19.25. The relays shall be provided with self-monitoring "watchdog" facilities. Automatic tests shall be performed on start-up and on a cyclic self-monitoring process. Both software and hardware shall be monitored for errors.

19.26. Access to the relay settings shall be password protected to prevent casual access to the relay control.

### **20. Protection relays**

#### **20.1. Overcurrent and earth fault relays**

20.1.1. Inverse Definite Minimum Time (I.D.M.T) overcurrent and earth fault relays shall be of the microprocessor protection type having adjustable operating settings for standard, very or extreme inverse current/time characteristics. The relays shall incorporate an adjustable high-set element for definite time operation.

20.1.2. The relay must be set in such a manner that when the breaker has operated two (2) times under fault condition (Hi-set over current and earth fault) within one (1) hour, the breaker would trip for the 3rd time and lockout, and the manual reset would be required. This would be considered for incomers and act as the secondary protection for transmission line panels where auto reclose function has been disabled.

20.1.3. Sensitive earth fault relays shall be of the microprocessor protection type and have a current setting of 0.5 percent – 8 percent and an operating time adjustable from 1-99 seconds.

20.1.4. Sensitive earth fault relay shall be installed for switchgear feeding transmission lines, as per appendix1.

#### **20.3. Arc/ flash protection**

20.3.1. The system shall consist of an arc/flash sensor in Bas bar chamber, Cable chamber and Circuit breaker chamber.

20.3.2. The sensor should not be triggered by any light such as sunlight, touch, bulb etc. except an arc.

20.3.3. The sensor and its cabling must be placed in a way that in the event of vibration it does not fall into the chamber.

20.3.4. A sensor using fibre optic may be used to eliminate the clearance concerns and to cover as much chamber space as possible.

20.3.5. A master trip relay shall be incorporated in circuitry so that when energised by the operation of the arc protection relay it shall trip all the switching devices and inhibit them from being closed from remote until the manual resetting of the master trip relay.

20.3.6. The master trip relay shall be a mechanical latched relay with flags and manual reset.

20.3.7. Instantaneous earth fault protection to isolate only the faulty section of a sectionalised busbar panel.

20.3.8. This system shall consist of individual zone relays, which shall trip all switching devices in their respective zones to isolate the fault from all sources of supply.

20.3.9. The bus-section switching device shall be a separate zone.

20.3.10. Insulating material between zones and earth shall be high grade non-deteriorating and non-hygroscopic, at least 2mm thick cut to size and ready for installation.

- 20.3.11. The insulating material shall have an electric strength of not less than 4 kV when tested in accordance with IEC 60243-1 for 1 minute.
- 20.3.12. The insulating material required for the installation of the switchgear, shall be supplied with the switchgear panels.

#### **20.4. Restricted earth fault protection**

20.4.1. The relay shall: -

- be of the high impedance instantaneous type,
- be fitted with low pass filter or be tuned to 50 Hz,
- stability on through fault shall be maintained up to the fault rating of the switchgear,
- sensitivity shall be equal to the rated current of the current transformer.

20.4.2. The successful tenderer shall supply the current transformer for installation in the neutral connection of the power transformer.

20.4.3. The insulation rating of the neutral current transformer shall be of withstanding the power frequency withstand test specified in IEC 60044-1 for electrical equipment with a rated insulation level for the highest voltage of 12kV.

20.4.4. The tenderer shall advise the maximum lead burden.

20.4.5. Should the current transformer be installed by others the Contractor shall be responsible for the correct operation of the restricted earth fault protection system.

#### **21. CURRENT TRANSFORMERS**

21.1. Current transformers shall be designed, manufactured in accordance with IEC 60044-1.

21.2. The current transformers shall have the following accuracies: -

- Indicating instruments: Class 3
- Metering: Class 0.5
- Protective systems: Class 10P

21.3. Ring type current transformers shall have separate insulation between live conductors of the main circuit and inner surface of the current transformers.

#### **22. VOLTAGE TRANSFORMER**

22.1. All voltage transformers shall be designed, manufactured and tested in accordance with IEC 60044-2.

22.2. Voltage transformer secondaries shall have the following minimum accuracy:

- Metering: Class 0.5
- Indicating Instrument: Class 3
- Protective systems: Class 6P

22.3. The secondary winding of the voltage transformer shall be provided with fuses.

22.4. Phase or neutral earthing of the secondary winding through a removable link shall be provided. No fuses or miniature circuit breaker shall be fitted in this connection to earth.

22.5. The burden shall be suitable for the connected load but shall not be less than 50VA per phase.

#### **23. REMOTE CONTROL OF ELECTRICAL SWITCHGEAR**

23.1. Remote control of electrical switchgear shall be equipped with circuits and wired up for the remote open and close operation and indication from the "Centralised Electrical Control Office".

23.2. The circuits shall include the following: -

- A minimum of one set of normally open (N/O) and normally closed (N/C) auxiliary contacts to indicate the "open" or "closed" condition of the switching device and for the closing and tripping operations.
- All remote circuits shall be wired to a terminal strip at the back of the panel.
- A selector switch on the front of the panel to select between "local" and "remote" operation.

#### **24. CLOSING AND TRIPPING SUPPLIES**

24.1. Battery voltage closing and tripping shall be utilised unless otherwise specified.

- 24.2. The battery and battery charging unit shall comply with requirements of Transnet Freight Rail's (TFR) specification No.CEE.0085.
- 24.3. The preferred battery supply voltage for the switchboard is 110V DC unless otherwise specified.
- 24.4. A battery undervoltage relay shall be provided. The relay shall be adjustable between 80% and 100% of the nominal battery supply voltage. Hysteresis adjustment shall be incorporated.
- 24.5. In the event of low voltage or no battery voltage, the battery undervoltage relay shall trip and inhibit the reclosing of all the circuit breakers.

## **25. TEST TERMINAL BLOCKS**

- 25.1. Readily accessible, suitably enclosed test terminal blocks as shown on drawing CEE-PA-13 shall be provided on the front panel of each switch unit for the purposes of testing all protective systems.
- 25.2. Test terminal blocks need not be provided for the frame protection systems if the associated current transformers are mounted externally.
- 25.3. The test block shall be wired to the protective relays and associated current transformer as indicated in the typical connection drawing CEE-PA-56.

## **26. CONTROL SWITCHES**

- 26.1. All control switches shall be designed, manufactured and tested in accordance with IEC 60947-51.
- 26.2. Rotary pistol grip switches or push buttons shall be used on electrically operated switching devices and accidental trip or close of circuit should be prevented.
- 26.3. The electrical and mechanical endurance of the control switches shall be not less than 100 000 operations.
- 26.4. A remote dependent control switch (chicken switch) shall be incorporate on all parts, complete with 15m cable per substation.

## **27. MOULDED-CASE CIRCUIT BREAKERS**

The moulded-case circuit breaker shall be designed, manufactured and tested in accordance with SANS 156.

## **28. METAL ENCLOSURES (PANELS)**

### **28.1. Design**

- 28.1.1. The switchgear and control-gear panels shall be modular, free standing, metal clad, cubicle type with a minimum thickness of 2mm
- 28.1.2. All panels shall be so constructed to ensure interchangeability of all components of the same type between different panels.
- 28.1.3. The switchgear and control-gear panels shall be bolted together to form a continuous, self-supporting and self-contained switchgear and control-gear board of uniform appearance.
- 28.1.4. The switchboards shall be of the indoor, totally enclosed, floor mounted and fully extendable.
- 28.1.5. The switchboards shall be vermin proof.
- 28.1.6. All removable covers shall be secured by means of bolts and nuts. Nuts shall be either welded in position or secured by means of a mechanical fixing device. Self-tapping screws are not acceptable.
- 28.1.7. Provision shall be made for lifting or slinging of each panel.
- 28.1.8. The design of the panels shall allow easy access to current transformers and cable terminations. The removal and replacement shall be able to be carried out in situ.
- 28.1.9. The high-voltage and low-voltage equipment shall be housed in separate compartments.
- 28.1.10. Entry through barriers between cubicles shall be via purpose designed bushings.
- 28.1.11. Degree of protection of persons against hazardous approach to live busbar shall be IP3X as recommended in IEC 60529.
- 28.1.12. The panels shall be built to withstand internal faults. Upwards venting shall be provided for withdrawable switchgear.
- 28.1.13. Vent outlets shall be suitably designed to prevent accidental inward opening.
- 28.1.14. The rated insulation levels shall be in accordance with IEC 62271-200.



- 28.1.15. Where panel doors are fitted, stops shall be provided to prevent over swing when opening to prevent interference with adjacent panels. The panel doors shall be suitably reinforced to prevent distortion when open.
- 28.1.16. Adequate openings between panels shall be provided for any interconnecting wiring.
- 28.1.17. The openings shall have PVC grommets to protect the wiring from being damaged.
- 28.1.18. Where two or more panels are bolted together, they shall be bonded by a 25mm x 6mm copper busbar.
- 28.1.19. All protection relays, indicating lights, indicating instruments, control switches and pushbuttons shall be visible without opening doors of the control panel.
- 28.1.20. The low-voltage switchgear and control-gear shall be in accordance with IEC60947-5-1.
- 28.1.21. Thermostatic controlled anti-condensation heaters shall be provided in the busbar and cable chambers.
- 28.1.22. The wiring from the heater elements to terminals shall be high temperature insulation covered.

## **28.2. Busbars**

- 28.2.1. All busbars shall be designed, manufactured, marked and tested in accordance with BS 159.
- 28.2.2. Busbars and droppers shall be made of copper and shall be of suitable cross sections with regard to temperature rise at the specified altitude and of sufficient mechanical strength for normal and fault conditions.
- 28.2.3. The busbars shall be fully encapsulated.
- 28.2.4. The busbars shall be contained in a separate compartment and shall be easily accessible.
- 28.2.5. There shall be no barriers down the busbar runs except on either side of the busbar section switch. Barriers shall not be used to provide mechanical support for busbars or connections.

## **29. LOW VOLTAGE WIRING**

- 29.1. Low voltage wiring shall be a stranded copper conductor type and shall comply with SANS 1507.
- 29.2. Wiring shall be:
- Numbered at the terminals using white non-split, PVC ferrule type markers with black lettering,
  - Terminated by means of compression lugs or soldering on terminal blocks or strips,
  - The minimum size of 1.5mm<sup>2</sup> for instrument or control circuits and 2.5mm<sup>2</sup> for current transformer circuits,
  - Heat-resistant from heaters to terminals,
  - Suitably strapped and enclosed in flexible conduit when looping from panels to doors,
  - Continuous without joints.
  - All DC wiring colours should be grey
  - All AC wiring should be according to SANS 10142
- 29.3. Current transformer star point on secondary windings shall be earthed in the immediate vicinity of the transformer as well as onto the main circuit earth.

## **30. NAMEPLATES AND LABELS**

- 30.1. All nameplates and labels shall be in English and the lettering, shall be minimum height of 6mm.
- 30.2. Each switchgear and control-gear panel shall be fitted with a nameplate in conspicuous position indicating the following: -
- Maker's name
  - Maker's type number
  - Maker's serial number
  - Service voltage
  - Number of phases
  - Continuous rating
  - Rating kA seconds
- 30.3. Identical nameplate as that on all current and voltage transformers shall be mounted in a conspicuous position inside the protection relay compartment. The phase colour with which each current/voltage transformer is associated shall appear beneath each nameplate.

- 30.4. Engraved labels, showing panel designation shall be fitted to the front and rear of the fixed part of each cubicle and associated withdrawable equipment.
- 30.5. All control equipment, relays, terminal strips etc shall clearly marked in accordance with the wiring and schematic drawings.
- 30.6. Voltmeter labels shall state whether busbar or cable voltage is indicated.

### **31. PAINTING AND OTHER PROTECTIVE COATINGS**

- 31.1. All equipment shall be power coated in accordance with specification SANS 1274.
- 31.2. The switchboard panels shall be painted light orange colour of B26 in accordance with SANS 1091.

### **32. TESTS**

All equipment shall be tested as detailed in Appendix 3.

### **33. Inspection**

Transnet Freight Rail (TFR) reserves the right to inspect the equipment at any stage during manufacture.

### **34. DRAWINGS AND INSTRUCTIONS**

Drawings, instruction manuals and spares lists shall be supplied in accordance with TFR's specification CEE.0224.

### **35. TOOLS AND APPLIANCES**

- 35.1. One set of special tools and appliances required for normal operation and maintenance of each installation shall be supplied. Chicken switch must be provided by contractor.

### **36. SPARES**

- 36.1. The tenderer shall state whether a complete range of spares is held in stock by their local representatives for subsequent purchase by Transnet Freight Rail, as and when required.
- 36.2. A detailed description of each item including manufacturer's catalogue for maintenance purposes.
- 36.3. The spares list shall be divided into two parts, one covering items likely to be used in a 12-month period and those likely to be used in a 10-year period

### **37. PACKING**

The equipment shall be packed in such a manner that it will be protected during handling and transport. The movement of instruments, meters and relays shall be protected against vibration damage during transit.

### **38. LIST OF REFERENCE SPECIFICATIONS**

The above stipulation is for information and reference purposes only.

Please refer to electronic references.

Drawing number	Revision	Title
SKETCH - 1	0	
Refer to technical specification document from Page 5		
BBB4182-VER-5		

## **39. PROCUREMENT**

### **39.1 THE *CONTRACTOR'S* INVOICES**

#### **39.1.1 The invoice states the following:**

- Invoice addressed to Transnet SOC Limited;
- Transnet Limited's VAT No: 4720103177;
- Invoice number;
- The *Contractor's* VAT Number; and

#### **39.1.2 The invoice contains the supporting detail:**

A bill format as per the tender document indicating previously paid, paid to date and amount due for the month.

**The invoice is presented either by post or by hand delivery.**

#### **39.1.3 Invoices submitted by post are addressed to:**

- Invoice to be send via email: [TFR.Statements@transnet.net](mailto:TFR.Statements@transnet.net)
- The invoice is presented as an original.

#### **39.1.4 Invoices submitted by hand are presented to:**

All invoice to be send via above email.

Table 2: List of sites

No	Site Name	Area
1.	Station substation	Polokwane station

Fig. 1 – 11KV switchgear (required set up)



**SCHEDULE OF REQUIREMENTS**

(To be completed by the Client) (Project Manager)

**A. SWITCHGEAR AND CONTROLGEAR**

Number of switching devices required : 2 .....

System voltage nominal voltage : 11 KV AC .....

Number of Phases : 3 .....

Frequency (Hz) : 50HZ .....

**1.0. NEUTRAL EARTHING**

1.1. Unearthed : .....

1.2. Solidly earthed : .....

1.3. Reactance earthed : .....

1.4. Resistance earthed : .....

**2.0. BATTERY SUPPLY**

Rated Voltage : 110V DC .....

Rated Current: : 10A DC .....

**2.1. CLOSING SUPPLY**

Rated voltage : 110 V DC .....

**2.2. TRIPPING SUPPLY**

Rated voltage : 110 V DC .....

**3.0. BUSBARS**

3.1. Rated nominal current : 800 A .....

**3.2. Dimensions:**

Width : 38 mm .....

Thickness : 13 mm .....

**4.0. BUSBAR EARTING**Required; Yes / **No****5.0. SPECIAL REQUIREMENTS FOR BUSBAR AERTHING****Provide earthing:**

.....

**6.0. REMOTE DEPENDANT CONTROL SYSTEM**

The switch gear must be connected to telecontrol/able to be operated remotely

APPENDIX 1

**SCHEDULE OF REQUIREMENTS**

(To be completed by the Client) (Project Manager)

**B. SWITCHING DEVICES**

<b>1.0. UNIT NUMBER. (Panel No.)</b>	: To be provided
Designation/ Drawing Number	: .....
Circuit Breaker	: VCB.....
Fuse Switch combination	: .....
Disconnecter	: .....
Incoming or outgoing	: Both incoming and outgoing
If outgoing- destination	: To the other substation
With-or-non-withdrawable	: Withdrawable
Rated Nominal Current	: .....
Rated Nominal circuit breaking current	: .....
Rated short time withstand current for disconnector	: .....
Type and size of cable	: 35 – 95 mm <sup>2</sup> XLPE
Voltage Transformer ratio	N/A:

**C. PROTECTION SCHEDULE**

<b>UNIT NUMBER. (Panel No.)</b>	: .....
---------------------------------	---------

**1.0. OVERCURRENT**

	Yes
Number of elements	: .....
IDMT Curve	: .....
IDMT Extremely Inverse	: .....
High Set Instantaneous	: .....
Definite Time	: .....

**2.0. EARTH FAULT**

	Yes
Number of elements	: .....
IDMT Inverse	: .....
IDMT Extremely Inverse	: .....
High Set Instantaneous	: .....
Instantaneous	: .....
Definite Time	: .....
Sensitive Earth Fault	: .....

**3.0. AUTO RECLOSING**

	No
	: .....

**SCHEDULE OF REQUIREMENTS**

(To be completed by the Client) (Project Manager)

**4.0 TRANSFORMER** (continues)

Winding Over Temperature : N/A.....

Top Oil Temperature : N/A.....

**5.0. INTERTRIPPING** : N/A.....**6.0. OTHER** : N/A.....**7.0. SPECIAL REQUIREMENTS**

Chicken switch to be added

**D. CURRENT TRANSFORMER**

To be provided

**1.0. UNIT NUMBER (Panel No.)** : .....**1.1. Overcurrent and Earth Fault**

Ratio : 20/5 .....

**1.2. Accuracy**

Limit Factor : .....

Class : Class 3 :15VA.....

**1.3. Differential**

Pilot wire : N/A .....

Feeder Ratio : N/A .....

Class X : N/A .....

**1.4. FRAME LEAKAGE**

Ratio : N/A .....

Class of Accuracy : N/A .....

Accuracy Limit Factor : N/A .....

**1.5. Transformer Restricted Earth Fault**

Ratio : N/A .....

Class of Accuracy : N/A .....

Accuracy Limit Factor : N/A .....

**1.6. Transformer Differential Protection**

Higher Voltage Winding Ratio : N/A .....

Lower Voltage Winding Ratio : N/A .....

Class of Accuracy : N/A .....

Accuracy Limit Factor : N/A .....

**1.7. Tank Earth Protection**

Ratio : N/A .....

Class of Accuracy : N/A .....

Accuracy limit Factor : N/A .....

**SCHEDULE OF REQUIREMENTS**

(To be completed by the Client) (Project Manager)

**E. INSTRUMENT**

<b>1.0. UNIT NUMBER (Panel No.)</b>	<b>: To be provided.....</b>
Voltmeter	: 1 Per panel.....
Frequency Meter	: N/A.....
Ammeter	: 3 per panel.....
Ammeter Maximum Demand	: Yes.....
Power Factor Meter	: N/A.....
KWH Meter (if required)	: N/A.....
Current Transformer Ratio	: N/A.....

**2.0. SPECIAL REQUIREMENTS:**

.....

.....

.....



**TECHNICAL DATAD SHEET**

(To be completed by Tenderers)

Type Test Certificate Number and name of Testing Authority: .....

**1.0. SWITCHGEAR AND CONTROLGEAR****GENERAL**

- 1.1. Makers' Name : .....
- 1.2. Designation Type : .....
- 1.3. Rated Voltage : .....
- 1.4. Rated Peak Withstand Current : .....
- 1.5. Rated Frequency : .....
- 1.6. Type of Insulating Medium : .....
- 1.7. Rated Insulation Level : .....
- 1.8. Impulse Withstand Voltage:
- a) To Earth and Between Phases : .....
- b) Across the isolating distance : .....
- 1.9. One Minute Power Frequency Withstand Voltage:
- a) To Earth and Between Phases : .....
- b) Across the isolating distance : .....
- 1.10. Degree of Protection
- a) For Covers : .....
- b) For Partitions : .....
- 1.11. Method of pressure relief : .....

**2.0. SWITCHING DEVICES****CIRCUIT BREAKER**

- 2.1. Interrupting Medium : .....
- 2.2. Rated Frequency : .....
- 2.3. Rated Normal Current : .....
- 2.4. Rated Short Circuit Breaking Current
- a) Root Mean Value (RMS) : .....
- b) Percent DC Component : .....
- 2.5. Rated Making Current : .....
- 2.6. Rated Duration of Short Circuit : .....
- 2.7. Rated Operating Sequence : .....
- 2.8. Operating Mechanism
- a) Type of Closing Mechanism : .....
- b) Rated Supply of Closing Mechanism : .....
- c) Current required : .....
- d) Rated Supply Voltage of Shunt Opening release : .....
- 2.9. Number and Type of spare auxiliary contacts : .....

**3.0. FUSE SWITCH COMBINATIONS**

- 3.1. Rated Voltage : .....
- 3.2. Rated Insulation Level : .....
- 3.3. Rated Frequency : .....
- 3.4. Rated Normal Current : .....
- 3.5. Rated Short Circuit Breaking Current : .....
- 3.6. Rated Short Circuit Making Current : .....
- 3.7. Type Test Certificate Number and Name of Testing Authority : .....

**4.0. DISCONNECTORS (ISOLATORS) AND EARTHING SWITCHES**

- 4.1. Rated Voltage : .....
- 4.2. Rated Insulation Level : .....
- 4.3. Rated Frequency : .....

4.4. Rated Normal Current (disconnectors only) : .....

**APPENDIX 2****TECHNICAL DATAD SHEET** (continues)

4.5. Rated Short Time Withstand Current : .....

4.6. Rated Duration of Short Circuit : .....

4.7. Rated Peak Withstand Current : .....

4.8. Rated Short Circuit making Current (earthing switches only) : .....

4.9. Type Test Certificate Number and name of Testing Authority : .....

**5.0. BUSBARS**

5.1. Size of Busbar : .....

5.2. Type of Principal Insulation : .....

5.3. Rated Normal Current : .....

5.4. Rated Short Time Withstand Current : .....

5.5. Rated Short Circuit Duration : .....

**6.0. BUSHINGS**

6.1. Type Test Certificate Number and name of Testing Authority : .....

**7.0. HIGH VOLTAGE FUSES**

7.1. Make of Fuse : .....

7.2. Design type Number : .....

7.3. Nominal Current Rating : .....

7.4. Type Test Certificate Number and name of Testing Authority : .....

**8.0. CURRENT TRANSFORMER**

8.1. Make : .....

8.2. CT Ratio : .....

8.3. VA Rating : .....

8.4. Class of Accuracy : .....

8.5. Short Time Current and Duration : .....

8.6. Connection Type : .....

8.7. Method of Limiting Partial Discharge : .....

8.8. Maximum Partial Discharge : .....

8.9. Type Test Certificate Number and name of Testing Authority : .....

**9.0. VOLTAGE TRANSFORMER**

9.1. Make : .....

9.2. Class of Accuracy : .....

9.3. Output : .....

9.4. Method of Limiting Partial Discharge : .....

9.5. Maximum Partial Discharge : .....

9.6. Type Test Certificate Number and name of Testing Authority : .....

**10.0. INDICATING INSTRUMENTS**

10.1. Voltmeter : .....

10.2. Ammeter : .....

10.3. Ammeter/Maximum Demand 15min : .....

10.4. Power Factor Meter : .....

10.5. Wattmeter : .....

10.6. Frequency Meter : .....

10.7. Ammeter Overload Rating and Duration : .....

10.8. Type Test Certificate Number and name of Testing Authority : .....

**11.0. ENERGY METERS**

11.1. Make and Type : .....

11.2. kW Rating : .....

11.3. kWh percent error : .....

**12.0. SPARES**

12.1. Range of Spares held in local stock : .....

12.2. Full description of items not held locally : .....

## **Test requirements**

### **1. Type tests**

- 1.1. Where type tests are specified, they shall be carried out in accordance with the recommended standards or specification referred to this specification.
- 1.2. Type tests certificates shall be submitted with tender documents.

### **2. Routine tests**

- 2.1. The following additional routine tests shall be carried out on the completed switchgear or control gear at the manufacturers works prior to delivery. Test certificate for these tests shall be supplied.
- 2.2. The ratio, polarity and magnetisation curve of each current transformer after their installation in the board.
- 2.3. The characteristic curves of each protection relay where applicable.
- 2.4. The ratio of each voltage transformer.
- 2.5. The errors of all indicating instruments.

### **3. Functional tests**

- 3.1. A functional test of the complete board including all protective relays by primary injection. Test certificate for these shall be supplied.
- 3.2. Breakers' opening times.
- 3.3. Four copies of all approved routine test certificates shall be supplied, at the date not later than the delivery date of the switchgear or control gear.
- 3.4. All routine testing shall be witnessed, and inspection carried out by the Quality Assurance Section of Transnet Freight Rail's Technology Management.