TRANSNET
freight rail

A Division of Transnet Limited

ENGINEERING & TECHNOLOGY
TECHNOLOGY MANAGEMENT

SPECIFICATION

INDOOR, MEDIUM VOLTAGE METAL ENCLOSED SWITCHGEAR AND CONTROL GEAR IN ACCORDANCE WITH IEC 62271-200

Author:	Engineering Technician Technology Management	L.N Makhathini	
Approved:	Senior Engineer Technology Management	L.O. Borchard	
Authorised:	Principal Engineer Technology Management	S.E Sibande	
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Dates Amended	Author	Amendments
03/03/2011	S P Rikhotso	From old specification to version 3
08/09/2014	L Makhathini	• Formatting • **Added 11.1.3.** Sensitive earth fault relay shall be installed for switchgear feeding transmission lines, as per appendix1. • **Added 11.3.7.** Auto-reclose relay shall be compulsory for switchgear feeding transmission lines. • **Added 21.0.** METAL ENCLOSURES (PANELS) • **Added 21.1.** Design • **Added 21.2.** Busbar • **Removed 11.4** Bus bar frame leakage protection
24/07/2017	L Makhathini	• **Added 11.1.2.**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. • **Added 11.4.2.**The sensor should not be triggered by any light such as sunlight, touch, bulb etc. except an arc. • **Added 11.4.3.**The sensor and its cabling must be placed in a way that in the event of vibration it does not fall into the chamber. • **Added 11.4.4.**A sensor using fibre optic may be used to eliminate the clearance concerns and to cover as much chamber space as possible.

1.0. SCOPE

1.1. This specification cover's TFR's requirements for the supply of indoor three phase medium voltage metal enclosed switchgear and controlgear.

2.0. STANDARDS AND PUBLICATIONS

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

2.1. 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.

2.2. 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

2.3. TRANSNET FREIGHT RAIL (TFR)

BBD 7524	Switching & Lightning Surges protection system for a low voltage equipment installed in substation.
BBD 8946	Testing, setting and operation of a rogowski coil.
CEE.0224	Drawings, catalogues, instruction manuals and spares list for electrical equipment supplied under contracts.

3.0. APPENDICES

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

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

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

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

4.0. TENDERING PROCEDURE

4.1. 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.

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

4.3. Tenderers shall complete Appendix 2. “Technical Data Sheet”.

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

4.5. Failure to comply with clauses 4.1, 4.2, 4.3 and 4.4 could preclude a tender from consideration.

5.0. SERVICE CONDITIONS

5.1. ATMOSPHERIC CONDITIONS

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

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

5.2. ELECTRICAL CONDITIONS

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

5.3. MECHANICAL CONDITIONS

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

6.0. GENERAL REQUIREMENTS OF SWITCHGEAR AND CONTROLGEAR

6.1. The switchgear and controlgear shall be designed, manufactured and tested in accordance with IEC 622171-200.

6.2. The design of the equipment shall be make provision for the safety of the persons concerned in the normal operation and maintenance of the equipment.

6.3. The equipment shall be capable to operate under full load and fault conditions.

6.4. It shall not be possible to manually operate the circuit breaker unless it is in the “service’ or “earthed’ position.

6.5. The switchgear and controlgear shall be of the following:

- Withdrawable vacuum interrupted switchgear and controlgear.
- Non-withdrawable SF6 gas insulated vacuum interrupted switchgear and controlgear.

7.0. WITHDRAWABLE VACUUM INTERRUPTED SWITCHGEAR AND CONTROLGEAR

7.1. It shall not be possible to rack in the circuit breaker unless the truck is properly located in the correct position.

7.2. 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.

7.3. 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 engages. These shutters shall automatically cover the sockets with a positive action when the switchgear is withdrawn.

7.4. Facilities of independently padlocking each shutter in the closed position shall be provided.

7.5. Busbar shutters shall be red (colour A11 in SANS 1091) and shall be clearly marked “Busbars”.

The “Circuit”

7.6. The withdrawable circuit breaker shall be mounted on a transporting truck device, and fitted with wheels.

7.7. Flexible test rigs/cables shall be provided for testing the operation of the circuit breaker when fully withdrawn from the panels.

8.0. NON-WITHDRAWABLE SF6 GAS INSULATED VACCUM INTERRUPTED SWITCHGEAR AND CONTROLGEAR.

8.1. Live parts, switching functions and vacuum interrupters shall be housed in a completely sealed stainless steel tank.

8.2. The steel tanks shall be fitted with gas pressure densiometers provided with alarm contacts for low gas conditions. Low SF6 gas pressure for gas insulated vacuum interrupted switchgear shall trip the switchgear.

8.3. Position indication shall be provided to mechanically/manually indicate the position of the non-withdrawable circuit breakers, disconnectors and earthing switches and fuse combinations, i.e. on/off and earthed (isolated). The indication shall be readily visible from the front of each panel.

8.4. The sealed stainless tank, housing the live high voltage switching equipment shall be safe to touch.

8.5. All components doors giving direct access to high voltage equipment shall be mechanically and electrically interlocked so that the doors cannot be opened whilst the equipment is live.

8.6. A visible voltage detection system shall be supplied to verify safe isolation from supply during switching and maintenance operations.

9.0. SWITCHING DEVICES -: WITHDRAWABLE AND NON-WITHDRAWABLE

9.1. GENERAL

Switching device shall be ganged triple-pole construction.

9.1.1. Motors used for spring charging or other applications shall be protected by thermal overload and low voltage circuit protection.

9.1.2. 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.

9.1.3. It shall be possible to manually charge the spring-operated mechanism.

9.1.4. A mechanical operated device shall indicate whether the spring is charged or free and this shall be visible without opening the operating cubicle doors.

9.1.5. 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.

9.1.6. 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.

9.1.7. Tripping shall be by means of shunt trip coils.

9.1.8. 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 controlgear auxiliary plugs and sockets shall be used.

9.1.9. Each individual switching device panel shall be fitted with “close’ and “open” controls.

9.1.10. Where “close” and “open” pushbuttons protrude to the outside of the panel they shall be shrouded.

9.2. CIRCUIT BREAKER

9.2.1. The circuit breaker shall be designed, manufactured and tested in accordance with IEC 62271-100.

9.2.2. Only Vacuum interrupters shall be used.

9.2.3. Circuit breakers shall be equipped with trip-free closing mechanisms. An electrical manual closing mechanism shall be provided for maintenance purposes.

9.2.4. Presrtiking and chopping current shall be kept to a minimum. The tenderer shall give full details regarding these characteristics at the time of tendering.

9.2.5. The first pole clear factor shall be 1.5.

9.2.6. The making time shall not be greater than 100 milliseconds.

9.2.7. The breaking time shall not be greater than 40 milliseconds.

9.2.8. 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.

9.2.9. 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.

9.3. FUSE-SWITCH COMBINATIONS

9.3.1. Fuse-switch combinations shall be designed, manufactured and tested in accordance with IEC 602271-105.

9.3.2. The switches shall be of the load break-fault make type.

9.3.3. Undervoltage releases shall not be fitted.

9.3.4. Fuse-switch combinations shall be fitted with striker pins for automatic tripping purposes.

9.3.5. High Rupturing Capacity (HRC) fuses used shall be in accordance with IEC 60282-1.

9.4. DISCONNECTORS (ISOLATORS) AND EARTHING SWITCHES

9.4.1. Disconnectors and earthing switches shall be designed, manufactured and tested in accordance with IEC 602271-102.

9.4.2. Earthing switches shall be of the fault make type.

9.4.3. The operation mechanism shall be positioned on the front of the panel and lockable in all switching positions.

9.4.4. The operation of the disconnectors shall be manually operated.

9.4.5. Reliable mechanical indication of these positions shall be visible from the front of the panel.

9.4.6. A notice with the following inscription shall be provided adjacent to the operating mechanism:-

“DO NOT OPERATE UNDER LOAD CONDITION”

10.0. PROTECTION SYSTEM

10.1. The protection relays shall be designed, manufactured and tested in accordance with IEC 60255-5.

10.2. 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.

10.3. The protection system shall be submitted to Transnet Freight Rail for approval.

10.4. Protection relays shall be supplied as specified in Appendix 1. (Protection schedule).

10.5. 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.

10.6. The protection relays shall be capable of being reset without the necessity for opening the case.

10.7. It shall not be possible to operate any relay by hand to trip without opening the case.

10.8. The protection relays shall unless otherwise approved be provided with double contacts independent of each other, for controlling duplicate tripping circuits if necessary.

10.9. High speed tripping relays shall be self-latching and unless otherwise specified, the coil circuit shall be broken by self-contained contacts.

10.10. Relays used for master tripping shall be of the electromechanical type which can only be reset manually.

10.11. Protection relays used shall be continuously rated for the rated current setting.

10.12. The protection relays shall have reset flag indication on each element, save for fuse switch combination protective systems.

10.13. 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.

10.14. 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.

10.15. Suitable surge protection shall be provided across the relay supply voltage to protect the electronic relays form incoming voltage transients. The surge protection shall be in accordance with BBD 7524.

10.16. Where multi-function, micro-processor protection relays are supplied they shall provide protection, measuring, supervisory and basic control functions.

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

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

USER INTERFACE

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

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

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

DATA COMMUNICATION

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

10.23. 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.

10.24. 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.

10.25. 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.

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

11.0. PROTECTION RELAYS

11.1. OVERCURRENT AND EARTH FAULT RELAYS

11.1.1. 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.

11.1.2. 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.

11.1.3. 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.

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

11.2. DIFFERENTIAL PILOT WIRE FEEDER PROTECTION

11.2.1. Only those systems, which do not require the use of, screened pilot wires and which utilise current transformers with earthed secondary windings will be considered.

11.2.2. The relays incorporate for this system shall:-

11.2.2.1. Have minimum settings not exceeding 90 percent for phase faults and 40 percent for earth faults where 100 percent corresponds to rated secondary current.

11.2.2.2. Provide “instantaneous” tripping.

11.2.2.3. Be compensated for any inherent out-of-balance in the current transformer supplied and shall be automatically biased against tripping on through faults.

11.2.3. It shall be the responsibility of the tenderer to ensure that the transformer and relays supplied will match exactly the equipment installed at the other end of the cable to be protected and that the whole protection system will be stable on through-faults but will operate satisfactory on feeder faults.

11.3. AUTO_RECLOSE RELAY

11.3.1. This system shall consist of instantaneous and time lag over-current and earth fault relays and auto-reclosing relay.

11.3.2. After a preselected number of times if the fault remains the auto-reclosing relay will lock-out.

11.3.3. If the fault clears during the reclosing cycle the auto-reclosing relay shall reset to initial condition.

11.3.4. The relay shall be provided with the following functions:-

11.3.4.1. The facility to select the number and sequence of the instantaneous and of the delayed trips which form the reclosing cycle, up to at least 4.

11.3.4.2. Adjustable setting to set the duration of the time interval between the tripping and reclosing in the range 0-30 seconds.

11.3.4.3. Adjustable setting to set the definite minimum time of the delayed tripping between 0-10 seconds.

11.3.5. The auto-reclosing system shall be provided with a non resettable cumulative operation counter.

11.3.6. The auto-reclosing system shall be inhibited in the event of a sensitive earth fault operation.

11.3.7. Auto-reclose relay shall be compulsory for switchgear feeding transmission lines.

11.4. ARC/FLASH PROTECTION

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

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

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

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

11.4.5. 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 been closed form remote until the manual resetting of the master trip relay.

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

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

11.4.8. 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.

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

11.4.10. 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.

11.4.11. 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.

11.4.12. The insulating material required for the installation of the switchgear, shall be supplied with the switchgear panels.

11.5. TRANSFORMER PROTECTION

(3 phase, 2 winding power transformer)

11.5.1. OVER-CURRENT AND EARTH-FAULT PROTECTION

11.5.1.1. The relay shall consist of the following elements:-

- two extremely inverse definite minimum time lag over-current elements,
- two high set instantaneous over-current elements with low transient over each characteristic,
- one extremely inverse definite minimum time lag earth fault element.

11.5.2. RESTRICTED EARTH FAULT PROTECTION

11.5.2.1. 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.

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

11.5.2.3. 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.

11.5.2.4. The tenderer shall advise the maximum lead burden.

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

11.5.3. BIASED DIFFERENTAIL PROTECTION

11.5.3.1. The relay shall:-

- have a high speed characteristic,
- be biased to provide stability during through faults,
- not be operated by normal magnetising inrush current.

11.5.3.2. Current transformer for the higher voltage winding of the power transformer will be installed by others but the tenderer shall advise the maximum lead burden.

11.5.4. OVER TEMPERATURE, GAS DETECTION AND OVERPRESSURE PROTECTION

11.5.4.1. Circuit breakers controlling transformers shall be provided with the instantaneous trip auxiliary relays with mechanical flags for indication purposes.

11.5.4.2. The relays for winding temperature shall trip and inhibit the reclosing of the circuit breaker until the winding temperature of the transformer has cooled down sufficiently for the relay to reset by itself.

11.5.4.3. The relays for the transformer Bucholz shall trip and inhibits the reclosing of the circuit breaker until Bucholz relay has been reset manually.

11.5.5. TANK - EARTH PROTECTION

11.5.5.1. The circuit breaker panel shall be provided with an instantaneous type relay.

11.5.5.2. The current transformer associated with the above relay for installation between the transformer tank and earth shall be supplied loose to Transnet Freight Rail when called for in APPENDIX 1.

12.0. INDICATING INSTRUMENTS

12.1. Al, indicating instruments shall be of the analogue type and shall comply with the requirements of IEC 60051.

12.2. All indicating instruments shall:-

- be flush-mounted and dustproof. The degree of protection shall be IP 34 in accordance with IEC 60529,
- have a minimum a scale length of not less than 85mm,
- have a minimum accuracy class of 2.5,
- be marked with the ratios of the associated current and/or voltage transformers.

12.3. The ammeter full-scale deflection shall be the first standard value above the normal primary current rating of the associated current transformers.

12.4. Voltmeter full-scale deflection shall indicate nominal voltage at approximately 75 percent of the scale length and shall be marked with a red line.

12.5. Maximum demand ammeters shall be of the 15-minute thermal type and shall be integrated with the marking ammeters.

13.0. ENERGY METERS

13.1. Energy meters shall comply with the requirements specified in IEC62053-21.

13.2. Suitable surge protection shall be provided across the low voltage supplies for the energy meters in accordance with BBD7524 version 1.

14.0. CURRENT TRANSFORMERS

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

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

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

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

15.0. VOLTAGE TRANSFORMER

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

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

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

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

15.4. 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.

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

16.0. REMOTE CONTROL OF ELECTRICAL SWITCHGEAR

16.1. 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”**.**

16.2. 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.

17.0. CLOSING AND TRIPPING SUPPLIES

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

17.2. The battery and battery charging unit shall comply with requirements of Transnet Fright Rail’s (TFR) specification No.CEE.0085.

17.3. The preferred battery supply voltage for the switchboard is 110V DC unless otherwise specified.

17.4. 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.

17.5. 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.

18.0. TEST TERMINAL BLOCKS

18.1. 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.

18.2. Test terminal blocks need not be provided for the frame protection systems if the associated current transformers are mounted externally.

18.3. The test block shall be wired to the protective relays and associated current transformer as indicated in the typical connection drawing CEE-PA-56.

19.0. CONTROL SWITCHES

19.1. All control switches shall be designed, manufactured and tested in accordance with IEC 60947-5-1.

19.2. 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.

19.3. The electrical and mechanical endurance of the control switches shall be not less than 100 000 operations.

19.4. A remote dependent control switch (chicken switch) shall be incorporate on all parts, complete with 15m cable per substation.

20.0. MOULDED-CASE CIRCUIT BREAKERS

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

21.0. METAL ENCLOSURES (PANELS)

21.1. DESIGN

21.1.1. The switchgear and controlgear panels shall be modular, free standing, metal clad, cubicle type with a minimum thickness of 2mm

21.1.2. All panels shall be so constructed to ensure interchangeability of all components of the same type between different panels.

21.1.3. The switchgear and controlgear panels shall be bolted together to form a continuous, self-supporting and self-contained switchgear and controlgear board of uniform appearance.

21.1.4. The switchboards shall be of the indoor, totally enclosed, floor mounted and fully extendable.

21.1.5. The switchboards shall be vermin proof.

21.1.6. 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.

21.1.7. Provision shall be made for lifting or slinging of each panel.

21.1.8. 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.

21.1.9. The high-voltage and low-voltage equipment shall be housed in separate compartments.

21.1.10. Entry through barriers between cubicles shall be via purpose designed bushings.

21.1.11. Degree of protection of persons against hazardous approach to live busbar shall be IP3X as recommended in IEC 60529.

21.1.12. The panels shall be built to withstand internal faults. Upwards venting shall be provided for withdrawable switchgear.

21.1.13. Vent outlets shall be suitably designed to prevent accidental inward opening.

21.1.14. The rated insulation levels shall be in accordance with IEC 62271-200.

21.1.15. Where panel doors are fitted, stops shall 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.

21.1.16. Adequate openings between panels shall be provided for any interconnecting wiring.

21.1.17. The openings shall have PVC grommets to protect the wiring from being damaged.

21.1.18. Where two or more panels are bolted together they shall be bonded by a 25mm x 6mm copper busbar.

21.1.19. All protection relays, indicating lights, indicating instruments, control switches and pushbuttons shall be visible without opening doors where fitted on the control panel.

21.1.20. The low-voltage switchgear and controlgear shall be in accordance with IEC60947-5-1.

21.1.21. Thermostatic controlled anti-condensation heaters shall be provided in the busbar and cable chambers.

21.1.22. The wiring from the heater elements to terminals shall be high temperature insulation covered.

21.2. BUSBARS

21.2.1. All busbars shall be designed, manufactured, marked and tested in accordance with BS 159.

21.2.2. 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.

21.2.3. The busbars shall be fully encapsulated.

21.2.4. The busbars shall be contained in a separate compartment and shall be easily accessible.

21.2.5. 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.

22.0. LOW VOLTAGE WIRING

22.1. Low voltage wiring shall be a stranded copper conductor type and shall comply with SANS 1507.

22.2. 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^2 for instrument or control circuits and 2.5mm^2 for current transformer circuits,
- Heat-resistant from heaters to terminals,
- Suitably strapped and enclosed in flexible conduit when looping form panels to doors,
- Continuous without joints.
- All DC wiring colours should be grey
- All AC wiring should be according to SANS 10142

22.3. 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.

23.0. NAMEPLATES AND LABELS

23.1. All nameplates and labels shall be in English and the lettering, shall be minimum height of 6mm.

23.2. Each switchgear and controlgear 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

23.3. 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.

23.4. Engraved labels, showing panel designation shall be fitted to the front and rear of the fixed part of each cubicle and associated withdrawable equipment.

23.5. All control equipment, relays, terminal strips etc shall clearly marked in accordance with the wiring and schematic drawings.

23.6. Voltmeter labels shall state whether busbar or cable voltage is indicated.

24.0. PAINTING AND OTHER PROTECTIVE COATINGS

24.1. All equipment shall be power coated in accordance with specification SANS 1274.

24.2. The switchboard panels shall be painted light orange colour of B26 in accordance with SANS 1091.

25.0. TESTS

25.1. All equipment shall be tested as detailed in Appendix 3.

26.0. INSPECTION

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

27.0. DRAWINGS AND INSTRUCTIONS

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

28.0. TOOLS AND APPLIANCES

28.1. One set of special tools and appliances required for normal operation and maintenance of each installation shall be supplied.

29.0. SPARES

29.1. 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.

29.2. A detailed description of each item including manufacturer's catalogue for maintenance purposes.

29.3. 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.

30.0. PACKING

30.1. 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.

31.0. TRAINING

31.1. In the event of training or training courses being required the contractor shall submit a training plan for approval by Transnet Freight Rail (TFR).

31.2. The cost of training shall be included in the tenderer.

END

A

APPENDIX 1

SCHEDULE OF REQUIREMENTS

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

A. SWITCHGEAR AND CONTROLGEAR

Number of switching devices required	: Three 3
System voltage nominal voltage	: 11kV
Number of Phases	: 3 Phase
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

2.1. CLOSING SUPPLY

Rated voltage : 110V DC

2.2. TRIPPING SUPPLY

Rated voltage : 110V DC

3.0. BUSBARS

3.1. Rated nominal current : 1250A

3.2. **Dimensions**:

Width : 38mm

Thickness : 13mm

4.0. BUSBAR EARTING

Required; Yes/No No Busbar earthing panel

5.0. SPECIAL REQUIREMENTS FOR BUSBAR AERTHING

Provide earthing

……

……

6.0. REMOTE DEPENDANT CONTROL SYSTEM

APPENDIX 1

SCHEDULE OF REQUIREMENTS

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

B. SWITCHING DEVICES

1.0.	**UNIT NUMBER. (Panel No.)**	**:**
	Designation/ Drawing Number	:
	Circuit Breaker	. VCB
	Fuse Switch combination	:
	Disconnector	:
	Incoming or outgoing	. Both incomer and feeders
	If outgoing- destination	. (are you feeding transformer or line)
	With-or-non-withdrawable	. Withdrawable
	Rated Nominal Current	. 800A and 1250A
	Rated Nominal circuit breaking current	:
	Rated short time withstand current for disconnector	:
	Type and size of cable	. 35-95mmSQ XLPE
	Voltage Transformer ratio	. 11kV/110V

C. PROTECTION SCHEDULE

	UNIT NUMBER. (Panel No.)	**:**
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**	. Yes
4.0.	**DIFFERENTIAL PILOT WIRE**	. Yes
5.0.	**TRANSFORMER**	N/A
	Restricted Earth Fault	:
	Differential	:
	Tank Earth	:
	Gas Detection	:
	Over Pressure	:

APPENDIX 1

SCHEDULE OF REQUIREMENTS

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

TRANSFORMER (continues) NA

Winding Over Temperature :……

Top Oil Temperature :……

6.0. INTERTRIPPING :……

7.0. OTHER :……

8.0. SPECIAL REQUIREMENTS

……

……

……

D. CURRENT TRANSFORMER

1.0. UNIT NUMBER (Panel No.) :……

1.1. Overcurrent and Earth Fault

Ratio . 100/5 for Incomer and 50/5 for Feeders

1.2. Accuracy

Limit Factor :……

Class . 10P10

1.3. Differential

Pilot wire . Yes

Feeder Ratio :……

Class X :……

1.4. FRAME LEAKAGE Yes

Ratio . 100/5

Class of Accuracy . 10P

Accuracy Limit Factor . 10P10

1.5. Transformer Restricted Earth Fault N/A

Ratio :……

Class of Accuracy :……

Accuracy Limit Factor :……

1.6. Transformer Differential Protection N/A

Higher Voltage Winding Ratio :……

Lower Voltage Winding Ratio :……

Class of Accuracy :……

Accuracy Limit Factor :……

Tank Earth Protection N/A

Ratio :……

Class of Accuracy :……

Accuracy limit Factor :……

APPENDIX 1

SCHEDULE OF REQUIREMENTS

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

E. INSTRUMENT

1.0. UNIT NUMBER (Panel No.) **:……**

Voltmeter	: 1 per Panel
Frequency Meter	: no
Ammeter	: 3 per panel
Ammeter Maximum Demand	: Yes
Power Factor Meter	: no
kWH Meter (if required)	: (if required)
Current Transformer Ratio	:……

2.0. SPECIAL REQUIREMENTS:

……

……

……

APPENDIX 2

TECHNICAL DATAD SHEET

(To be completed by Tenderers)

1.0. SWITCHGEAR AND CONTROLGEAR

GENERAL

1.1. Makers' Name :……..

1.2. Designation Type :……..

1.3. Rated Voltage : 11kV……..

1.4. Rated Peak Withstand Current : 25kA……..

1.5. Rated Frequency : 50Hz……..

1.6. Type of Insulating Medium : AIS……..

1.7. Rated Insulation Level : 95kV……..

1.7.1. Impulse Withstand Voltage:

a) To Earth and Between Phases : 95kV……..

b) Across the isolating distance : 95kV……..

1.7.2. **One Minute Power Frequency Withstand Voltage:**

a) To Earth and Between Phases : 28kV……..

b) Across the isolating distance : 28kV……..

1.8. Degree of Protection

a) For Covers : IP3X……..

b) For Partitions : IP3X……..

1.9. Method of pressure relief : ARC VENTING COVERS……..

1.10. Type Test Certificate No, and Name of Testing Authority:

……....

2.0. SWITCHING DEVICES

CIRCUIT BREAKER

2.1. Interrupting Medium : VCB……

2.2. Rated Frequency : 50Hz……

2.3. Rated Normal Current : 800A and 1250A……

2.4. Rated Short Circuit Breaking Current

a) Root Mean Value (RMS) : 25kV……

b) Percent DC Component :……

2.5. Rated Making Current : 63kA……

2.6. Rated Duration of Short Circuit : 3s……

2.7. Rated Operating Sequence :……

2.8. Operating Mechanism

a) Type of Closing Mechanism : MOTOR WOUND SPRING……

b) Rated Supply of Closing Mechanism : 110V……

c) Current required : 7.2A……

d) Rated Supply Voltage of Shunt Opening release : 110V……

2.9. Number and Type of spare auxiliary contacts : 4 Normally open and 4 Normally close……

APPENDIX 2

TECHNICAL DATAD SHEET (continues)

(To be completed by Tenderers)

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

……

FUSE SWITCH COMBINATIONS

2.11. Rated Voltage : N/A

2.12. Rated Insulation Level :……

2.13. Rated Frequency :……

2.14. Rated Normal Current :……

2.15. Rated Short Circuit Breaking Current :……

2.16. Rated Short Circuit Making Current :……

2.17. Type Test Certificate Number and Name of Testing Authority:

……

DISCONNECTORS (ISOLATORS) AND EARTHING SWITCHES

2.18. Rated Voltage : N/A

2.19. Rated Insulation Level :……

2.20. Rated Frequency :……

2.21. Rated Normal Current (disconnectors only) :……

2.22. Rated Short Time Withstand Current :……

2.23. Rated Duration of Short Circuit :……

2.24. Rated Peak Withstand Current :……

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

……

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

……

3.0. BUSBARS

3.1. Size of Busbar ;……

3.2. Type of Principal Insulation : HEATSHRINK

3.3. Rated Normal Current : 1250A

3.4. Rated Short Time Withstand Current : 25kA

3.5. Rated Short Circuit Duration : 3s

4.0. BUSHINGS

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

……

5.0. HIGH VOLTAGE FUSES

5.1. Make of Fuse ; N/A

5.2. Design type Number :……

5.3. Nominal Current Rating :……

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

……

APPENDIX 2

TECHNICAL DATAD SHEET (continues)

(To be completed by Tenderers)

6.0. CURRENT TRANSFORMER

6.1. Make : BAR PRIMARY

6.2. CT Ratio : 100/5A FOR INCOMER AND 50/5A FOR FEEDERS

6.3. VA Rating : 10VA

6.4. Class of Accuracy : 10P10, CL 0.5

6.5. Short Time Current and Duration : 25kA, 3s

6.6. Connection Type : N/A

6.7. Method of Limiting Partial Discharge : N/A

6.8. Maximum Partial Discharge :

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

7.0. VOLTAGE TRANSFORMER

7.1. Make : 3 x Single phase

7.2. Class of Accuracy : 100VA, CL 0.5

7.3. Output : 110V

7.4. Method of Limiting Partial Discharge : N/A

7.5. Maximum Partial Discharge : <50PC@14.44kV & 20PC@8.32kV

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

8.0. INDICATING INSTRUMENTS

		Accuracy	Scale length (mm)
8.1.	Voltmeter	3	96 x 96
8.2.	Ammeter	3	96 x 96
8.3.	Ammeter/Maximum Demand 15min	3	96 x 96
8.4.	Power Factor Meter	N/A	N/A
8.5.	Wattmeter	N/A	N/A
8.6.	Frequency Meter	N/A	N/A
8.7.	Ammeter Overload Rating and Duration	20% 15mins	

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

9.0. ENERGY METERS

9.1. Make and Type :

9.2. kW Rating :

9.3. kWH percent error :

10.0. SPARES

10.1. Range of Spares held in local stock:

10.2. Full description of items not held locally:

APPENDIX 3

TEST REQUIREMENTS

1.0. 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.

2.0. 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.

3.0. 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 nor 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.

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