TRANSNET
freight rail

TECHNOLOGY MANAGEMENT

SPECIFICATION

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

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1.0 SCOPE

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

2.0 BACKGROUND.

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

3.0 STANDARDS AND PUBLICATIONS.

The following publications are referred to:

3.1 IEC - INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

3.2 SOUTH AFRICAN NATIONAL STANDARDS

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

3.3 TRANSNET FREIGHT RAIL'S SPECIFICATIONS

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

3.4 TRANSNET FREIGHT RAIL'S DRAWINGS

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

4.0 APPENDICES

The following appendices form part of this specification:

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

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

Appendix 3: Schedule of requirements.

5.0 TENDERING PROCEDURE

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

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

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

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

6.0 SERVICE CONDITIONS

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

6.1 ATMOSPHERIC CONDITIONS

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

6.2 MECHANICAL

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

6.3 ELECTRICAL

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

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

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

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

7.0 GENERAL REQUIREMENTS OF CONTROL /DISTRIBUTION PANELS.

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

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

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

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

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

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

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

8.0 AC PRIMARY CIRCUIT BREAKER CONTROL PANEL

The panel shall be fitted with the following:

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

8.1 FLAG ANNUCIATOR UNIT

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

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

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

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

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

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

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

8.1.8 The annunciator shall have the following minimum indications.

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

8.2 AC PRIMARY CIRCUIT BREAKER CONTROL AND INDICATION

8.2.1 Provision shall be made for the following:

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

8.3 RECTIFIER FAN CONTROL AND PROTECTION CIRCUITRY

8.3.1 Provision shall be made for the following:

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

8.4 MAIN AC THERMAL OVERLOAD AND INSTANTANEOUS OVERLOAD PROTECTION RELAYS.

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

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

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

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

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

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

8.4.7 The thermal overload protection shall be provided to permit loads not less than the specified load-rating curve of the 3 kV rectifier, which is tabled below and shall not exceed the manufacturers, declared rectifier rating.
2 x full load for 30 minutes
3 x full load for 1 minute
3.5 x full load for 10 seconds.
4.25 x full load instantaneous
Short circuit proof for 200 milli seconds

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

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

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

8.5 AC EARTH LEAKAGE PROTECTION RELAY

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

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

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

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

8.6 DC EARTH LEAKAGE PROTECTION RELAY.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

8.8 OVERLOAD PROTECTION FOR AUXILIARY TRANSFORMERS

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

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

8.9 LOCAL AND REMOTE CONTROL CIRCUITRY AND INDICATION EQUIPMENT

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

8.10 TRIP CONDITIONS

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

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

8.11 LOCKOUT CONDITIONS

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

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

8.12 EMERGENCY STOP

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

8.13 LOCK OUT RESET BUTTON AND INDICATION.

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

9.0 AC/DC DISTRIBUTION PANEL

The panel shall make provision for:

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

9.1 AC DISTRIBUTION. (400V, 3 PHASE)

Provision shall be for the following:

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

9.1.1 400V 3PHASE DISTRIBUTION SUPPLY

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

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

9.1.2 3 PHASE DETECTION FAILURE RELAY.

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

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

9.1.3 230 V SINGLE PHASE DISTRIBUTION SUPPLY

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

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

9.1.4 400V AUXILIARY SUPPLY CHANGE OVER SYSTEM

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

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

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

9.1.5 INDICATING INSTRUMENTS FOR THE 400 V AC DISTRIBUTION

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

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

9.2 110 DC VOLT DISTRIBUTION

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

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

9.2.2 INDICATING INSTRUMENTS

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

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

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

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

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

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

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

9.3 110V DC DISTRIBUTION SUPPLY

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

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

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

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

9.4 DC CONTROL AND SUPERVISORY CIRCUITRY AND TRACK BREAKER CONTROL.

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

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

10.0 PROTECTION RELAYS

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

11.0 CIRCUIT BREAKERS, CONTACTORS, RELAYS AND INDICATING LAMPS.

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

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

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

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

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

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

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

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

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

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

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

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

12.0 ELECTRICAL MEASURING INSTRUMENTS

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

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

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

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

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

13.0 TELECONTROL

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

13.1 AC PRIMARY CIRCUIT BREAKER

- Open, Close and Lockout conditions.

13.2 3 kV DC HIGH SPEED CIRCUIT BREAKERS.

- Open, Close and Lockout conditions.

13.3 TRANSFORMERS (Main and Auxiliary where applicable)

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

13.4 EARTH FAULT CONDITIONS

- DC Earth Leakage.
- AC Earth Leakage.

13.5 RECTIFIER FAILURE

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

13.6 SUPPLY VOLTAGE FAILURES

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

13.7 BATTERY

- Battery undervoltage.

13.8 MAIN OVERLOAD/AC EARTH LEAKAGE RELAY FAILURE

- Protection relay failure. (Watchdog)

14.0 WIRING AND TERMINALS.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PROTECTION TEST BLOCK

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

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

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

15.0 PANEL CONSTRUCTION.

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

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

15.2 The minimum dimensions shall be:

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

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

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

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

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

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

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

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

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

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

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

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

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

16.0 QUALITY ASSURANCE

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

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

17.0 SITE TESTS AND COMMISSIONING.

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

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

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

17.4 Commissioning will include the energising of equipment from the primary isolator to the track feeder circuits. The contractor must prove the satisfactory operation of equipment under live conditions.

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

18.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS

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

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

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

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

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

19.0 SPECIAL TOOLS AND/OR SERVICING AIDS

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

19.2 Tenderers shall submit detailed offers for special tools and servicing aids including all specialised equipment required for the servicing and maintenance of the equipment supplied.

20.0 TRAINING

20.1 The tenderer shall submit details with the tender of the training courses, which will be conducted by the contractor for the training of Transnet Freight Rail's maintenance staff in the operation and maintenance of the equipment supplied. The courses shall include theoretical as well as practical tuition. The date and venue of this training course shall be arranged with the maintenance manager.

21.0 GUARANTEE AND DEFECTS

21.1 The contractor shall guarantee the satisfactory operation of the complete electrical installation supplied and installed by him and accept liability for maker's defects, which may appear in design, materials and workmanship.

21.2 The guarantee period for all substations shall expire after:
A period of 12 months commencing on the date of completion of the contract or the date the equipment is handed over to Transnet Freight Rail whichever is the later.

21.3 Any specific type of fault occurring three times within the guarantee period and which cannot be proven to be due to other faulty equipment not forming part of this contract e.g., faulty locomotive or overhead track equipment, etc., shall automatically be deemed an inherent defect. Such inherent defect shall be fully rectified to the satisfaction of the Maintenance manager and at the cost of the Contractor.

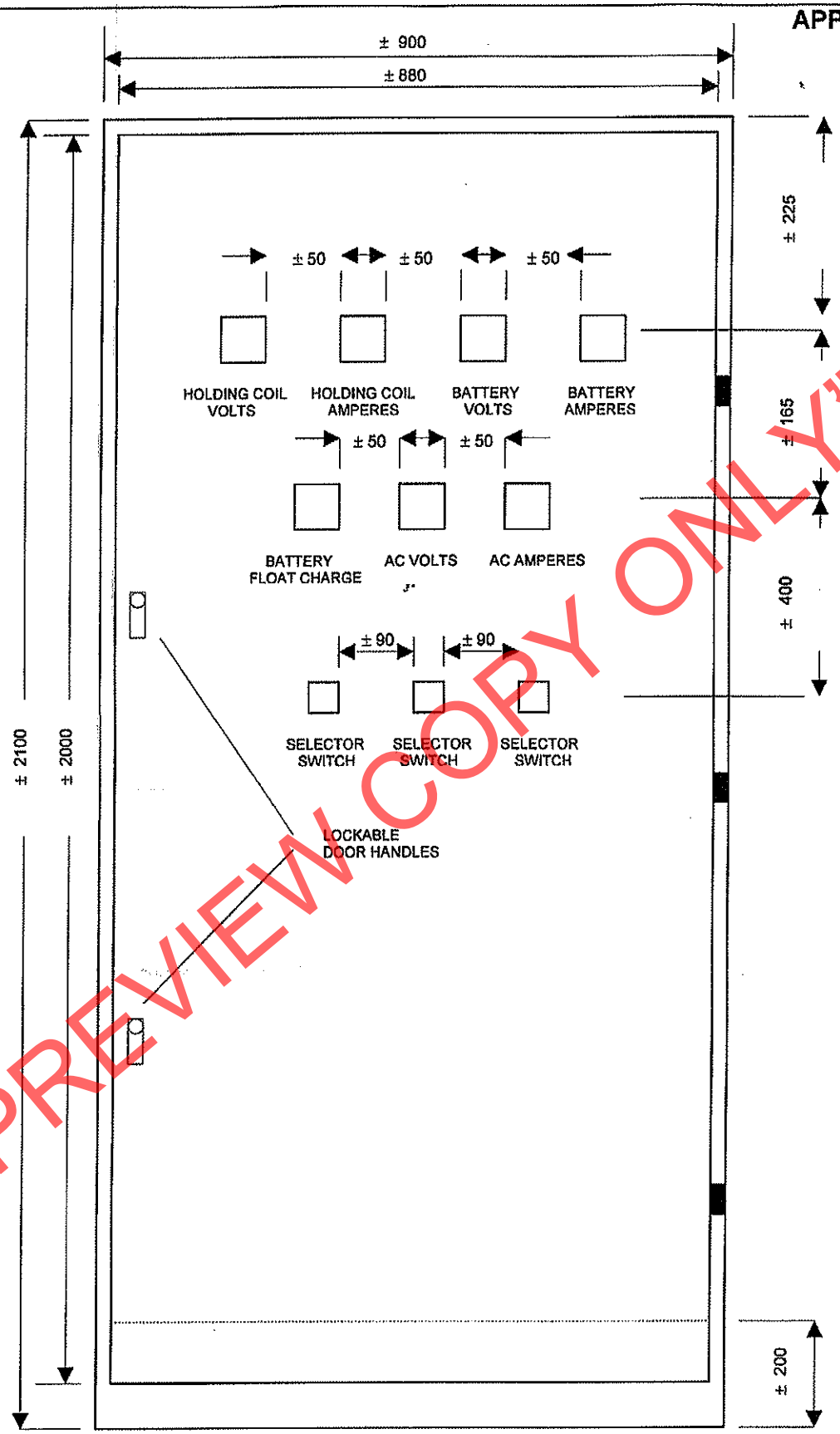
21.4 If urgent repairs have to be carried out by Transnet Freight Rail's staff to maintain supply during the guarantee period the contractor shall inspect such repairs to ensure that the guarantee period is not affected and should they be covered by the guarantee, reimburse Transnet Freight Rail the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

22.0 PACKAGING AND TRANSPORT.

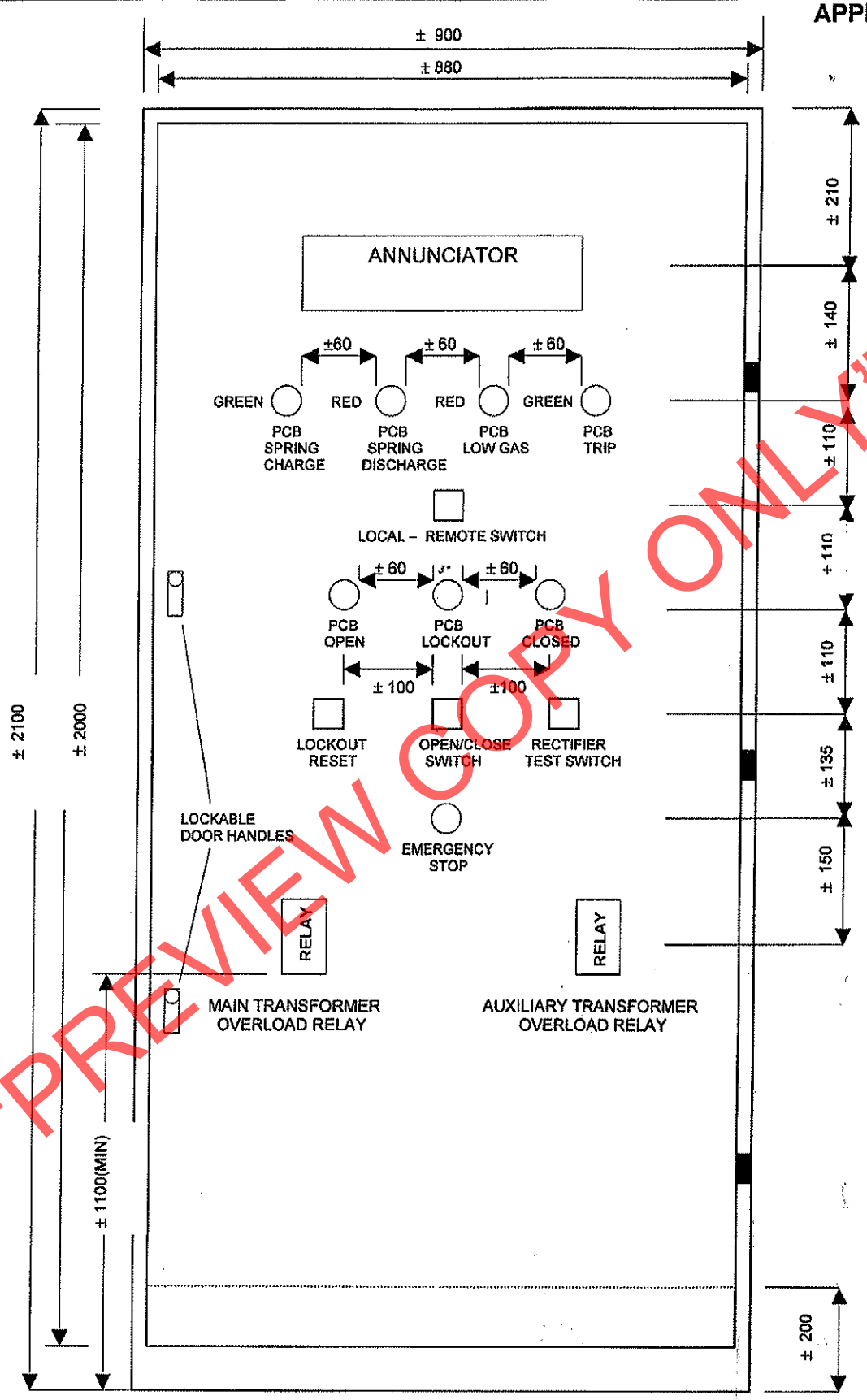
22.1 The tenderer shall ensure that the equipment be packed in such a manner that it will be protected during handling and transport.

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

END



AC/DC DISTRIBUTION PANEL



AC PRIMARY CIRCUIT BREAKER CONTROL PANEL

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

APPENDIX 3

SCHEDULE OF REQUIREMENTS

(To filled in by the client)

OPTIONS OF CONTROL PANELS CONSTRUCTION.

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