HOAC-HO-52920

ANNEXURE A1- SPECIFICATION BBB0937 VERSION 5

TRANSNET
freight rail

A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

REQUIREMENTS FOR OUTDOOR POST TYPE CURRENT TRANSFORMERS FOR TRACTION AND DISTRIBUTION SUBSTATIONS.

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Circulation Restricted To:

Transnet Freight Rail
Transnet and Relevant Third Parties

Contents

1.0 SCOPE

1.1 This specification covers Transnet Freight Rail's requirements for the design, manufacture, testing and supply of outdoor post type current transformers for use with electrical measuring instruments and electrical protection devices.

1.2 The current transformers shall be suitable rated for nominal system phase to phase rms voltages ranging from 22 kV up to 220 kV.

2.0 STANDARDS

2.1 Unless otherwise specified all materials used and equipment developed and supplied shall comply with the current equivalent edition of the relevant SANS, IEC or Transnet Freight Rail publications where applicable.

2.2 The following publications/specifications (latest editions) are referred to herein:

2.2.1 SOUTH AFRICAN NATIONAL STANDARD (SANS)

SANS 1019:	Standard voltages, currents and insulation levels for electricity supply.
SANS 60529:	Degree of protection provided by enclosures (IP code)
SANS 61869-1:	Instrument transformers Part 1: General requirements.
SANS 61869-2:	Instrument transformers Part 2: Additional requirements for current transformers.
SANS 62271-204:	High-voltage switchgear and control gear Part 204: Rigid gas-insulated transmission lines for rated voltage above 52 kV
SANS 9001:	Quality management systems - Requirements.

2.2.2 INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60296:	Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear.
IEC 60376:	Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment.
IEC 60417:	Graphical symbols for use on equipment.
IEC 60455:	Resin based reactive compounds used for electrical insulation.
IEC 60815:	Selection and dimensioning of high-voltage insulators intended for use in polluted conditions.
IEC 60867:	Insulating liquids - Specifications for unused liquids based on synthetic aromatic hydrocarbons.

2.2.3 TRANSNET FREIGHT RAIL'S SPECIFICATIONS

CEE 0183:	hot dipped galvanizing and painting of electrification steelwork.

3.0 METHOD OF TENDERING

3.1 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. This document can be used by tenderers to elaborate on their response to a clause.

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

3.3 Tenderers shall submit descriptive literature consisting of a detailed technical specifications,

general constructional details and principal dimensions, together with clear illustrations of the equipment offered.

3.4 Failure to comply with clauses 3.1, 3.2 and 3.3 could preclude a tender from consideration.

4.0 SERVICE CONDITIONS

4.1 ENVIRONMENTAL CONDITIONS

Altitude:	0 - 1800 m above sea level
Relative humidity:	10% to 90%
Ambient temperature:	-10° C to +55° C
Wind pressure:	750 Pa
Lightning conditions:	20 ground flashes/km^2 per annum
Pollution:	Heavily salt laden with industrial pollutants including diesel-electric locomotive emissions
Electromagnetic interference:	The device shall be used in environments exposing it to substantial electric and magnetic field intensities

4.2 ELECTRICAL SERVICE CONDITIONS

4.2.1 The current transformer shall be suitable for single phase AC traction supply systems with nominal voltage ranging from 22 kV – 220 kV AC with +-5% tolerance.

4.2.2 The current transformer shall be able to operate at a frequency of 50 Hz with +- 2.5% tolerance.

4.3 MECHANICAL SERVICE CONDITIONS

4.3.1 The device may be exposed to vibration and shock. The design must be adequately robust so as to ensure reliability of the equipment under such handling and transportation conditions.

5.0 TECHNICAL REQUIREMENTS

5.1 GENERAL REQUIREMENTS

5.1.1 The current transformers shall be designed, manufactured and tested in accordance with the requirements of SANS 61869-1 and SANS 61869-2 specifications.

5.1.2 The current transformers shall be suitable for operation under the nominal phase to phase voltages or phase to neutral voltages specified in Appendix A.

5.1.3 The current transformers shall be designed for outdoor use.

5.1.4 The current transformers shall be provided with measuring and protection cores as specified in Appendix A.

5.1.5 For certain applications, dual measuring cores as specified in Appendix A shall be provided for the purpose of ESKOM metering.

5.2 INSULATION LEVELS

The rated insulation levels of the current transformers shall comply with the requirements specified in Table 1.

Table 1 lists the nominal system voltages present on Transnet Freight Rail and the required insulation levels as specified in accordance with SANS 1019.

Highest phase-to-phase r.m.s voltage for equipment. (Um)	Nominal system phase-to-phase r.m.s. voltage	Rated lightning impulse withstand voltage peak.	Rated short duration power- frequency withstand r.m.s voltage.
24 kV	22 kV	150kV	50 kV
36 kV	33 kV	200 kV	70 kV
52 kV	44 kV	250 kV	95 kV
72,5 kV	66 kV	350 kV	140 kV
100 kV	88kV	380 kV 450 kV	150 kV 185 kV
145 kV	132 kV	550 kV 650kV	230 kV 275 kV
245 kV	220 kV	550 kV 650kV	360 kV 395 kV
Insulation levels for highest voltage for equipment U_m < 100 kV are based on an earth fault factor equal to $\sqrt{3}$ and for U_m > 100 kV an earth fault factor equal to $0{,}8\sqrt{3}$.			

TABLE 1: Standard Voltages and insulation levels in accordance with SANS 1019:2014

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

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

5.2.1 Primary terminal

5.2.1.1 The primary terminal insulation levels of the current transformer shall be as per clause 5.2 table 2 of SANS 61869-1 specification.

5.2.1.2 The partial discharge level shall not exceed the limits specified in Table 3 of SANS 61869-1 specification. These limits shall be tested as per clause 7.3.2.2 of SANS 61869-1 specification.

5.2.1.3 Current transformers that are not Gas Insulated shall be capable to withstand a chopped lightning impulse voltage applied to its primary terminals having a peak value of 115 % of the rated lightning impulse withstand voltage.

5.2.1.4 The primary terminals shall be of approved type material i.e. aluminium or electroplated copper and shall be able to carry the rated short circuit current of the current transformer.

5.2.1 **Secondary terminal**

5.2.1.1 The rated power-frequency withstand voltage for secondary insulation shall be at least 3 kV.

5.2.1.2 The secondary terminals shall be mounted in a metal terminal box suitable for the termination of the current transformer secondary windings to the outgoing external circuits for the protection relays, metering and indicating instruments.

5.2.1.3 The secondary winding connections shall be brought out through the tank into the terminal box by means of bushings.

5.2.1.4 Links shall be provided for shorting out the secondary windings not in use.

5.2.1.5 A rail mounted terminal strip shall be provided inside the terminal box for the termination of the current transformer secondary connections to the external circuits. The terminals shall be of the screw clamp type or spring-loaded insertion type.

5.2.1.6 The secondary winding terminal box shall be provided with a weatherproof cover and bottom entry cable entries. The degree of protection shall be at least IP 54 in accordance with SANS 60529.

5.2.1.7 An earthing stud of at least 6mm shall be provided inside the terminal box for the earthing of the secondary windings.

5.3 CURRENT TRANSFORMER RATINGS

5.3.1 MEASURING CURRENT TRANSFORMERS

5.3.1.1 The transformer ratio(s) shall comply with the requirements of Appendix A.

5.3.1.2 The secondary current rating shall be 1 Ampere unless otherwise specified in Appendix A.

5.3.1.3 The minimum rated output burden shall be 10 VA unless otherwise specified in Appendix A.

5.3.1.4 The accuracy class shall be as follows:

- For metering purposes the class of accuracy shall be 0.5 for current transformers with ratios up to 400/1 and class 0.2 for ratios greater than 400/1.
- For Indication or measuring purposes the accuracy class shall be 0.5.

5.3.2 PROTECTION CURRENT TRANSFORMERS

5.3.2.1 The transformer ratio(s) shall comply with the requirements of Appendix A.

5.3.2.2 The secondary current rating shall be 1or 5 Ampere. Refer to Appendix A.

5.3.2.3 The rated output burden shall comply with the requirements of Appendix A but shall not be less than 10 VA.

5.3.2.4 The accuracy limit factor shall be as specified in Appendix A.

5.3.2.5 The accuracy class shall be as specified in Appendix A.

5.3.2.6 The protection core shall be provided with a 10 ampere test winding.

CLASS PX CURRENT TRANSFORMERS

5.3.2.7 Class PX protection current transformers shall be provided where specified in Appendix A.

5.4 DESIGN AND CONSTRUCTION

5.4.1 Requirements for liquid filled in equipment

5.4.1.1 The manufacturer shall specify the type and the required quantity and quality of the liquid to be used in current transformer.

5.4.1.2 For oil-filled equipment, insulating oil shall comply with IEC 60296 specification.

5.4.1.3 For synthetic liquid-filled equipment refer to IEC 60867 specification.

5.4.1.4 The current transformer shall have a device for checking the liquid level. The device shall indicate whether the liquid level is within the operating range, during operation. This device shall be readable from the ground level.

5.4.1.5 The device shall be sealed to avoid any liquid loss. Liquid loss represents a danger of insulation contamination.

5.4.2 Requirements for gas filled in equipment

5.4.2.1 The manufacturer shall specify the type and the required quantity and quality in the equipment.

5.4.2.2 New SF6 (sulphur hexafluoride) gas shall comply with IEC 60376 specification.

5.4.2.3 The handling of SF6 gas shall be in accordance with clause 6.2 of SANS 61869-1 specification.

5.4.2.4 The maximum allowed moisture content within current transformers filled with gas at rated filling density for insulation shall be as per clause 6.2.2 of SANS 61869-1 specification.

5.4.2.5 Gas-insulated transformers having a minimum functional pressure above 0,2 MPa shall be provided with pressure or density monitoring device. Gas monitoring devices may be provided alone or together with the associated equipment.

5.4.2.6 All current transformers that use gas, other than air at atmospheric pressure, as an insulating medium shall conform to clause 6.2.4.2 of SANS 61869-1 specification.

5.4.2.7 The pressure relief valve shall be protected against any accidental damage.

5.4.2.8 For Gas Insulated Switchgear (GIS) current transformers refer to SANS 62271-204, Clause 5.105.

5.4.3 Requirements for solid materials used in equipment

5.4.3.1 Specifications for organic material used on current transformer (i.e. epoxy resin, polyurethane resin, epoxy-cycloaliphatic resin, composite material, etc.) shall conform to IEC 60455 series specifications.

5.4.3.2 For insulation guidance, IEC 61109 specification for outdoor insulation shall be used.

5.4.4 Requirements for temperature rise of parts and components

5.4.4.1 The temperature-rise of windings, magnetic circuits and any other parts of the current transformer shall not exceed the appropriate value given in SANS 61869-1 specification Table 5, when operating under the conditions specified on 4.0 of this specification.

5.4.4.2 The influence of altitude on temperature rise of the transformer shall be as per clause 6.4.2 of SANS 61869-1 specification.

5.4.5 Requirements for earthing of equipment

5.4.5.1 The frame of each equipment device, if intended to be earthed, shall be provided with a reliable earthing terminal for connection to an earthing conductor suitable for specified fault conditions. The connecting point shall be marked with the "earth" symbol, as indicated by symbol No 5019 of IEC 60417 specification.

5.4.5.2 The enclosure of current transformers for gas-insulated switchgear (GIS) shall be connected to earth. All metal parts which do not belong to a main or an auxiliary circuit shall be earthed.

5.4.5.3 The continuity of the earthing circuits shall be ensured.

5.4.5.4 For the interconnection of enclosures, frames, etc., fastening (e.g. bolting or welding) is acceptable for providing electrical continuity.

5.4.5.5 The tank or base of each current transformer shall be fitted with an earthing terminal suitable to accommodate a cable lug for a 95mm² copper conductor or copper busbar for the earthing of the current transformer.

5.4.6 Requirements for the external insulation

5.4.6.1 For outdoor instrument transformers with ceramic insulators susceptible to contamination, the creepage distances for given pollution levels shall conform to Table 6 of SANS 61869-1 specification.

5.4.6.2 The creepage distances shall also conform to IEC 60815 specification.

5.4.6.3 For installations at an altitude higher than 1000 m, the arcing distance under the standardised reference atmospheric conditions shall be determined by multiplying the withstand voltages required at the service location by a factor k in accordance with Figure 2 of SANS 61869-1 specification.

5.4.7 Mechanical requirements

These requirements apply only to current transformers having a highest voltage for equipment of 72,5 kV and above.

5.4.7.1 The current transformer shall be capable of withstanding static loads as per table 7 of SANS 61869-1 specification.

5.4.7.2 Provision shall be made that the current transformers can be bolted to the support structure.

5.4.8 Multiple chopped impulse on primary terminals

5.4.8.1 Chopped impulses shall be as per clause 7.4 of SANS 61869-1 specification.

5.4.9 Internal arc fault protection requirements

5.4.9.1 Internal arc fault test on all oil- immersed and gas-insulated free-standing current transformers having rated voltage ≥ 72,5 kV shall conducted and classed as per clause 6.9 of SANS 61869-1 specification.

5.4.10 Degrees of protection by enclosures

5.4.10.1 The degree of protection of all current transformers with the associated components shall be as per clause 6.10 of SANS 61869-1 specification; this shall be done in conjunction with SANS 60529 specification.

5.4.11 Electromagnetic Compatibility (EMC)

5.4.11.1 For current transformers that have rated voltage (*U*m) ≥ 123 kV, the Radio Interference Voltage (RIV) shall not exceed 2 500 µV at 1,1 *U*m 3 .

5.4.11.2 The current transformers that are containing active electronic components shall conform with the requirements of electromagnetic immunity as per clause 6.11 of SANS 61869-1 specification.

5.4.11.3 All current transformers that have rated voltage (*U*m) ≥ 72,5 kV shall have requirement for transmitted overvoltage's as stipulated in SANS 61869-1 specification.

5.4.12 Corrosion

5.4.12.1 Caution has to be taken against corrosion of the equipment during the service life.

5.4.12.2 All bolted or screwed parts of the main circuit and of the enclosure shall remain easy to demount.

5.4.12.3 Galvanic corrosion between materials in contact shall be considered because it can lead to the loss of tightness. All these parts shall be galvanized as per CEE 0183 specification.

5.4.13 Markings

All instrument transformers shall carry at least the following markings on a rating plate securely attached to the transformer:

a) The manufacturer's name or other mark by which he may be readily identified;

b) The year of manufacture and a serial number or a type designation, preferably both,

c) Rated frequency;

d) Highest voltage of equipment;

e) Rated insulation level;

f) Temperature category;

g) Mass in kg;

h) Class of mechanical requirements (for *U*m≥72kV).

i) Class of insulation if different from Class A;

j) All indications relative to the measuring characteristics;

k) Type of the insulating fluid;

l) Rated filling pressure;

m) Minimum functional pressure;

n) Insulating fluid volume (or mass) contained;

p) the corresponding terminals of each winding.

6.0 QUALITY ASSURANCE

6.1 The manufacturer shall ensure a manufacturing process that is compliant with specification SANS 9001.

7.0 DOCUMENTATION REQUIREMENTS

7.1 The manufacturer must provide one PDF file and two hard copies of the technical specification of the current transformer.

7.2 The manufacturer must provide one PDF file and two hard copies of the installation procedure, these includes connection diagram with terminal and polarity markings.

7.3 Drawings showing details of construction and outline dimensions of the currents transformers shall be submitted with the tender documents.

7.4 The manufacturer must provide type test certificates from a SANAS/international accredited laboratory to verify conformance to the requirements and these must be submitted with tender documents.

7.5 The manufacturer must complete and provide technical data sheet as per Appendix B.

8.0 GUARANTEE AND DEFECTS

8.1 The contractor shall guarantee the satisfactory operation of the current transformers supplied and accept liability for maker's defects, which may appear in design, materials and workmanship.

8.2 The guarantee period shall expire after: - A period of 12 months commencing on the date of energising of the current transformers

8.3 Any specific type of fault occurring three times within the guarantee period and which cannot be proven to be due to other faulty equipment not forming part of this contract, shall automatically be deemed an inherent defect. Such inherent defect shall be fully rectified to the satisfaction of the maintenance manager of the depot and at the cost of the Supplier.

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

9.0 SUPPORT

9.1 The supplier shall provide support whenever is required, this can be in a form of telephone or email communications and also a site visit.

9.2 Training and support shall be provided by the supplier if required.

10.0 PACKAGING AND TRANSPORT

10.1 The package shall have handling instructions on it.

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

END

APPENDIX A

SCHEDULE OF REQUIREMENTS
(To be completed by client)

1.0 SYSTEM DETAIL

1.1 Current transformers required for: _____ substation/location.

1.2 Pollution level: Heavy_____ Very Heavy _____

1.3 Quantity of current transformers required. 2

1.4 Nominal phase to phase voltage for 3 phase system: _____ kV.

1.5 Nominal phase to neutral voltage for single phase systems: _____ kV.

1.6 Frequency: 50 Hz

2.0 DETAIL OF CURRENT TRANSFORMER.

MEASURING CURRENT TRANSFORMERS

2.1 Measuring current transformer required: Yes / No

2.2 Number of measuring cores required: _____

2.3 Transformer ratio: Primary _____ Ampere, Secondary _____ Ampere.

2.4 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere

2.5 Rated burden: _____ VA

2.6 Accuracy class: _____

PROTECTION CURRENT TRANSFORMERS

2.7 Protection current transformer required: Yes/No

2.8 Number of protection cores required: _____

2.9 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere

2.10 Accuracy class: _____

2.11 Accuracy limit factor: _____

2.12 Rated Burden: _____ VA

CLASS PX PROTECTION CURRENT TRANSFORMERS

2.13 Class PX protection required: Yes/No

2.14 Number of Class PX protection cores required:_____

2.15 Transformation ratio: Primary_____Ampere, Secondary_____Ampere.

2.16 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere.

2.17 Rated turns ratio: _____

2.18 Rated knee point e.m.f: _____V

2.19 Maximum secondary winding resistance: _____ Ohms at _____ ° C

END

APPENDIX B

TECHNICAL DATA SHEET
(To be completed by tenderer)

1.0 DESIGN DETAIL

1.1 Manufacturers name: _____

1.2 Highest voltage for equipment: _____ kV

1.3 Nominal r.m.s voltage: _____ kV

1.4 Rated insulation level: _____ kV

1.5 Rated frequency: _____ Hz

2.0 DETAIL OF CURRENT TRANSFORMERS.

MEASURING CURRENT TRANSFORMERS

2.1 Transformer ratio: _____

2.11 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere

2.12 Accuracy class: _____

2.13 Rated Burden: _____ VA

2.14 Rated short-time current: _____kA for _____ seconds

PROTECTION CURRENT TRANSFORMERS

2.15 Transformer ratio: _____

2.8 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere

2.16 Accuracy class: _____

2.17 Accuracy limit factor: _____

2.11 Rated Burden: _____ VA

2.12 Rated short-time current: _____kA for _____ seconds

CLASS PX PROTECTION CURRENT TRANSFORMERS

2.20 Rated primary current: _____ Ampere. Rated secondary current: _____ Ampere.

2.21 Rated turns ratio: _____

2.22 Rated knee point e.m.f: _____V

2.23 Maximum secondary winding resistance: _____ Ohms at _____ ° C

2.24 Rated short-time current: _____kA for _____ seconds

END

HOAC-HO-52920

ANNEXURE A2- DRAWINGS BBH6954 VERSION 2 (1)

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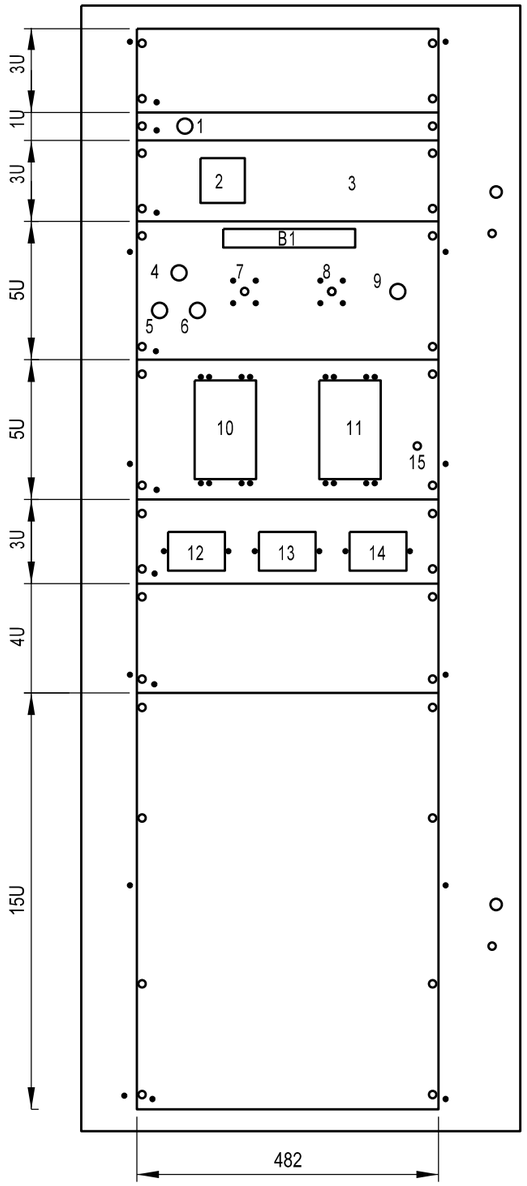
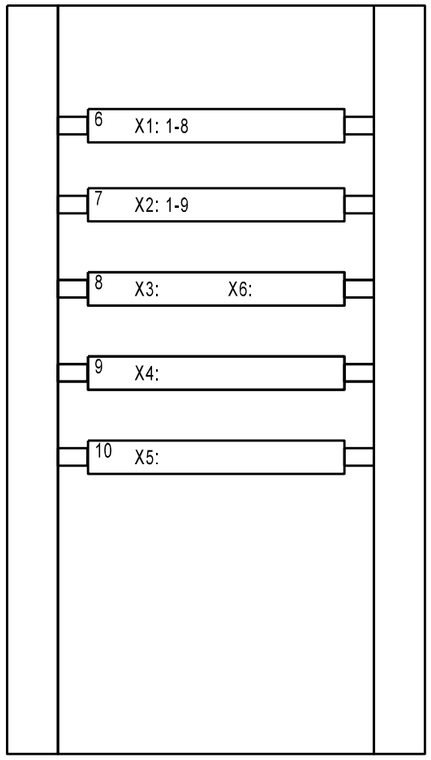
FRONT VIEW



TERMINAL PLATE



POSITION	DESIGNATION	DESCRIPTION	MANUFACTURER CATALOG NUMBER	MANUFACTURER
FRONT VIEW OF PANEL				
B1	LABEL	25kV TSS VCB V37		
1	PNH	PROTECTION NOT HEALTHY LAMP		AC/DC
2	A	AMMETER		AC/DC
3	V	VOLTMETER		AC/DC
4	READY	MV CIRCUIT BREAKER LAMP (READY)		AC/DC
5	OPEN	MV CIRCUIT BREAKER LAMP (OPEN)		AC/DC
6	CLOSED	HV CIRCUIT BREAKER LAMP (CLOSED)		AC/DC
7	CB CONTR	MV CIRCUIT BREAKER CONTROL SWITCH		KRAUS
8	LOCAL/REMOTE	LOCAL REMOTE SWITCH		KRAUS
9	LAMP TEST	LAMP TEST PUSH BUTTON		AC/DC
10	P125	DIRECTIONAL EARTH FAULT RELAY		SCHNEIDER
11	P122	OVER CURRENT RELAY		SCHNEIDER
12	VTTB	VOLTAGE TRANSFORMER TEST BLOCK		ALBRO
13	METTB	METERING TEST BLOCK		ALBRO
14	CTTB	CURRENT TRANSFORMER TEST BLOCK		ALBRO
15	ESD	ELECTROSTATIC DISCHARGE CONNECTION		AC/DC
REAR VIEW OF PANEL				
X1				
1	MCB1	MINIATURE CIRCUIT BREAKER (CONTROL)		GE
2	MCB2	MINIATURE CIRCUIT BREAKER (TRIP & ALARMS)		GE
3	MCB3	MINIATURE CIRCUIT BREAKER (INDICATION LIGHTS)		GE
4	MCB4	MINIATURE CIRCUIT BREAKER (PANEL LIGHT)		GE
5	MCB5	MINIATURE CIRCUIT BREAKER (VOLTAGE TRFR)		GE
6	DEHNGUARD	SURGE PROTECTION POSITVE TO NEGATIVE		DEHN
7	DEHNGUARD	SURGE PROTECTION POSITIVE TO NEGATIVE		DEHN
8	DEHNGUARD	SURGE PROTECTION NEGATIVE TO EARTH		DEHN
9	DEHNGAP	SURGE PROTECTION LIVE - NEUTRAL		DEHN
10	DEHNGAP	SURGE PROTECTION LIVE - EARTH		DEHN
11	DEHNGAP	SURGE PROTECTION NEUTRAL - EARTH		DEHN
X2				
1	ST-X	SUPERVISORY TRIP AUXILIARY RELAY		RELE
2	SC-X	SUPERVISORY CLOSE AUXILIARY RELAY		RELE
3	DCF-X	DC FAIL AUXILIARY RELAY		RELE
4	U/V	110VDC UNDERVOLTAGE RELAY		RHOMBERG
5	PNH-X	PROTECTION NOT HEALTHY AUXILIARY RELAY		RELE
6	CH-X	CLOSE INHIBIT AUXILIARY RELAY		RELE
7	VCB-X	MV CIRCUIT BREAKER OPEN AUXILIURY RELAY		RELE
8	L/R-X	LOCAL REMOTE AUX RELAY		RELE
X3				
	CT & VT	CURRENT & VOLTAGETRANSFORMER TERMINALS		VIKING
X4				
	CON & IND	220VAC & 48VDC CONTROLS & INDICATIONS TERMINALS		VIKING
X5				
	TELE	TELE CONTROL TERMINALS		VIKING
	DIODE	DIODE BOARD D1 - D12		IST
X6	TRANSCUDERS	M1416 VOLTAGE AC TRANSD		
		M1418 CURRENT AC TRANSD		

NOTE:
1. DRAWINGS ARE DEVELOPED BASED ON CURRENT TECHNOLOGY.
   PLEASE CONTACT TECHNOLOGY MANAGEMENT FOR SITE SPECIFIC DRAWINGS.
2. 1U = 44.45mm
   THE SCHEME IS DESIGNED FPR MOUNTING A 19 INCH RACK SYSTEM AS PER IEC 60297
   THE MODULE AND BACK PLATE ARE 482.6mm WIDE. THE MODULE IS 600mm DEEP.

DIMENSIONS : mm SCALE : -
TOLERANCE : LIN± - ANG± - ITEM NO : -
MATERIAL : -
VERSION INFO : ADDED A DIRECTIONAL EARTH RELAY AT POSITION 10

+ 14/05/2024
APPROVED

+
AUTHORISED

25kV INCOMER RELAY PANEL
PANEL EQUIPMENT LAYOUT

TRANSNET freight rail

BBH6954 SHT 1 OF 9
VERSION 2 A3

DO REF: CDO/ E0560 ECP REF: - DRAWN: L.S KEKANE DESIGNED: - CHECKED: X.R BHOMELA

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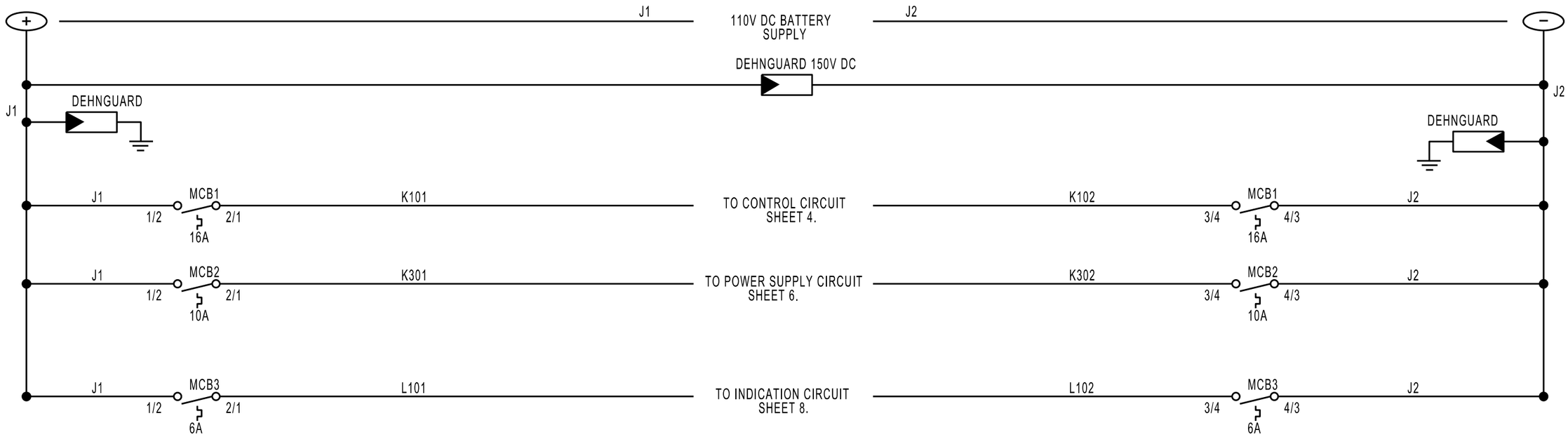

DIMENSIONS : mm TOLERANCE : LIN± - ANG± - MATERIAL : - VERSION INFO : REDRAWN INTO TRANSNET DRAWINGS	+ 23/04/2024 APPROVED	+ AUTHORISED	25kV INCOMER RELAY PANEL AC/DC SUPPLY DIAGRAM	TRANSNET freight rail BBH6954 SHT 2 OF 9 VERSION 1 A3

DO REF: CDO/ E0529 ECP REF: - DRAWN: L.S KEKANE DESIGNED: - CHECKED: X.R BHOMELA

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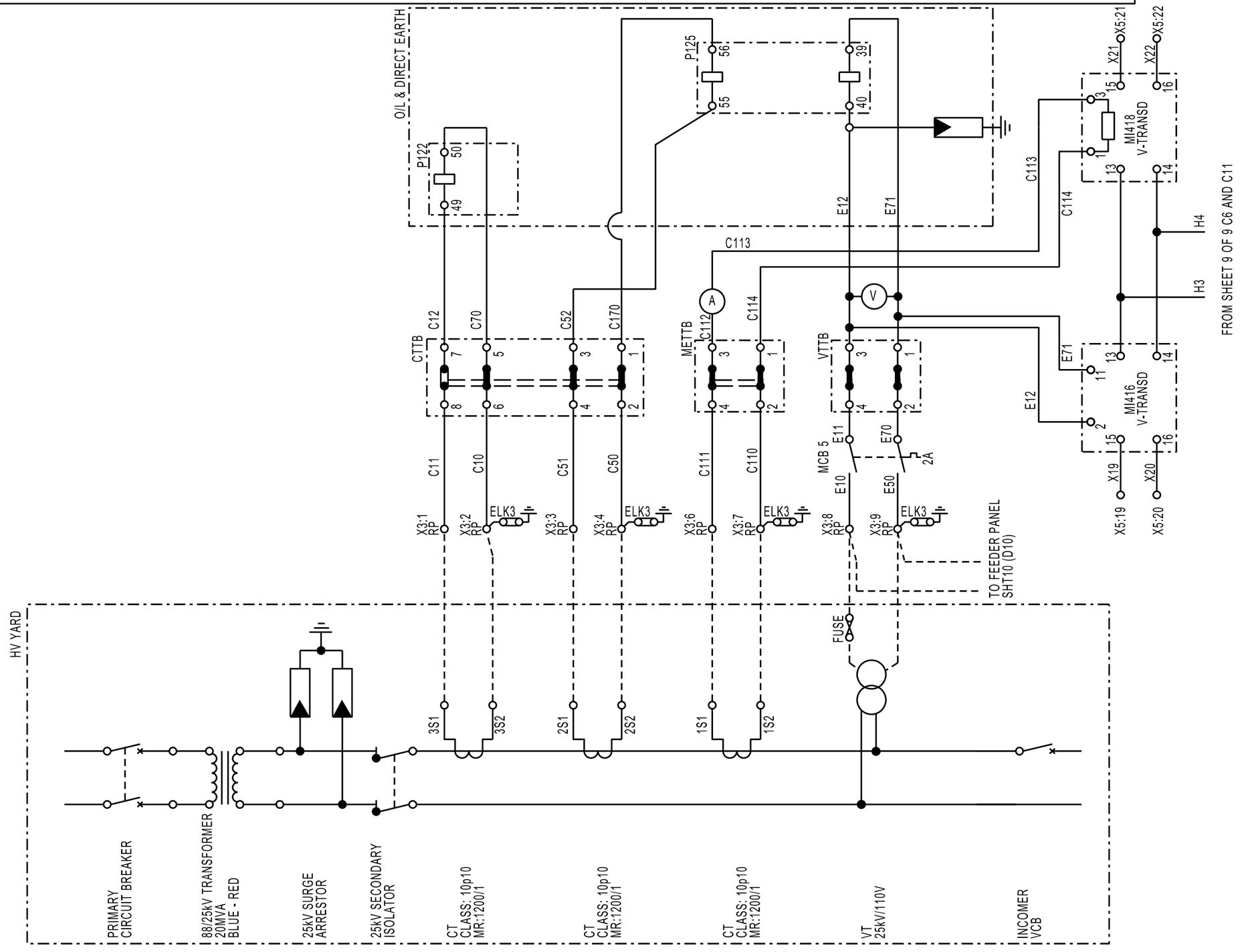
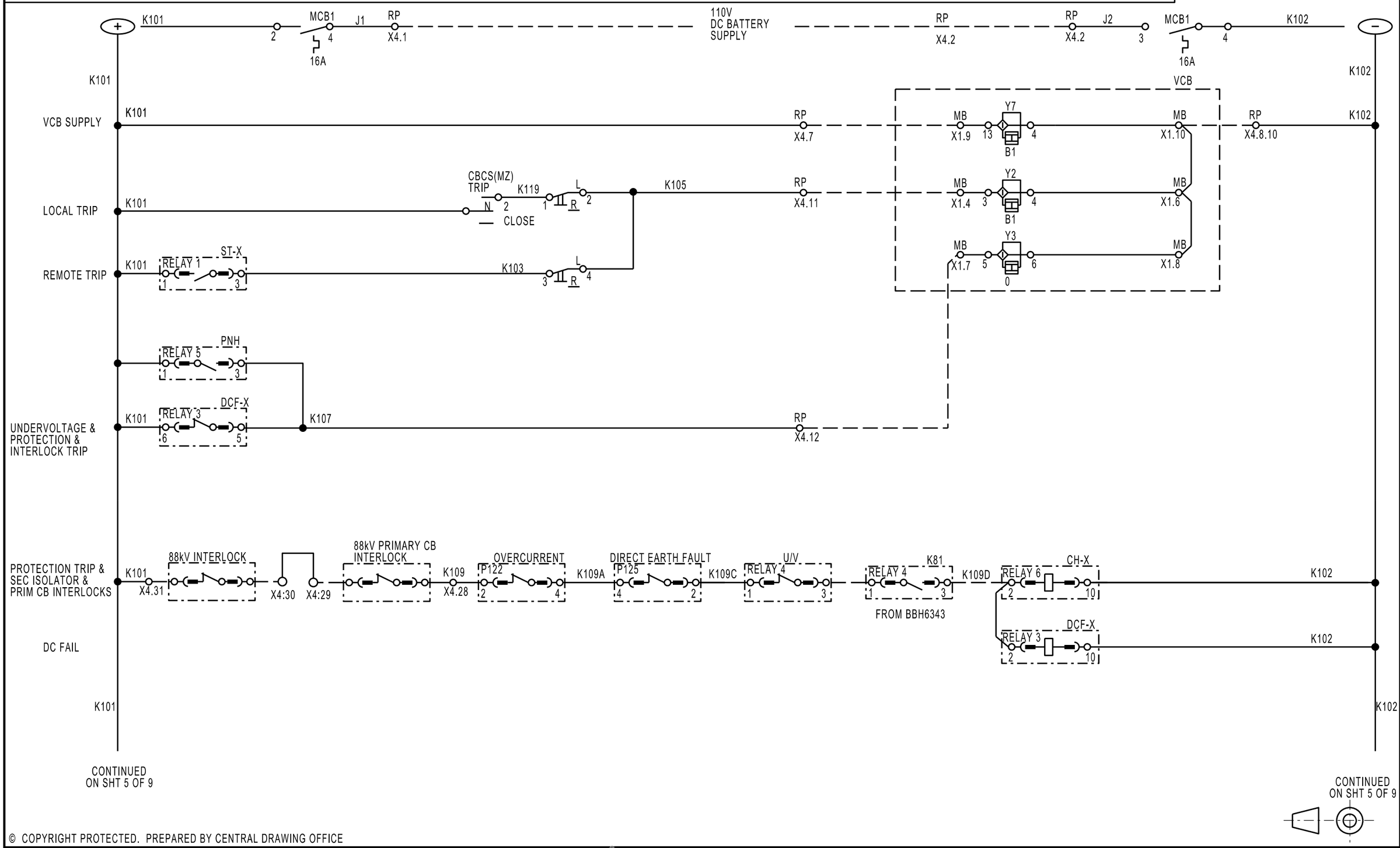


DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - ITEM NO : - MATERIAL : - VERSION INFO : REDRAWN INTO TRANSNET DRAWINGS	+ 23/04/2024 APPROVED	+ AUTHORISED	25kV INCOMER RELAY PANEL AC KEY DIAGRAM	TRANSNET freight rail BBH6954 SHT 3 OF 9 VERSION 1 A3

DO REF: CDO/ E0529 ECP REF: - DRAWN: L.S KEKANE DESIGNED: - CHECKED: X.R BHOMELA

"THIS DRAWING CONTAINS PERSONAL INFORMATION AS DEFINED IN THE PROTECTION OF PERSONAL INFORMATION ACT, 2013 (POPIA). THE INFORMATION CONTAINED HEREIN WILL BE PROCESSED IN ACCORDANCE WITH THE PROVISIONS OF POPIA".



DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - ITEM NO : - MATERIAL : - VERSION INFO : REDRAWN INTO TRANSNET DRAWINGS	+ 23/04/2024 APPROVED	+ AUTHORISED	25kV INCOMER RELAY PANEL TRIP DC LINE DIAGRAM	TRANSNET freight rail BBH6954 SHT 4 OF 9 VERSION 1 A3

DO REF: CDO/ E0529 ECP REF: - DRAWN: L.S KEKANE DESIGNED: - CHECKED: X.R BHOMELA

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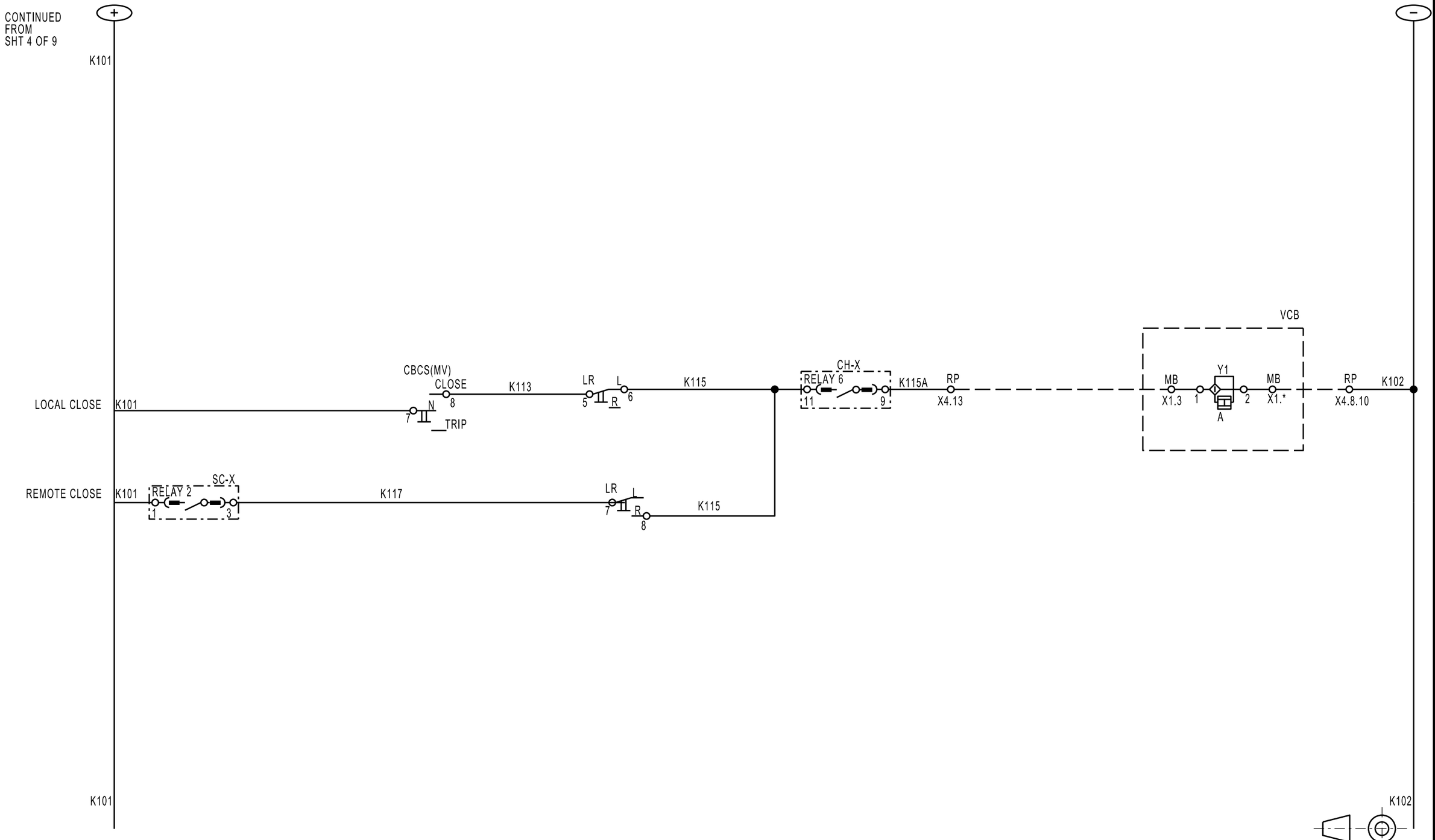

DIMENSIONS : mm TOLERANCE : LIN± - ANG± - MATERIAL : - VERSION INFO : REDRAWN INTO TRANSNET DRAWINGS	+ 23/04/2024 APPROVED	+ AUTHORISED	25kV INCOMER RELAY PANEL CLOSE DC LINE DIAGRAM	TRANSNET freight rail BBH6954 SHT 5 OF 9 VERSION 1 A3

DO REF: CDO/ E0529 ECP REF: - DRAWN: L.S KEKANE DESIGNED: - CHECKED: X.R BHOMELA

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+ K301 — 2 — MCB2 — 10A — J1 — 110V DC LOOP SUPPLY — J2 — MCB2 — 10A — K302 —

OVERCURRENT RELAY POWER SUPPLY: K301 — 50/51 P122 (33–34) — K302

REVERSE POWER RELAY POWER SUPPLY: K301 — 67N P125 (33–34) — K302

LOCAL REMOTE AUX RELAY CONTROL: K301 — L/R (9–10) — K313 — L/R-X RELAY 8 (2–10) — K302

110VDC SUPPLY TO TELECONTROL TERMINALS X5: K301 — SHT.7 - 17

P122 RELAY FAULTY: K301 — P122 (36–35) — K307 — PNH-X RELAY 5 (2–10) — K302

P125 RELAY FAULTY: K301 — P125 (36–35)

VCB

25kV CB NOT HEALTHY: K301 — RP X4.16 — MB X1.13 — VCBF 52b (25–23) — MB X4.14 — RP X4.18 — K307

25kV CB OPEN: MB X1.43 — VCBO 52b (19–20) — MB X4.44 — RP X4.21 — K209 — VCB-X RELAY 8 (2–10) — K302

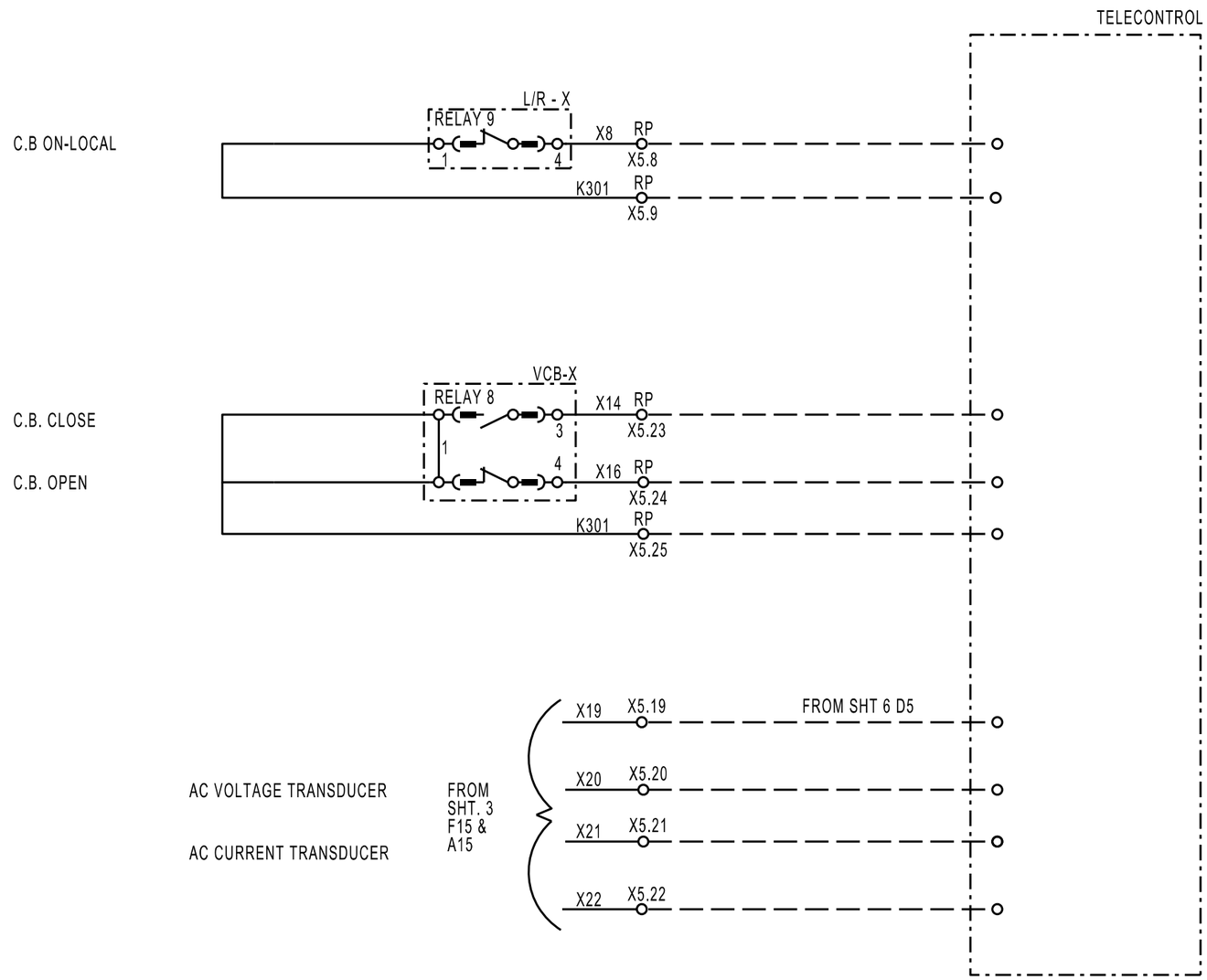
SUPERVISOR TRIP 110V DC: K301 — RP X5.12 — TELECONTROL TRIP — RP X5.13 — K305 — ST-X RELAY 1 (2–10) — K302

SUPERVISOR CLOSE 110V DC: TELECONTROL CLOSE — RP X5.14 — K311 — SC-X RELAY 2 (2–10) — K302

UNDERVOLTAGE MONITOR RELAY: K301 — U/V SP-201 4 (2–10, 5) — K302

DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - ITEM NO : - MATERIAL : - VERSION INFO : REDRAWN INTO TRANSNET DRAWINGS	+ 23/04/2024 APPROVED	+ AUTHORISED	25kV INCOMER RELAY PANEL TRIP & ALARMS DC DIAGRAM	TRANSNET freight rail BBH6954 SHT 6 OF 9 VERSION 1 A3

DO REF: CDO/ E0529 ECP REF: - DRAWN: L.S KEKANE DESIGNED: - CHECKED: X.R BHOMELA



DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - ITEM NO : - MATERIAL : - VERSION INFO : REDRAWN INTO TRANSNET DRAWINGS	+ 23/04/2024 APPROVED	+ AUTHORISED	25kV INCOMER RELAY PANEL SUPERVISORY DIAGRAM	TRANSNET freight rail BBH6954 SHT 7 OF 9 VERSION 1 A3

DO REF: CDO/ E0529 ECP REF: - DRAWN: L.S KEKANE DESIGNED: - CHECKED: X.R BHOMELA

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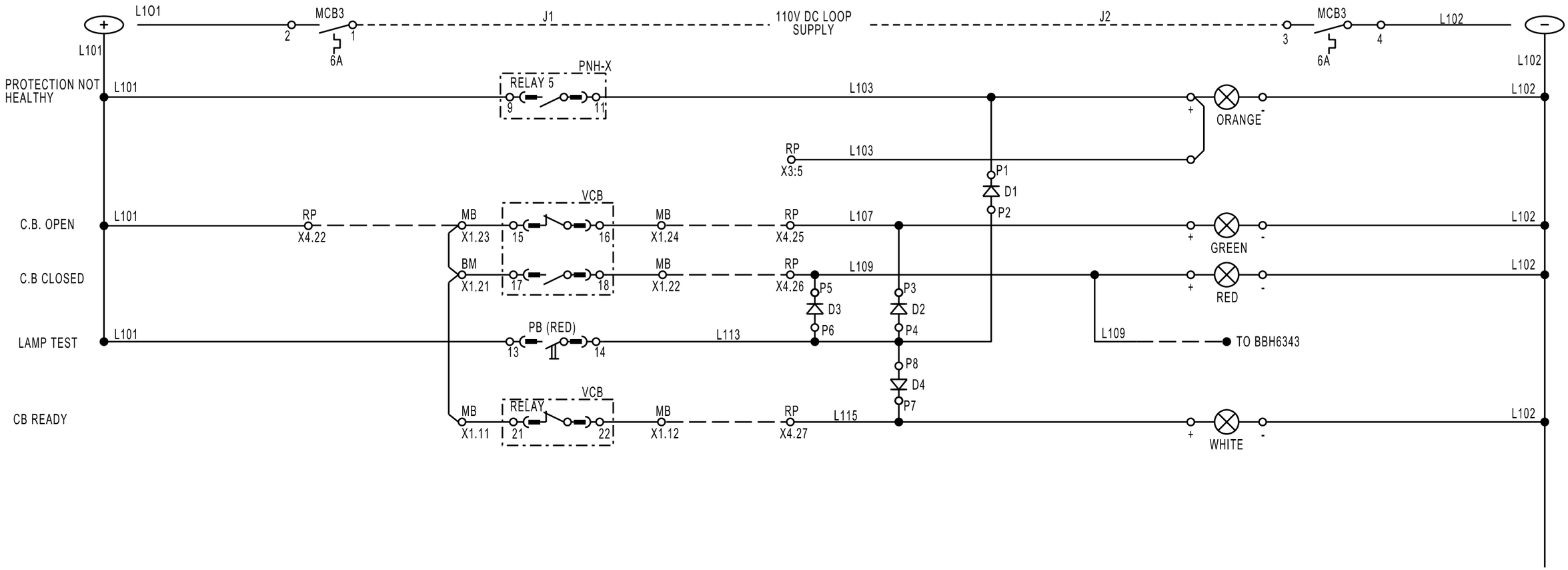

DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - ITEM NO : - MATERIAL : - VERSION INFO : REDRAWN INTO TRANSNET DRAWINGS	+ 23/04/2024 APPROVED	+ AUTHORISED	25kV INCOMER RELAY PANEL INDUCTION DC KEY DIAGRAM	TRANSNET freight rail BBH6954 SHT 8 OF 9 VERSION 1 A3

DO REF: CDO/ E0529 ECP REF: - DRAWN: L.S KEKANE DESIGNED: - CHECKED: X.R BHOMELA

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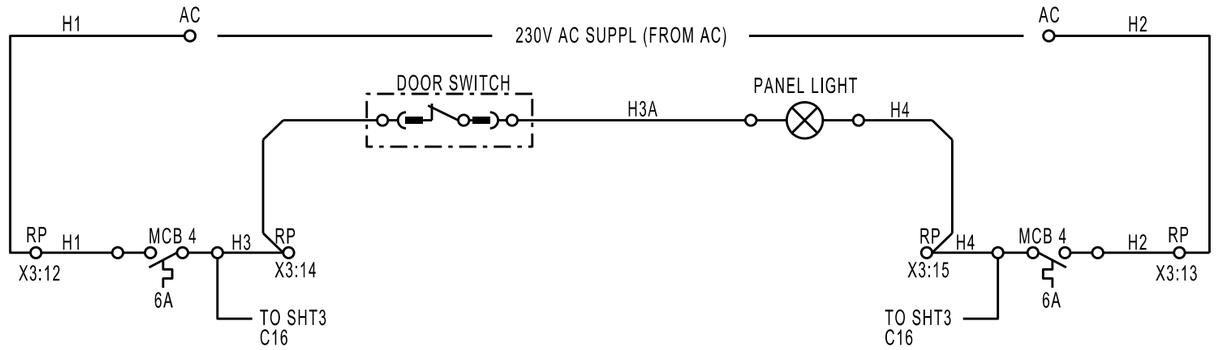


DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - ITEM NO : - MATERIAL : - VERSION INFO : REDRAWN INTO TRANSNET DRAWINGS	+ 23/04/2024 APPROVED	+ AUTHORISED	25kV INCOMER RELAY PANEL ACTUATOR AS KEY DIAGRAM	TRANSNET freight rail BBH6954 SHT 9 OF 9 VERSION 1 A3

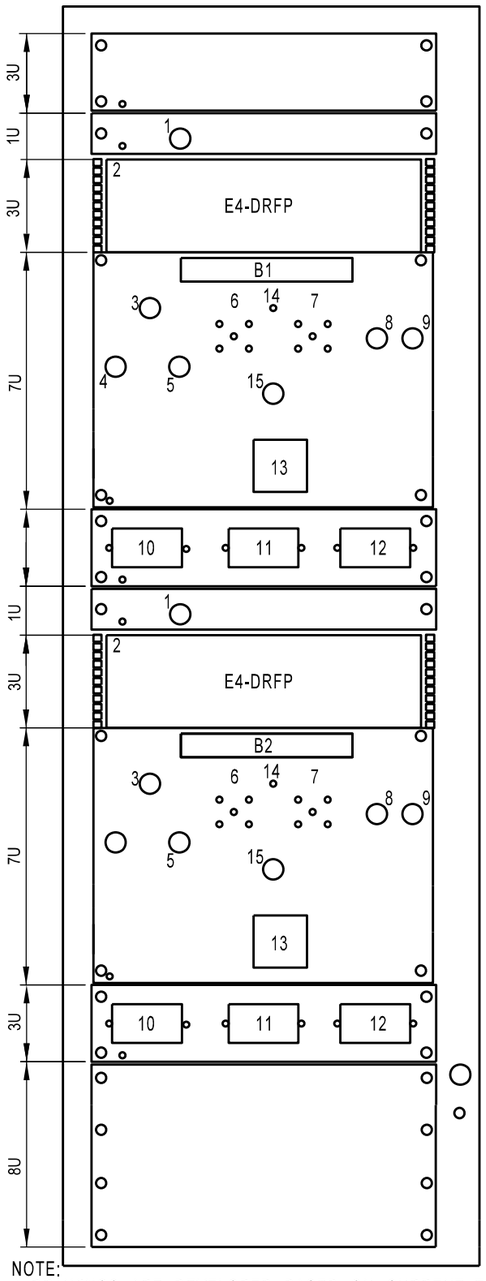
DO REF: CDO/ E0529 ECP REF: - DRAWN: L.S KEKANE DESIGNED: - CHECKED: X.R BHOMELA

HOAC-HO-52920

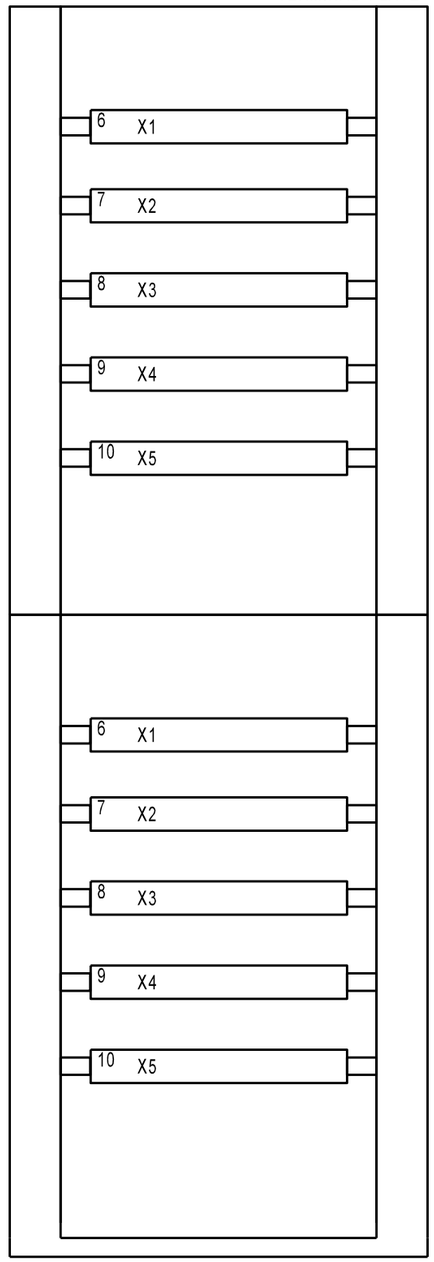
ANNEXURE A3- DRAWINGS BBH6955 VERSION 3

"THIS DRAWING CONTAINS PERSONAL INFORMATION AS DEFINED IN THE PROTECTION OF PERSONAL INFORMATION ACT, 2013 (POPIA). THE INFORMATION CONTAINED HEREIN WILL BE PROCESSED IN ACCORDANCE WITH THE PROVISIONS OF POPIA".

FRONT VIEW



TERMINAL PLATE



POSITION		DESIGNATION	DESCRIPTION	MANUFACTURER CATALOG NUMBER	MANUFACTURER
FRONT VIEW OF PANEL					
	B1	LABEL	25kV FEEDER BREAKER PANEL (V21)		
	B2	LABEL	25kV FEEDER BREAKER PANEL (V22)		
	1	PNH	PROTECTION NOT HEALTHY LAMP (YELLOW)		AC/DC
	2	E4-DRFP	DISTANCE PROTECTION RELAY		PROTECTA
	3	READY	CIRCUIT BREAKER LAMP (WHITE) (READY)		AC/DC
	4	OPEN	CIRCUIT BREAKER LAMP (GREEN) (OPEN)		AC/DC
	5	CLOSED	CIRCUIT BREAKER LAMP (RED) (CLOSED)		AC/DC
	6	CB CONTR	CIRCUIT BREAKER CONTROL SWITCH		KRAUS
	7	LOCAL/REMOTE	LOCAL REMOTE SWITCH		KRAUS
	8	LAMP TEST	LAMP TEST PUSH BUTTON		AC/DC
	9	ARC ENABLED	AUTO RECLOSE LAMP (ORANGE)		AC/DC
	10	VTTB	VOLTAGE TRANSFORMER TEST BLOCK		ALBRO
	11	METTB	METERING TEST BLOCK		ALBRO
	12	PTTB	PROTECTION TEST BLOCK		ALBRO
	13	A	AMMETER		AC/DC
	14	ESD	ELECTROSTATIC DISCHARGE CONNECTION		AC/DC
	15	ARC-ENABLE	AUTO-RECLOSE ENABLE SWITCH		
REAR VIEW OF PANEL					
	X1				
	1	MCB1	MINIATURE CIRCUIT BREAKER (CONTROL)		GE
	2	MCB2	MINIATURE CIRCUIT BREAKER (TRIP & ALARMS)		GE
	3	MCB3	MINIATURE CIRCUIT BREAKER (INDICATION LIGHTS)		GE
	4	MCB4	MINIATURE CIRCUIT BREAKER (PANEL LIGHT)		GE
	5	MCB5	MINIATURE CIRCUIT BREAKER (VOLTAGE TRFR)		GE
	6	DEHNGAP 1	SURGE PROTECTION PHASE TO PHASE (255V AC)		DEHN
	7	DEHNGAP 2	SURGE PROTECTION PHASE TO EARTH (255V AC)		DEHN
	8	DEHNGAP 3	SURGE PROTECTION PHASE TO EARTH (255V AC)		DEHN
	9	DEHNGUARD 1	SURGE PROTECTION POSITIVE TO NEGATIVE (150V/75V DC)		DEHN
	10	DEHNGUARD 2	SURGE PROTECTION POSITIVE TO EARTH (150V/75V DC)		DEHN
	11	DEHNGUARD 3	SURGE PROTECTION NEGATIVE TO EARTH (150V/75V DC)		DEHN
	X2				
	1	ST-X	SUPERVISORY TRIP AUXILIARY RELAY		RELE
	2	SC-X	SUPERVISORY CLOSE AUXILIARY RELAY		RELE
	3	DCF-X	DC FAIL AUXILIARY RELAY		RELE
	4	U/V	110V/48VDC UNDERVOLTAGE RELAY		RHOMBERG
	5	PNH-X	PROTECTION NOT HEALTHY AUXILIARY		RELE
	6	CH-X	CLOSE INHIBIT AUXILIARY RELAY		RELE
	7	VTMCB-X	VOLTAGE TRANSFORMER MINIATURE CIRCUIT BREAKER AUXILIARY		RELE
	8	VCB-X	MV CIRCUIT BREAKER OPEN AUXILIURY RELAY		RELE
	9	ARC-X	AUTO CLOSE AUXILIARY RELAY		RELE
	10	L/R-X	LOCAL REMOTE AUX RELAY		RELE
	X3				
		CT & VT	CURRENT & VOLTAGETRANSFORMER TERMINALS		VIKING
	X4				
		CON & IND	220VAC & 110V/48V DC CONTROLS & INDICATIONS TERMINALS		VIKING
	X5				
		TELE	TELE CONTROL TERMINALS		VIKING
		DIODE	DIODE BOARD		IST

NOTE:
1. DRAWINGS ARE DEVELOPED BASED ON CURRENT TECHNOLOGY,
PLEASE CONTACT TECHNOLOGY MANAGEMENT FOR SITE SPECIFIC DRAWINGS OR PROPOSED TECHNOLOGIES.
2. 1U=44.45mm THE SCHEME IS DESIGNED FOR MOUNTING A 19 INCH RACK SYSTEM AS PER IEC 60297
THE MODULE AND BACK PLATE ARE 482.6mm WIDE. THE MODULES IS 600mm DEEP. FEEDER IN BROKEN LINE.
3. CONTROL VOLTAGE IS SITE SPECIFIC.
4. 75VDC AND 150VDC SURGE PROTECTION TO BE USED FOR 48VDC AND 110VDC CONTROL VOLTAGE, RESPECTIVELY.
5. IT IS DESIRED THAT EACH TERMINAL STRIP SHOULD HAVE 4 SPARE CONNECTION POINTS.

DIMENSIONS : mm SCALE : -
TOLERANCE : LIN± - ANG± - ITEM NO : -
MATERIAL : -
VERSION INFO : BLOCKING DIODES ADDED TO THE FEEDER CB & MOD INTERLOCK TRIP CIRCUIT IN SHEET 4 OF 9.

04/06/2025
APPROVED: TJ SELEMELA

AUTHORISED: T CHETTY

DUAL FEEDER 25kV RELAY PANEL EQUIPMENT LAYOUT

TRANSNET freight rail

BBH6955 SHT 1 OF 9
VERSION 3 A3

DO REF: CDO/ E0850 ECP REF: - DRAWN: X.R BHOMELA DESIGNED: - CHECKED: L.S KEKANE

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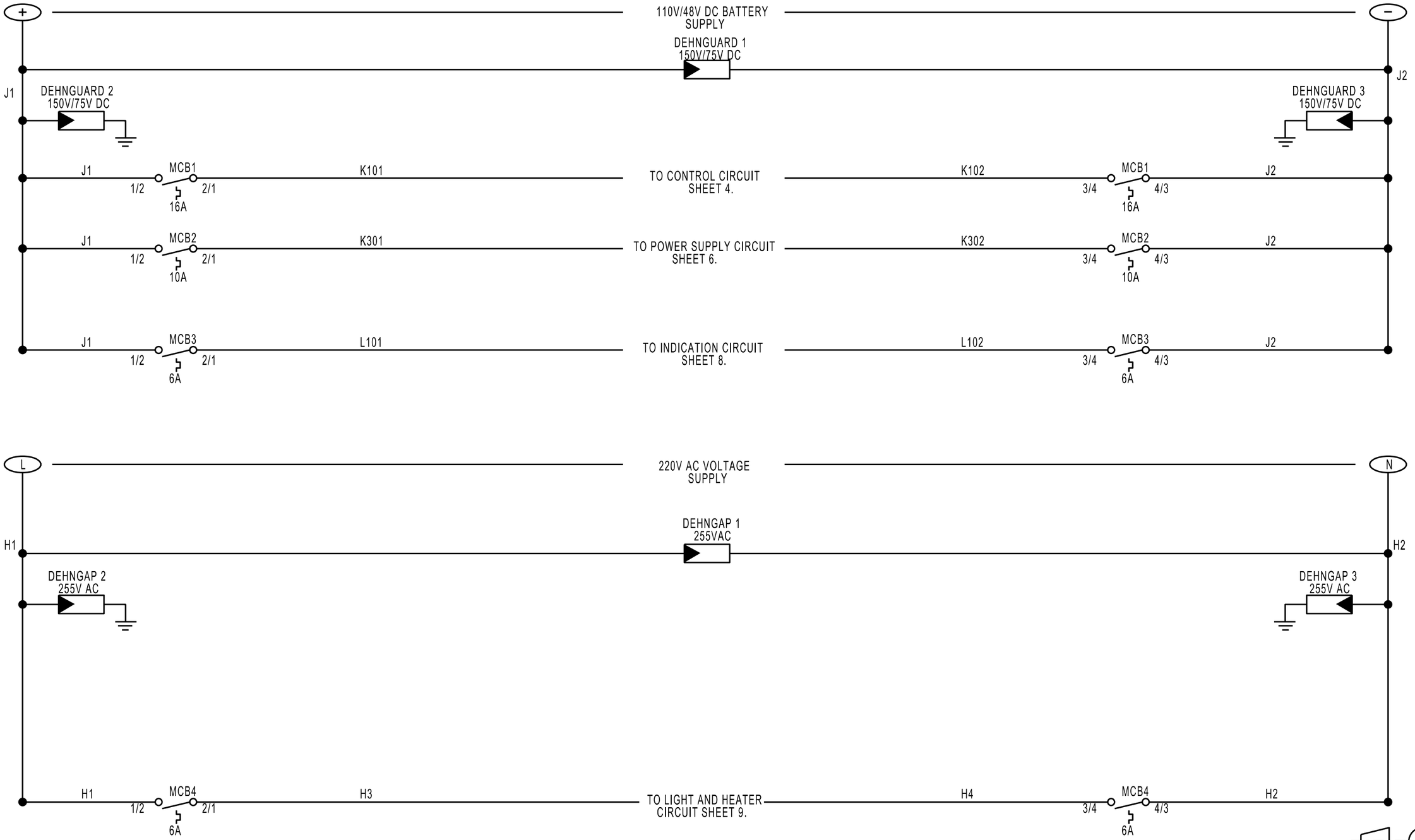

	DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - MATERIAL : -	DUAL FEEDER 25kV RELAY PANEL AC/DC SUPPLY DIAGRAM	TRANSNET freight rail BBH6955 SHT 2 OF 9 VERSION 3 A3
	DRAWN : XR BHOMELA CHECKED : LS KEKANE		

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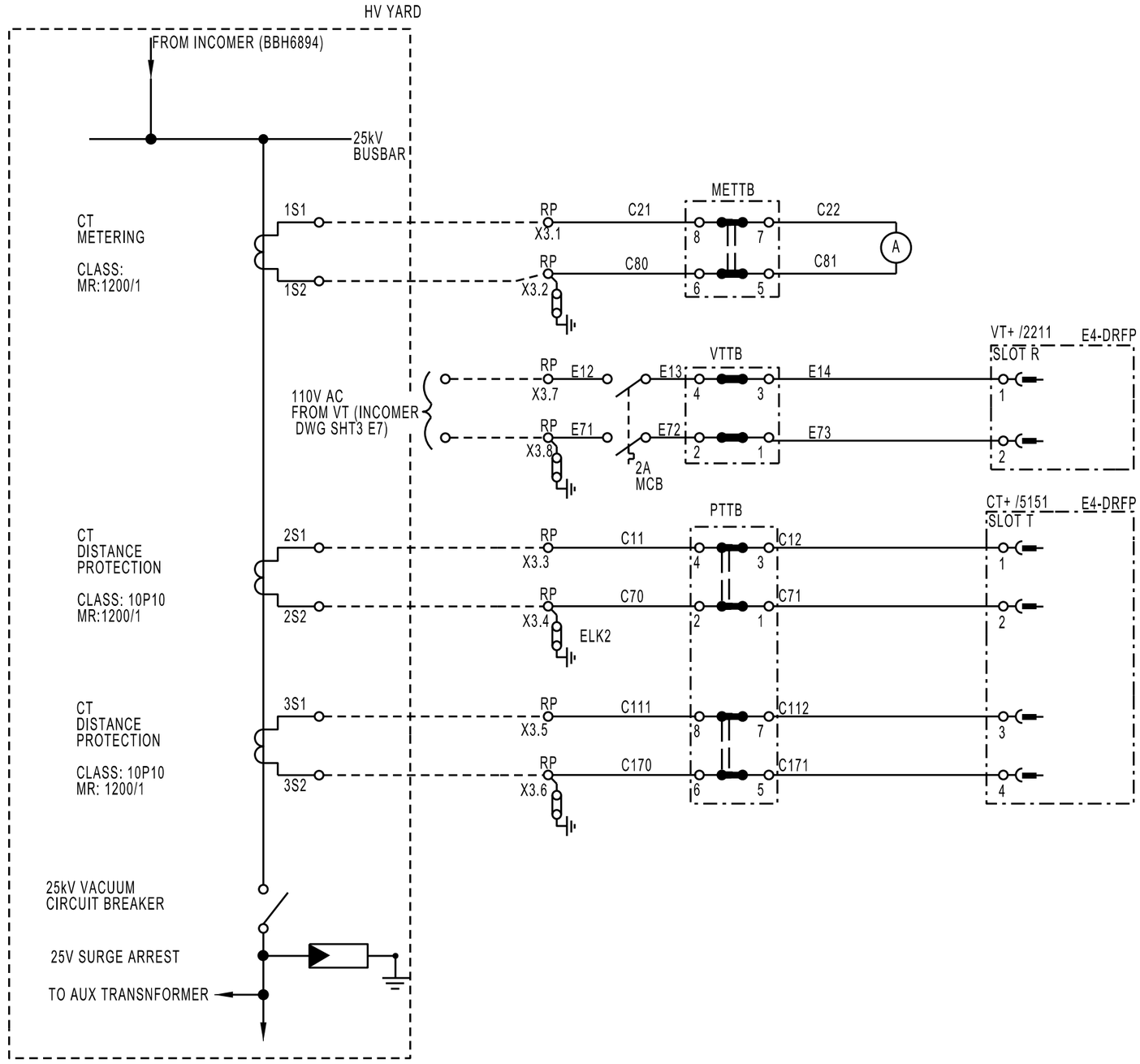

DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - MATERIAL : - DRAWN : XR BHOMELA CHECKED : LS KEKANE	DUAL FEEDER 25kV RELAY PANEL AC KEY DIAGRAM	TRANSNET freight rail BBH6955 SHT 3 OF 9 VERSION 3 A3

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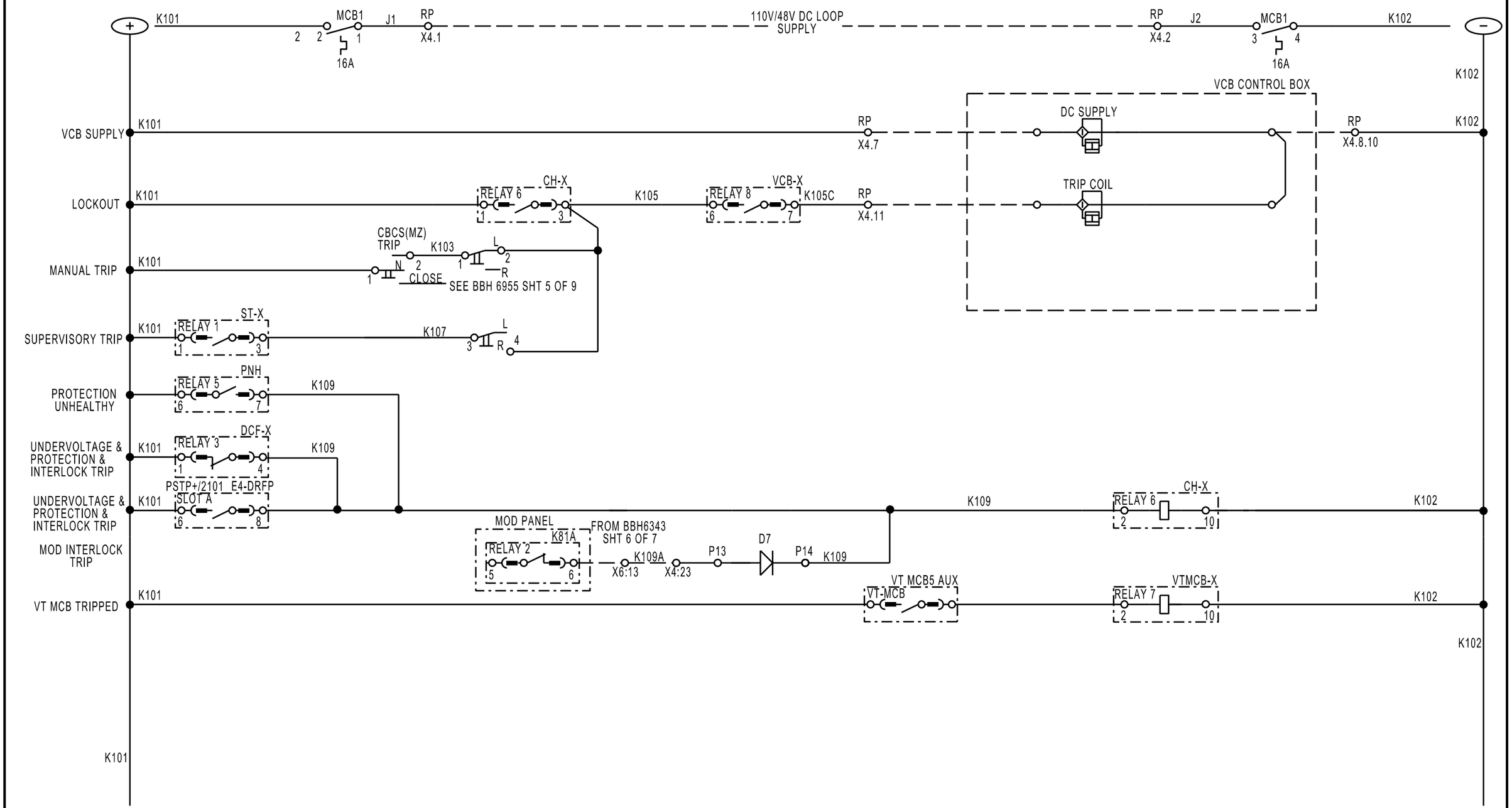

NOTE:
FOR BREAKER CONTROL BOX CONNECTIONS, CONSULT MANUFACTURER MANUAL.

	DIMENSIONS : mm TOLERANCE : LIN± - ANG± - MATERIAL : -	DUAL FEEDER 25kV RELAY PANEL TRIP DC LINE DIAGRAM	TRANSNET freight rail BBH6955 SHT 4 OF 9 VERSION 3 A3
	SCALE : - DRAWN : XR BHOMELA CHECKED : LS KEKANE		

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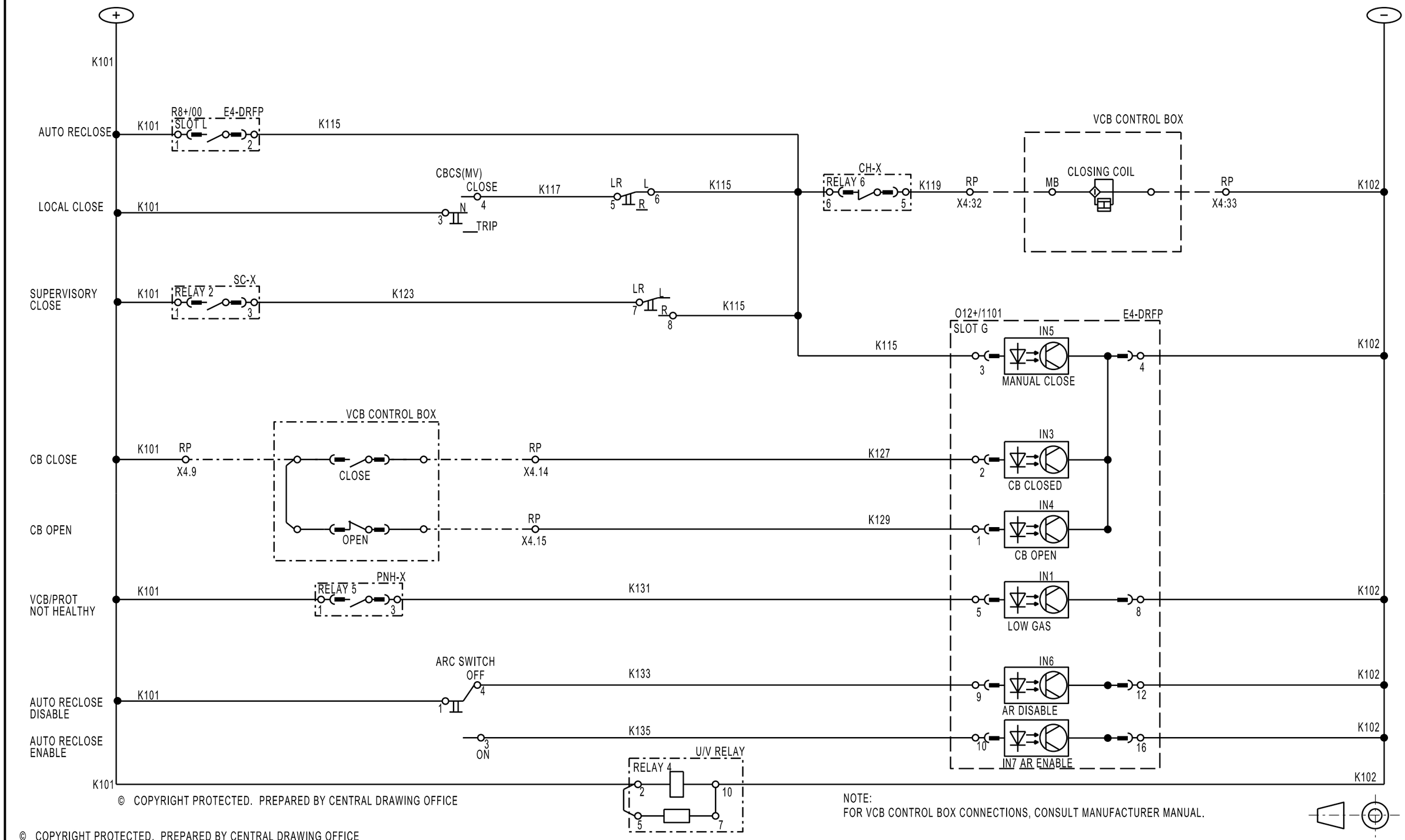

NOTE:
FOR VCB CONTROL BOX CONNECTIONS, CONSULT MANUFACTURER MANUAL.

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DIMENSIONS : mm TOLERANCE : LIN± - ANG± - MATERIAL : -	SCALE : -	DUAL FEEDER 25kV RELAY PANEL CLOSE DC LINE DIAGRAM
DRAWN : XR BHOMELA	CHECKED : LS KEKANE	TRANSNET freight rail BBH6955 SHT 5 OF 9 VERSION 3 A3

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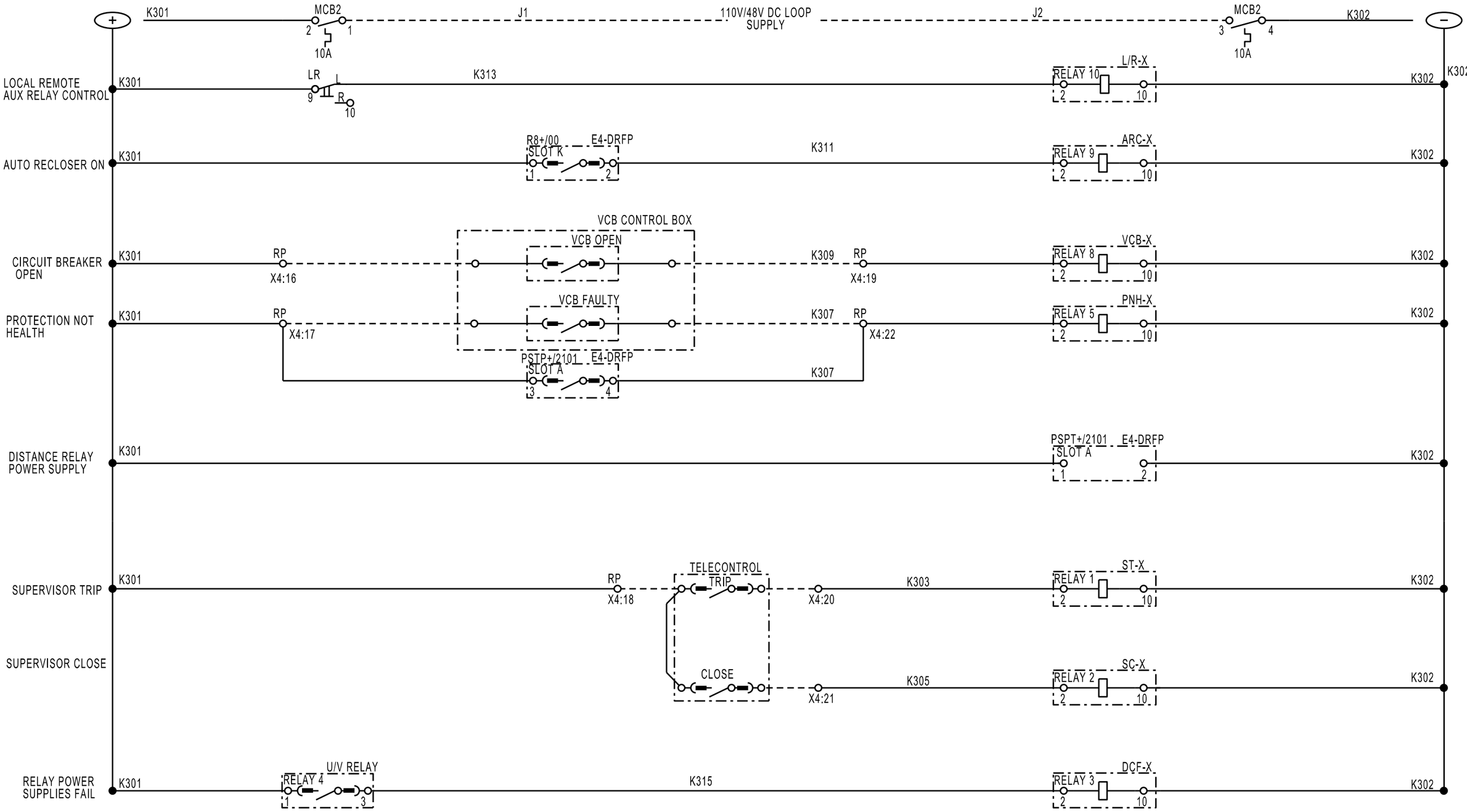

	DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - MATERIAL : - DRAWN : XR BHOMELA CHECKED : LS KEKANE	DUAL FEEDER 25kV RELAY PANEL TRIP AND ALARMS DC DIAGRAM

TRANSNET freight rail

BBH6955 SHT 6 OF 9

VERSION 3 A3

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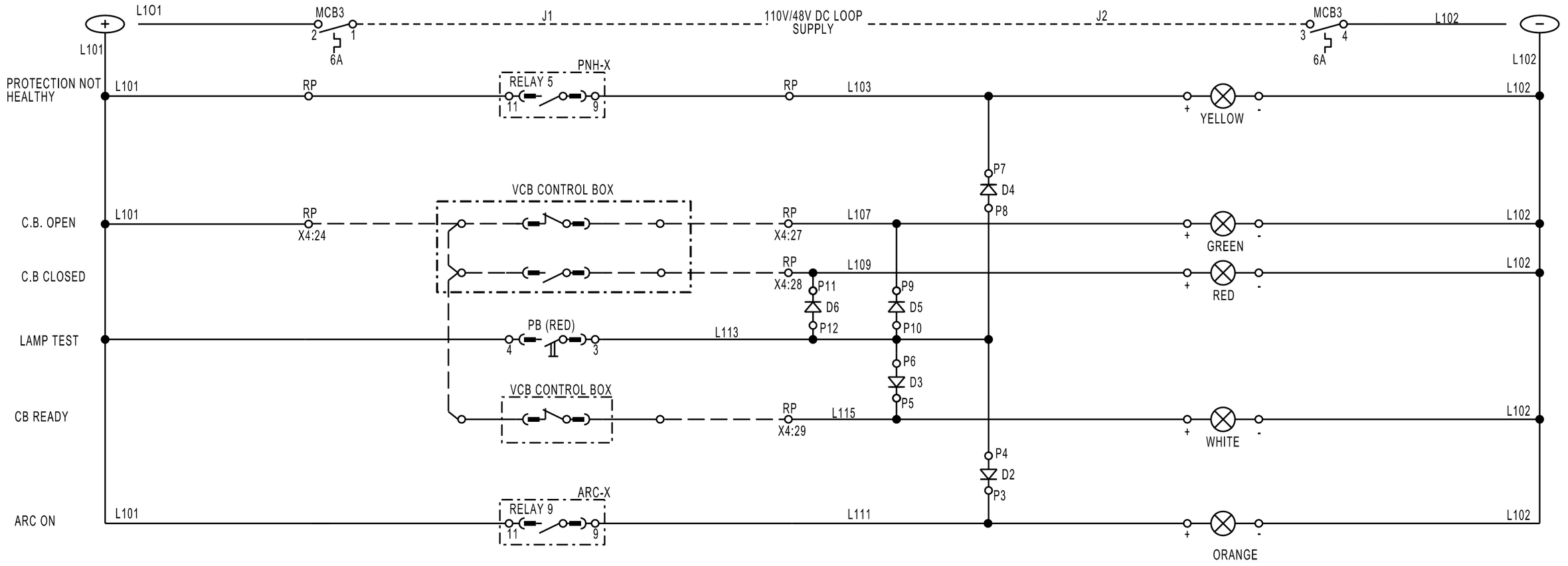

NOTE:
CONSULT MANUFACTURER MANUAL FOR VCB CONTROL BOX CONNECTIONS.

	DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - MATERIAL : - DRAWN : XR BHOMELA CHECKED : LS KEKANE	DUAL FEEDER 25kV RELAY PANEL INDICATION DC KEY DIAGRAM

TRANSNET freight rail

BBH6955 SHT 7 OF 9

VERSION 3 A3

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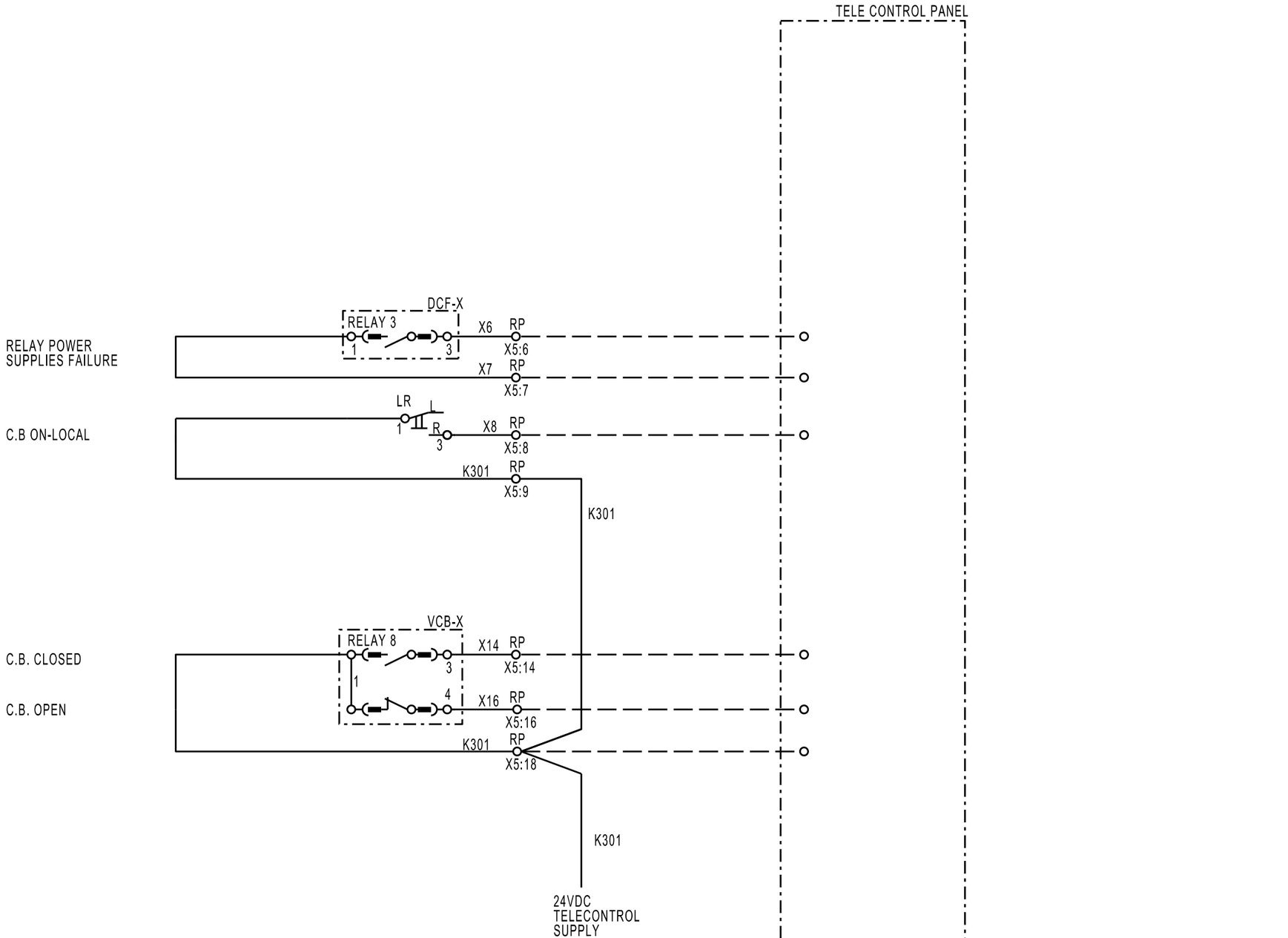

NOTE:
TELECONTROL DEPARTMENT TO BE CONSULTED FOR CONNECTIONS TO THE TELECONTROL PANEL.

	DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - MATERIAL : - DRAWN : XR BHOMELA CHECKED : LS KEKANE	DUAL FEEDER 25kV RELAY PANEL SUPERVISORY DIAGRAM	TRANSNET freight rail BBH6955 SHT 8 OF 9 VERSION 3 A3

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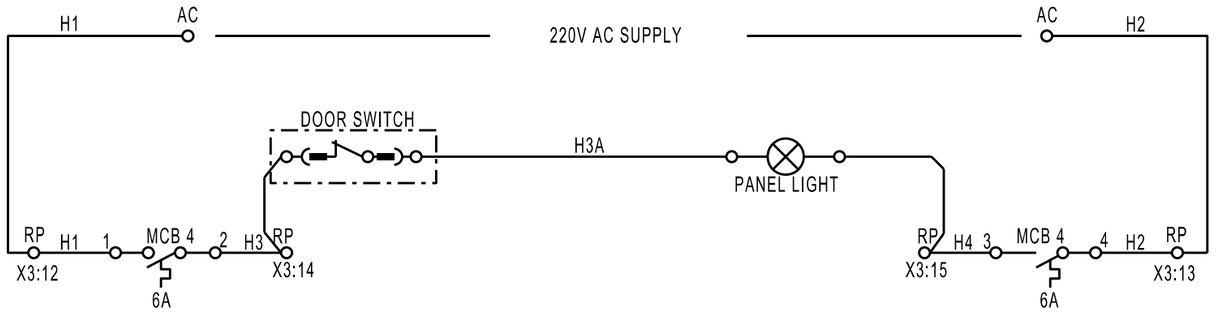
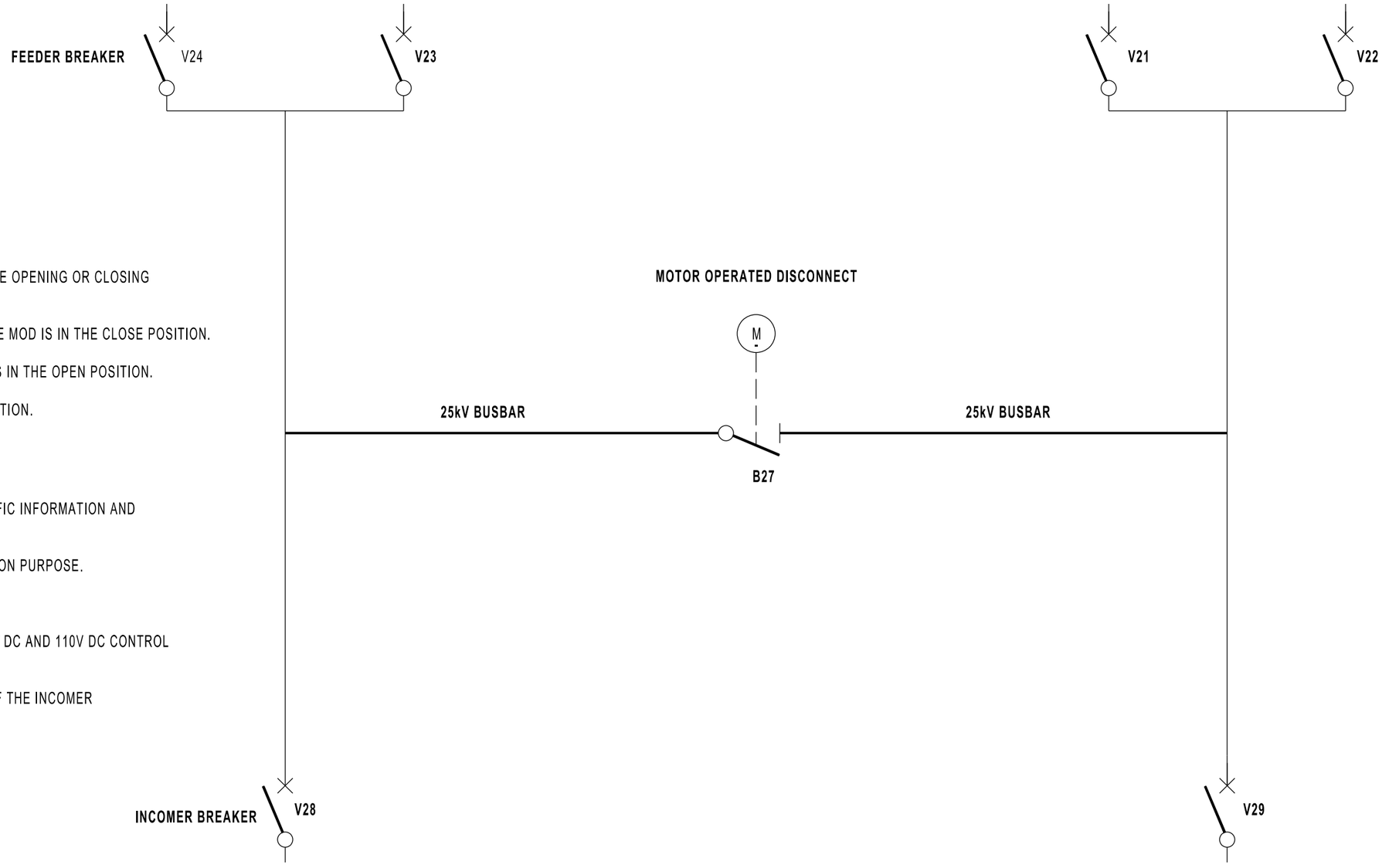


DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - MATERIAL : -	DUAL FEEDER 25kV RELAY PANEL LIGHT DIAGRAM	TRANSNET freight rail BBH6955 SHT 9 OF 9 VERSION 3 A3
DRAWN : XR BHOMELA CHECKED : LS KEKANE		

HOAC-HO-52920

ANNEXURE A4- DRAWINGS BBH6343 VERSION 4

"THIS DRAWING CONTAINS PERSONAL INFORMATION AS DEFINED IN THE PROTECTION OF PERSONAL INFORMATION ACT, 2013 (POPIA). THE INFORMATION CONTAINED HEREIN WILL BE PROCESSED IN ACCORDANCE WITH THE PROVISIONS OF POPIA".



SWITCHGEAR INTERLOCKING RULES:

1. TRIP ALL INCOMER AND FEEDER BREAKERS WHEN STARTING THE OPENING OR CLOSING OPERATION OF THE MOD.

2. ONLY ONE INCOMER BREAKER IS ALLOWED TO CLOSE WHEN THE MOD IS IN THE CLOSE POSITION.

3. BOTH INCOMER BREAKERS CAN BE CLOSED ONLY WHEN MOD IS IN THE OPEN POSITION.

4. MOD CANNOT CLOSE IF BOTH INCOMERS ARE IN A CLOSED POSITION.

NOTES:

1. DRAWING IS DEVELOPED BASED ON CURRENT TECHNOLOGY.

2 PLEASE CONTACT TECHNOLOGY MANAGEMENT FOR SITE SPECIFIC INFORMATION AND PROPOSED TECHNOLOGIES.

3.DESIGNATION OF BREAKERS AND MOD IS ONLY FOR ILLUSTRATION PURPOSE.

4. MANUFACTURER TO PROVIDE AS WIRED DRAWINGS.

5. 75V DC AND 150V DC SURGE PROTECTION TO BE USED FOR 48V DC AND 110V DC CONTROL VOLTAGE , RESPECTIVELY.

6. MOD BUS COUPLER PANEL TO BE INCORPORATED INTO ONE OF THE INCOMER BREAKER PANEL (BBH6954) IN 25kV DOUBLE UNIT SUBSTATIONS.

DIMENSIONS : mm TOLERANCE : LIN± - ANG± - VERSION INFO :1. BLOCKING DIODES ADDED TO THE FEEDER CB INTERLOCK TRIP CIRCUIT IN SHEET 6 OF 7. 2. ADDED N/C CONTACT PARALLEL TO N/O CONTACT OF THE 25kV SECONDARY ISOLATOR INTERLOCK IN SHEET 6 OF 7.	SCALE : NTS ITEM NO : -	04/06/2025 APPROVED: TJ SELEMELA	AUTHORISED: T CHETTY

25kV MOD BUS COUPER PANEL (HV SINGLE LINE DIAGRAM)

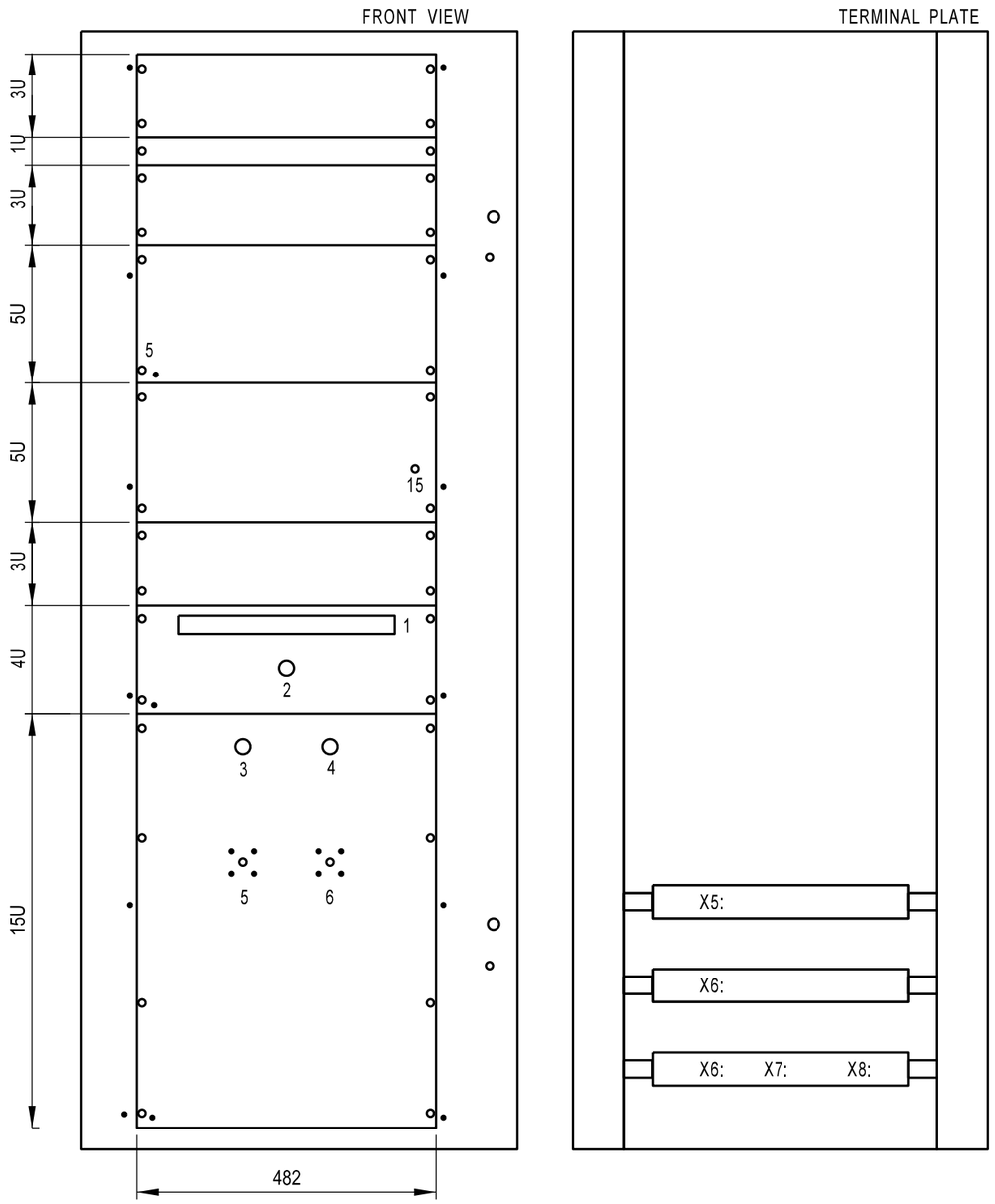
TRANSNET rail infrastructure manager

BBH6343 SHT 1 OF 7

VERSION 4 A3

DO REF: CDO/ E0850 ECP REF: - DRAWN: XR BHOMELA DESIGNED: - CHECKED: LS KEKANE

"THIS DRAWING CONTAINS PERSONAL INFORMATION AS DEFINED IN THE PROTECTION OF PERSONAL INFORMATION ACT, 2013 (POPIA). THE INFORMATION CONTAINED HEREIN WILL BE PROCESSED IN ACCORDANCE WITH THE PROVISIONS OF POPIA".



NOTE:

1. 1U = 44.45mm

2. THE SCHEME IS DESIGNED FOR MOUNTING A 19 INCH RACK SYSTEM AS PER IEC 60297
   THE MODULE AND BACK PLATE ARE 482.6mm WIDE. THE MODULE IS 600mm DEEP.

POSITION	DESIGNATION	DESCRIPTION
FRONT VIEW OF PANEL		
1	LABEL	25kV MOD BUS COUPLER PANEL (B27)
2	LAMP TEST	LAMP TEST PUSH BUTTON (ORANGE)
3	OPEN	MOD LAMP (OPENED) (GREEN)
4	CLOSED	MOD LAMP (CLOSED) (RED)
5	MOD CONTR	MOD CONTROL SWITCH (OPEN/CLOSE)
6	LOCAL/REMOTE	LOCAL REMOTE SWITCH
REAR VIEW OF PANEL		
X5		
	TELE	TELECONTROL TERMINALS
	DIODE	DIODE BOARD (D7-D10)
X6		
	RL1	FEEDER BREAKER TRIP RELAY
	RL2	INCOMER BREAKER TRIP RELAY
	RL3	MOD CLOSED RELAY
	RL4	INCOMER (V28) CLOSED RELAY
	RL5	INCOMER (V29) CLOSED RELAY
	RL6	INCOMER (V29) CLOSE INHIBIT RELAY
	RL7	INCOMER BREAKER (V28) CLOSE INHIBIT RELAY
	RL8	MOD CLOSED RELAY
	RL9	SUPERVISORY OPEN RELAY
	RL10	SUPERVISORY CLOSE RELAY
	RL11	MOD OPENED SUPERVISORY INDICATION
	RL12	MOD CLOSED SUPERVISORY INDICATION
	MOD CON	48V/110V DC MOD PANEL CONTROL TERMINALS
X7		
	MOD IND	MOD INDICATION TERMINALS
	TELE	TELECONTROL TERMINALS
X8		
1	MCB 6	MINIATURE CIRCUIT BREAKER 6A (MOD CONTROL)
2	MCB 7	MINIATURE CIRCUIT BREAKER 6A (MOD INDICATION)
3	MCB 8	MINIATURE CIRCUIT BREAKER 6A (MOD 220V AC SUPPLY)
4	DEHNGAP 4	SURGE PROTECTION LIVE TO NEUTRAL
5	DEHNGAP 5	SURGE PROTECTION LIVE TO EARTH
6	DEHNGAP 6	SURGE PROTECTION NEUTRAL TO EARTH
7	DEHNGUARD 4	SURGE PROTECTION POSITIVE TO NEGATIVE
8	DEHNGUARD 5	SURGE PROTECTION POSITIVE TO EARTH
9	DEHNGUARD 6	SURGE PROTECTION NEGATIVE TO EARTH
10	MOD AC	MOD SUPPLY TERMINALS

DIMENSIONS : mm SCALE : NTS
TOLERANCE : LIN± - ANG± -
MATERIAL : -

DRAWN : XR BHOMELA CHECKED : LS KEKANE

MOD BUS COUPLER PANEL EQUIPMENT LAYOUT

TRANSNET rail infrastructure manager

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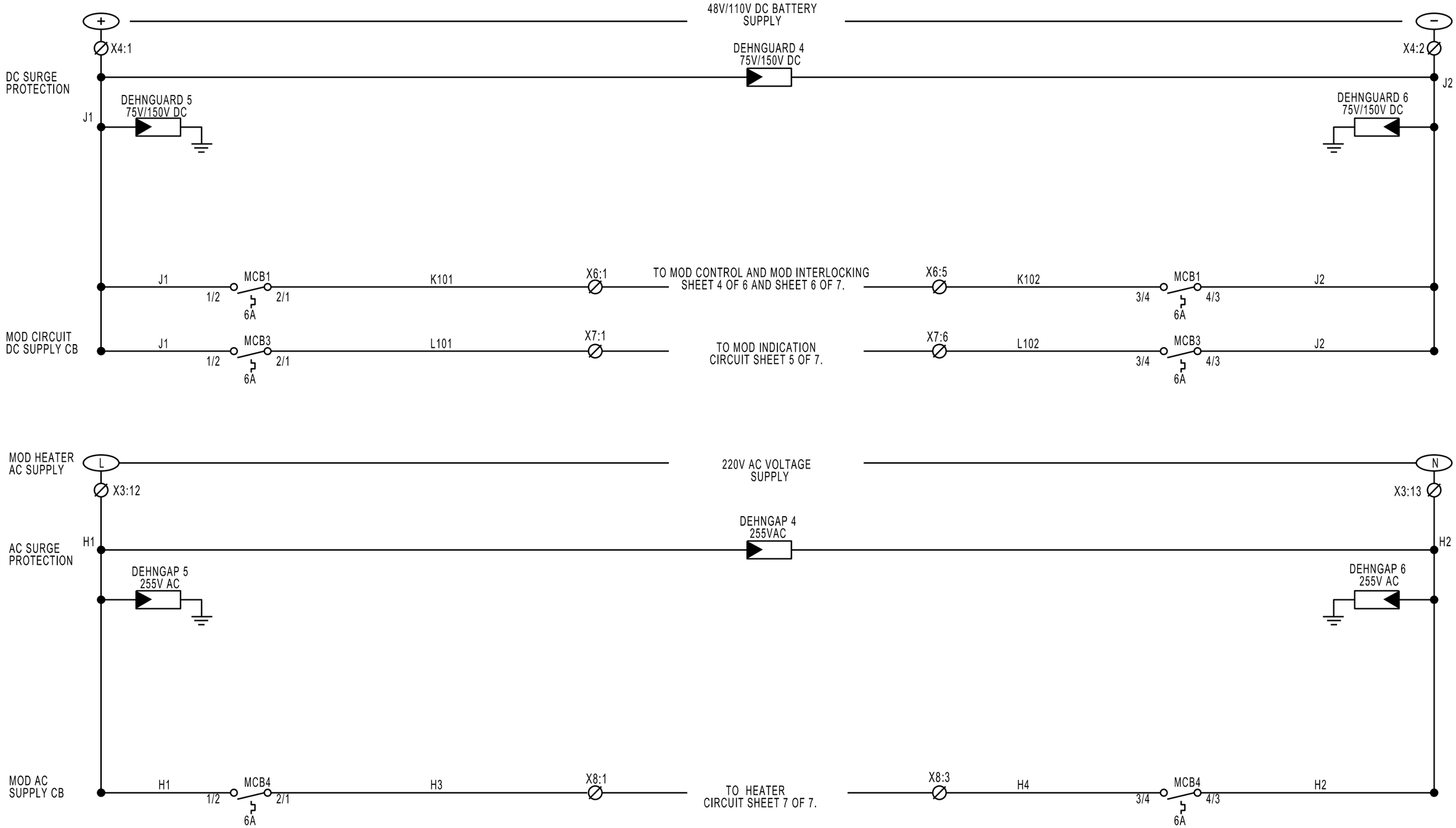

DIMENSIONS : mm TOLERANCE : LIN± - ANG± - MATERIAL : -	SCALE : NTS	25kV MOD BUS COUPLER PANEL (AC/DC SUPPLY DIAGRAM)
DRAWN : XR BHOMELA	CHECKED : LS KEKANE	TRANSNET rail infrastructure manager BBH6343 SHT 3 OF 7 VERSION 4 A3

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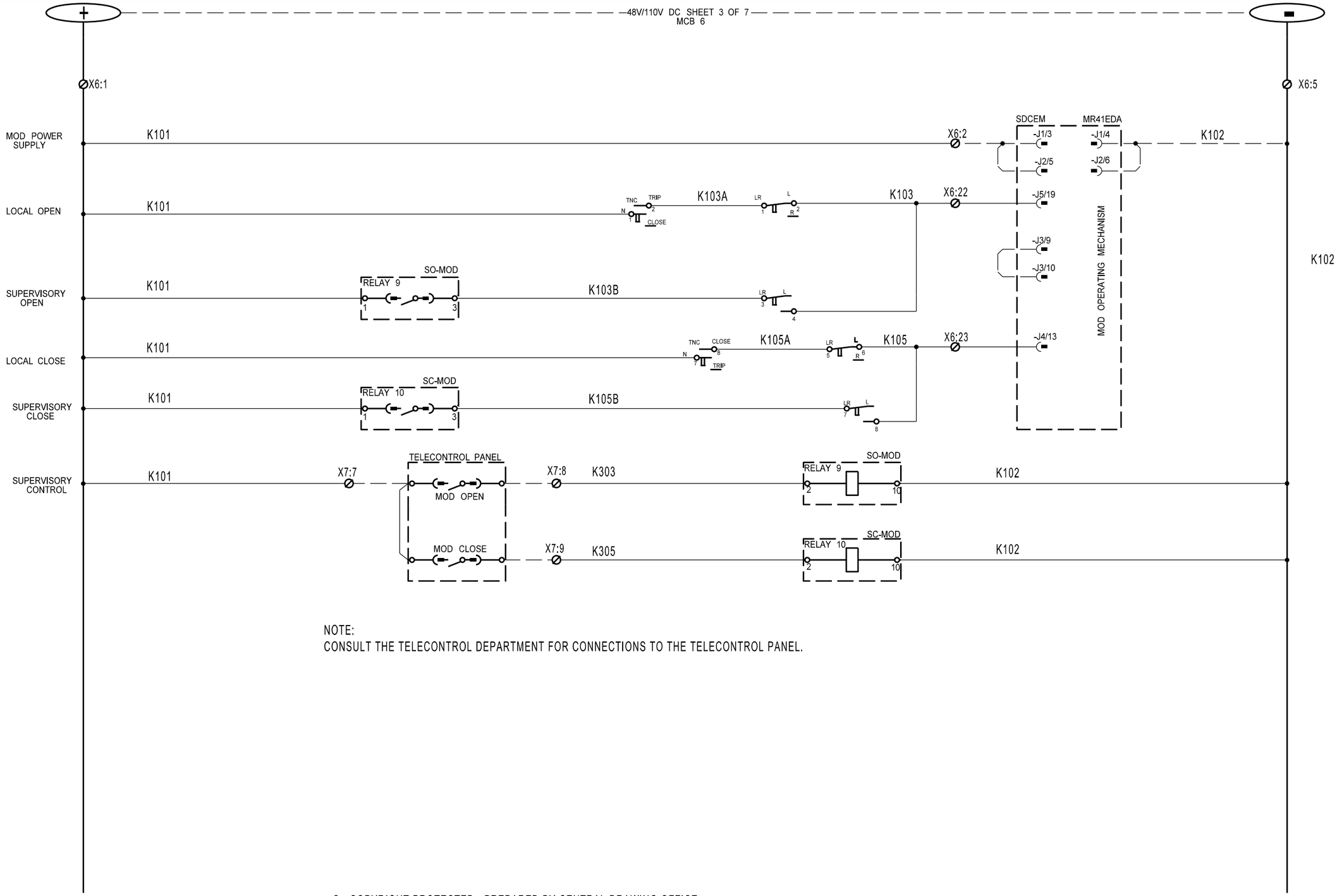

NOTE:
CONSULT THE TELECONTROL DEPARTMENT FOR CONNECTIONS TO THE TELECONTROL PANEL.

DIMENSIONS : mm	SCALE : -
TOLERANCE : LIN± - ANG± -	
MATERIAL : -	
DRAWN : XR BHOMELA	CHECKED : LS KEKANE

25kV MOD BUS COUPLER PANEL
(MOD CONTROL CIRCUIT).

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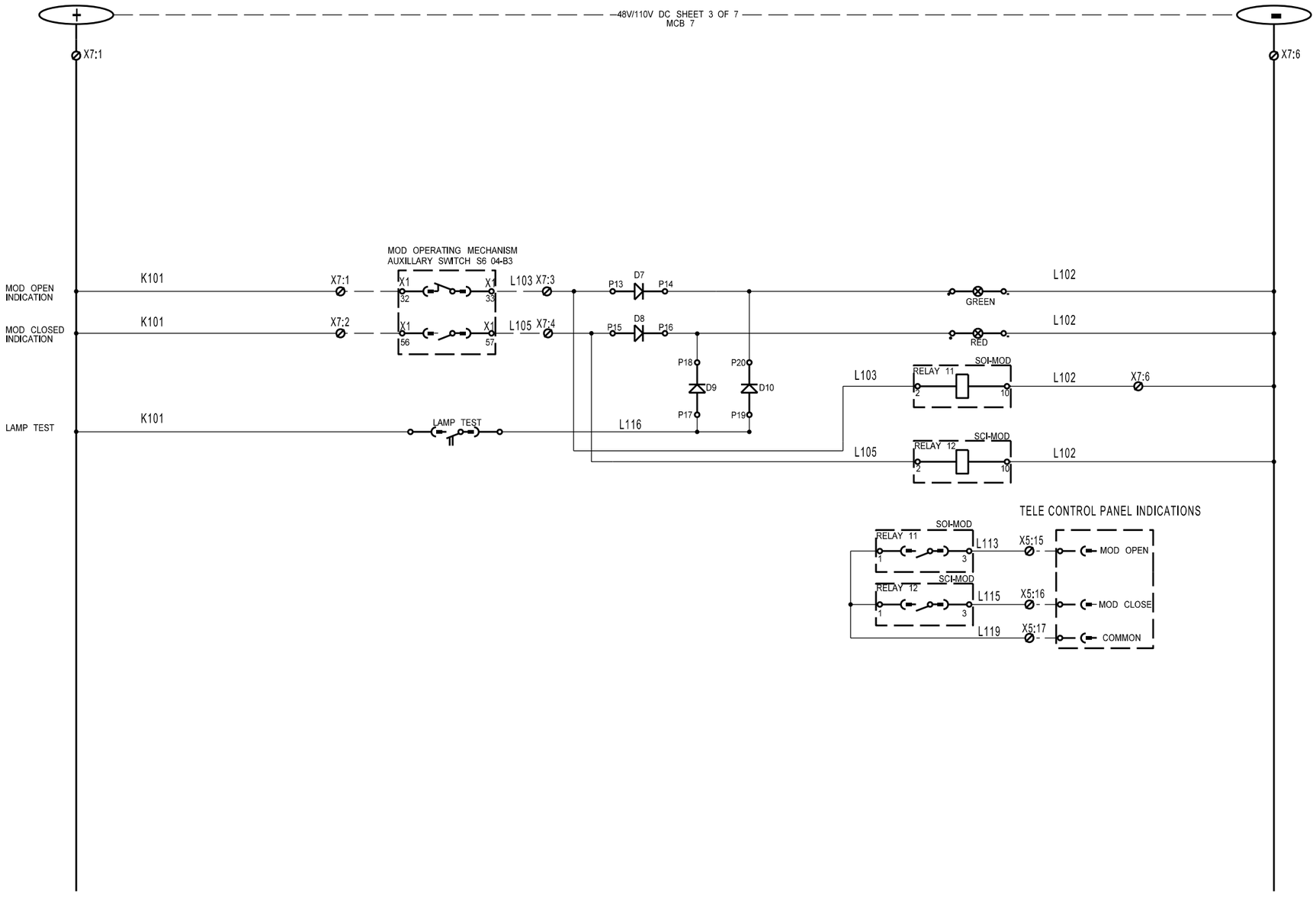

DIMENSIONS : mm	SCALE : NTS	25kV BUS COUPLER PANEL INDICATION CIRCUIT
TOLERANCE : LIN± - ANG± -		
MATERIAL : -		
DRAWN : XR BHOMELA	CHECKED : LS KEKANE	

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VERSION 4 A3

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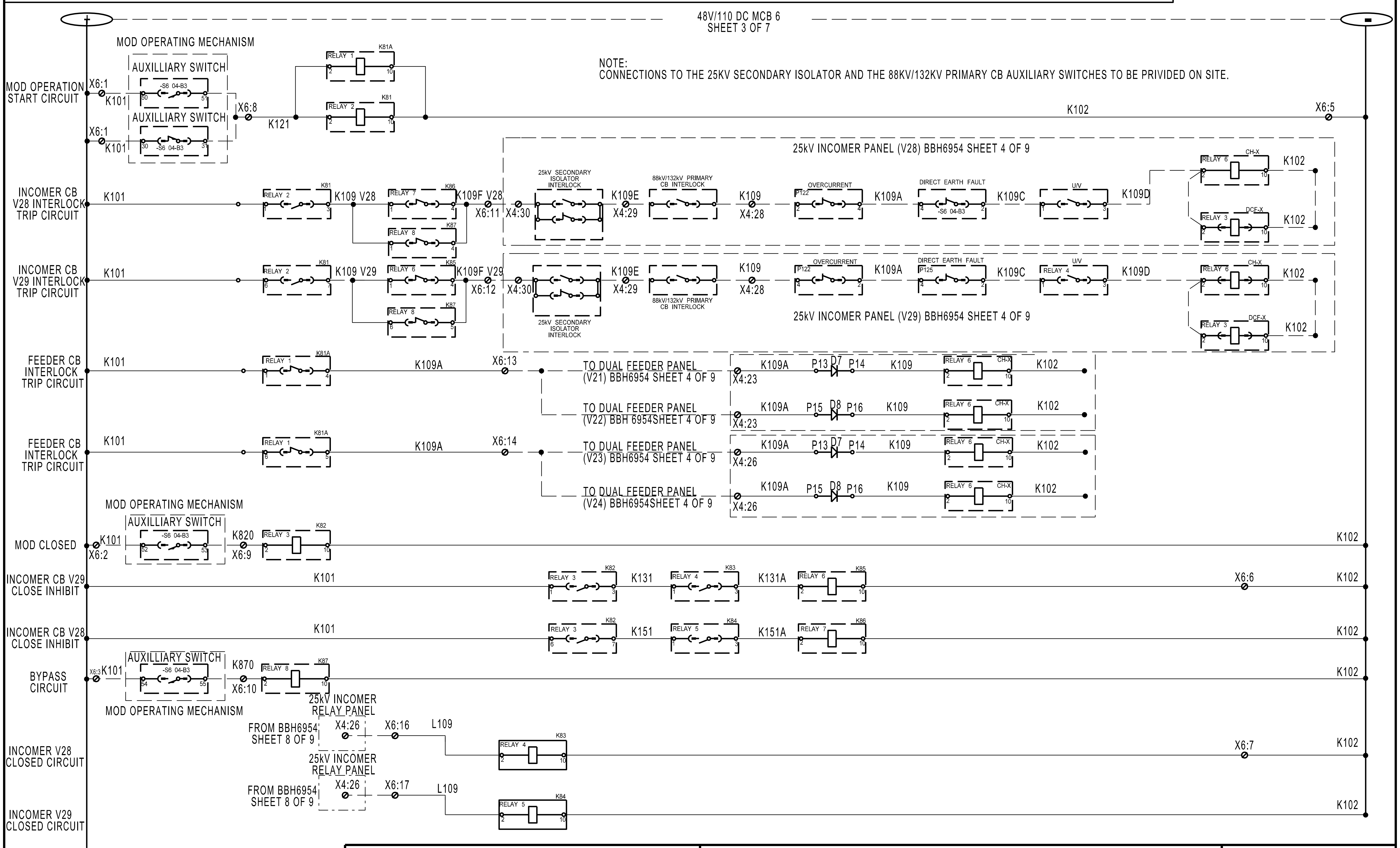

48V/110 DC MCB 6
SHEET 3 OF 7
NOTE:
CONNECTIONS TO THE 25KV SECONDARY ISOLATOR AND THE 88KV/132KV PRIMARY CB AUXILIARY SWITCHES TO BE PRIVIDED ON SITE.
MOD OPERATING MECHANISM
AUXILLIARY SWITCH
MOD OPERATION START CIRCUIT
X6:1
K101
X6:8
K121
RELAY 1
K81A
RELAY 2
K81
K102
X6:5
25kV INCOMER PANEL (V28) BBH6954 SHEET 4 OF 9
INCOMER CB V28 INTERLOCK TRIP CIRCUIT
K109 V28
RELAY 7
K86
RELAY 8
K87
K109F V28
X6:11
X4:30
25kV SECONDARY ISOLATOR INTERLOCK
K109E
X4:29
88kV/132kV PRIMARY CB INTERLOCK
K109
X4:28
OVERCURRENT
K109A
DIRECT EARTH FAULT
K109C
U/V
K109D
RELAY 6
CH-X
RELAY 3
DCF-X
INCOMER CB V29 INTERLOCK TRIP CIRCUIT
K109 V29
K85
K109F V29
X6:12
RELAY 4
25kV INCOMER PANEL (V29) BBH6954 SHEET 4 OF 9
FEEDER CB INTERLOCK TRIP CIRCUIT
X6:13
TO DUAL FEEDER PANEL (V21) BBH6954 SHEET 4 OF 9
X4:23
P13 D7 P14
TO DUAL FEEDER PANEL (V22) BBH 6954SHEET 4 OF 9
P15 D8 P16
X6:14
TO DUAL FEEDER PANEL (V23) BBH6954 SHEET 4 OF 9
X4:26
TO DUAL FEEDER PANEL (V24) BBH6954SHEET 4 OF 9
MOD CLOSED
X6:2
K820
X6:9
K82
INCOMER CB V29 CLOSE INHIBIT
K131
K83
K131A
X6:6
INCOMER CB V28 CLOSE INHIBIT
K151
RELAY 5
K84
K151A
BYPASS CIRCUIT
X6:3
K870
X6:10
25kV INCOMER RELAY PANEL
FROM BBH6954 SHEET 8 OF 9
X6:16
L109
INCOMER V28 CLOSED CIRCUIT
X6:7
X6:17
INCOMER V29 CLOSED CIRCUIT

DIMENSIONS : mm	SCALE : -	
TOLERANCE : LIN± - ANG± -		
MATERIAL : -		
DRAWN : XR BHOMELA	CHECKED : LS KEKANE	

25 kV MOD BUS COUPLER PANEL (MOD INTERLOCKING CIRCUIT)

TRANSNET rail infrastructure manager

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VERSION 4

A3

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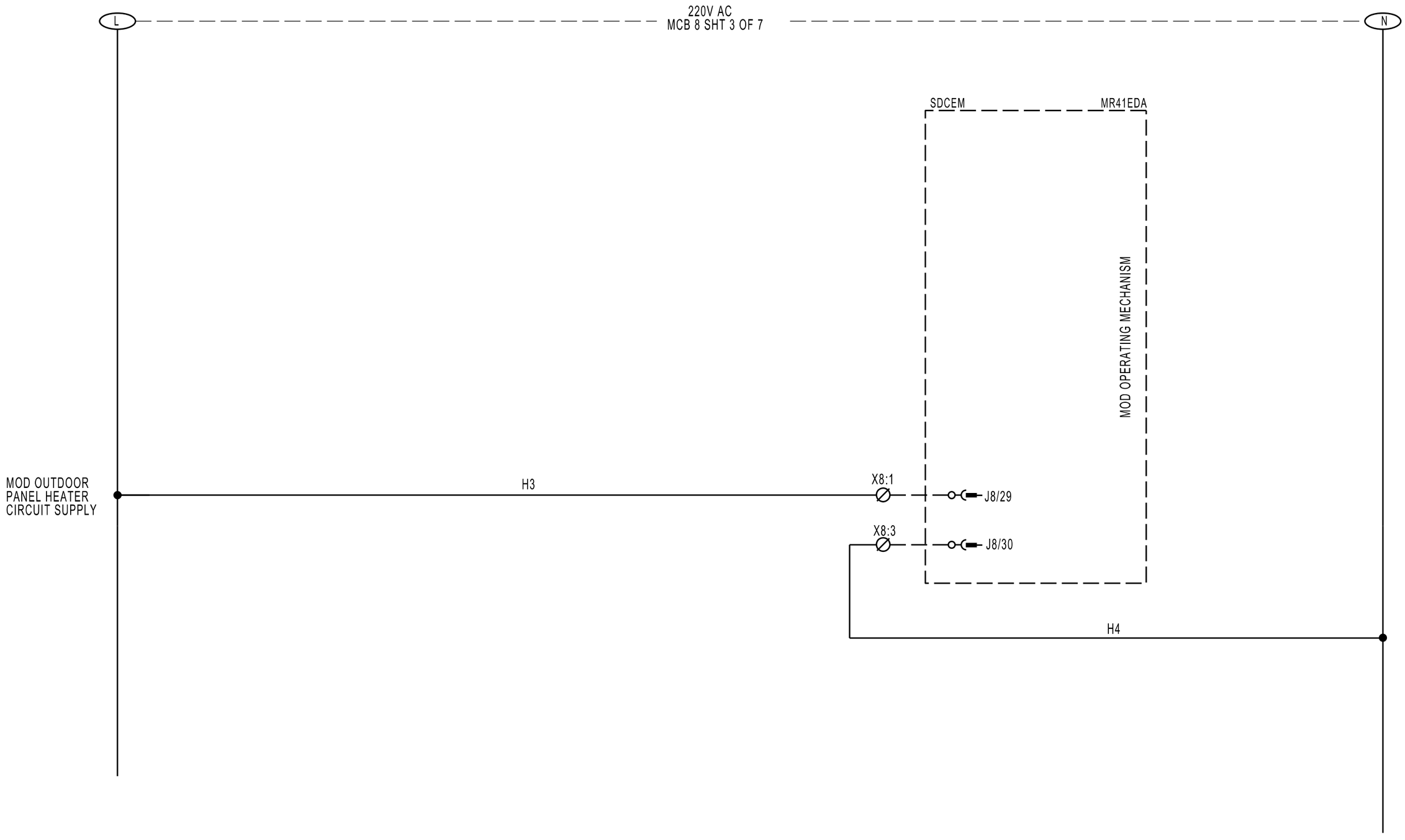

DIMENSIONS : mm SCALE : NTS TOLERANCE : LIN± - ANG± - MATERIAL : - DRAWN : XR BHOMELA CHECKED : LS KEKANE	25kV MOD BUS COUPLER PANEL (220V HEATER CIRCUIT SUPPLY)	TRANSNET rail infrastructure manager BBH6343 SHT 7 OF 7 VERSION 4 A3

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ANNEXURE A5- SPECIFICATION BBB4182 VERSION 5

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	
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Authorised:	Principal Engineer Technology Management	S.E Sibande	
Date:			30 August 2017

Circulation Restricted To:

Transnet Freight Rail

Transnet and Relevant Third Parties

DOCUMENT HISTORY:

SPECIFICATION BBB 4182 INDOOR, MEDIUM VOLTAGE METAL ENCLOSED SWITCHGEAR AND CONTROL GEAR IN ACCORDANCE WITH IEC 62271-200

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

APPENDIX 1

SCHEDULE OF REQUIREMENTS

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

A. SWITCHGEAR AND CONTROLGEAR

Number of switching devices required :……

System voltage nominal voltage :……

Number of Phases :……

Frequency (Hz) :……

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 :……..

2.2. TRIPPING SUPPLY

Rated voltage :……..

3.0. BUSBARS

3.1. Rated nominal current :……...

3.2. **Dimensions**:

Width :……....

Thickness :……

4.0. BUSBAR EARTING

Required; Yes/No

5.0. SPECIAL REQUIREMENTS FOR BUSBAR AERTHING

……..

……..

……..

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 :……

Fuse Switch combination :……

Disconnector :……

Incoming or outgoing :……

If outgoing- destination :……

With-or-non-withdrawable :……

Rated Nominal Current :……

Rated Nominal circuit breaking current :……

Rated short time withstand current for disconnector :……

Type and size of cable :……

Voltage Transformer ratio :……

C. PROTECTION SCHEDULE

UNIT NUMBER. (Panel No.) **:……..**

1.0. OVERCURRENT

Number of elements :……..

IDMT Curve :……..

IDMT Extremely Inverse :……..

High Set Instantaneous :……..

Definite Time :…… ……

2.0. EARTH FAULT

Number of elements :……..

IDMT Inverse :……..

IDMT Extremely Inverse :……..

High Set Instantaneous :……..

Instantaneous :……..

Definite Time :……..

Sensitive Earth Fault :……..

3.0. AUTO RECLOSING **:……..**

4.0. DIFFERENTIAL PILOT WIRE **:……..**

5.0. TRANSFORMER

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)

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 :……

1.2. Accuracy

Limit Factor :……

Class :……

1.3. Differential

Pilot wire :……

Feeder Ratio :……

Class X :……

1.4. FRAME LEAKAGE

Ratio :……

Class of Accuracy :……

Accuracy Limit Factor :……

1.5. Transformer Restricted Earth Fault

Ratio :……

Class of Accuracy :……

Accuracy Limit Factor :……

1.6. Transformer Differential Protection

Higher Voltage Winding Ratio :……

Lower Voltage Winding Ratio :……

Class of Accuracy :……

Accuracy Limit Factor :……

Tank Earth Protection

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 :……..

Frequency Meter :……..

Ammeter :……..

Ammeter Maximum Demand :……..

Power Factor Meter :……..

kWH Meter (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 :……..

1.4. Rated Peak Withstand Current :……..

1.5. Rated Frequency :……..

1.6. Type of Insulating Medium :……..

1.7. Rated Insulation Level :……..

1.7.1. Impulse Withstand Voltage:

a) To Earth and Between Phases :……..

b) Across the isolating distance :……..

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

a) To Earth and Between Phases :……..

b) Across the isolating distance :……..

1.8. Degree of Protection

a) For Covers :……..

b) For Partitions :……..

1.9. Method of pressure relief :……..

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

……....

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 :……

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 :……

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 :……

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 :……

3.3. Rated Normal Current :……

3.4. Rated Short Time Withstand Current :……

3.5. Rated Short Circuit Duration :……

4.0. BUSHINGS

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

……

5.0. HIGH VOLTAGE FUSES

5.1. Make of Fuse ;……

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 :……..

6.2. CT Ratio :……..

6.3. VA Rating :……..

6.4. Class of Accuracy :……..

6.5. Short Time Current and Duration :……..

6.6. Connection Type :……..

6.7. Method of Limiting Partial Discharge :……..

6.8. Maximum Partial Discharge :……..

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

……

7.0. VOLTAGE TRANSFORMER

7.1. Make :……..

7.2. Class of Accuracy :……..

7.3. Output :……..

7.4. Method of Limiting Partial Discharge :……..

7.5. Maximum Partial Discharge :……..

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

……

8.0. INDICATING INSTRUMENTS

	Accuracy	Scale length (mm)
8.1. Voltmeter	…….	…….....
8.2. Ammeter	……..	……..
8.3. Ammeter/Maximum Demand 15min	……..	……
8.4. Power Factor Meter	……..	……..
8.5. Wattmeter	……..	……...
8.6. Frequency Meter	……..	……
8.7. Ammeter Overload Rating and Duration	……	

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.

***

HOAC-HO-52920

ANNEXURE A6- SPECIFICATION BBG5882

TRANSNET
freight rail

A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

VOLTAGE TRANSFORMERS USED FOR PROTECTION AND METERING

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Authorised:	Principal Engineer Technology Management	S Sibande	

Date: 20 April 2018

Circulation Restricted To:

Transnet Freight Rail

Transnet and Relevant Third Parties

TABLE OF CONTENTS

1.0 SCOPE

1.1 This specification covers Transnet Freight Rail's requirements for the design, manufacture, testing and supply of new outdoor voltage transformers for metering and protection.

2.0 STANDARDS AND PUBLICATIONS

2.1 Unless otherwise stated, all materials used and equipment developed and supplied shall comply with the current edition of the relevant IEC and SANS publications where applicable.

2.2 The following standards are referred to in this document.

2.2.1 **International Electrotechnical Commission (IEC)**

IEC 60060-1 : High-voltage test techniques - Part 1: General definitions and test requirements.

IEC 60296 : Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear

IEC 60376 : Specification of technical grade sulfur hexafluoride (SF6) for use in electrical equipment

IEC 60480 : Guidelines for the checking and treatment of sulphur hexafluoride (SF6) taken from electrical equipment and specification for its re-use.

IEC 61869-1 : Instrument transformers part 1: General requirements.

2.2.2 **South African National Standard (SANS)**

SANS 121 : Hot dip galvanised coatings on fabricated iron and steel articles – Specifications and test methods.

SANS 61869-1 : Instrument transformers part 1: General requirements.

SANS 61869-3 : Instrument transformers part 3: Additional requirements for inductive voltage transformers.

3.0 METHOD OF TENDERING

3.1 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. This document can be used by tenderers to elaborate on their response to a clause.

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

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

3.4 Failure to comply with clauses 3.1, 3.2 and 3.3 could preclude a tender from consideration.

4.0 SERVICE CONDITIONS

4.1 ATMOSPHERIC CONDITIONS

Altitude	: 0 - 1800 m above sea level
Relative humidity	: 10% to 90%
Ambient temperature	:-10° C to +50° C
Wind pressure	: 750 Pa
Lightning conditions	: 20 ground flashes/km^2 per annum
Pollution	: Heavily salt laden with industrial pollutants including diesel-electric locomotive emissions

4.2 MECHANICAL SERVICE CONDITIONS

Traction substations are situated next to railway lines, exposing them to severe vibration. The design must take appropriate measures that will ensure reliability of the equipment under such conditions.

5.0 REQUIREMENTS FOR VOLTAGE TRANSFORMERS

5.1 GENERAL REQUIREMENTS

5.1.1 The voltage transformers shall be designed, manufactured and tested in accordance with the requirements of specification SANS 61869 part 3.

5.1.2 The voltage transformers shall be suitable for operation under the nominal phase to phase voltages or phase to neutral voltages as specified in Appendix A.

5.1.3 The voltage transformers shall be designed for outdoor use and will be of bar type.

5.1.4 The voltage transformers shall be used for metering and protection purposes.

5.2 TRANSFORMER RATINGS

5.2.1 The rated primary voltage of the voltage transformers shall range between 11kV and 220kV. This will be specified in Appendix A by TFR.

5.2.2 The rated secondary voltage of the voltage transformers shall be 110V.

5.2.3 The rated voltage factor of the voltage transformers shall be at a minimum of 1.2.

5.2.5 The ratio error of the voltage transformers shall be a maximum of 1% for both protection and metering transformers.

5.3 ACCURACY REQUIREMENTS FOR ***METERING*** VOLTAGE TRANSFORMERS

5.3.1 All voltage transformers intended for metering purposes shall be assigned a measuring accuracy class in accordance to clause 5.6.301.1 and 5.6.301.2 of SANS 61689-3.

5.3.2 The standard accuracy classes for metering voltage transformers are 0.1, 0.2, 0.5, 1.0 and 3.0. The accuracy class shall be given on the manufacturing specification given in Appendix A

5.3.3 The voltage error and phase displacement shall be in accordance to 5.6.301.3 of SANS 61689-3.

5.4 ACCURACY REQUIREMENTS FOR ***PROTECTION*** VOLTAGE TRANSFORMERS

5.4.1 All voltage transformers intended for protection purposes shall be assigned a measuring accuracy class in accordance to clause 5.6.302.1 and 5.6.302.2 of SANS 61689-3.

5.4.2 The standard accuracy classes for protection voltage transformers are 3P and 6P. The accuracy class shall be given on the manufacturing specification given in Appendix A

5.4.3 The voltage error and phase displacement shall be in accordance to 5.6.302.3 of SANS 61689-3.

5.4.4 The accuracy class for residual voltage winding shall be 6P or better.

5.5 INSULATION LEVELS AND CREEPAGE DISTANCES

5.5.1 The rated insulation levels of the voltage transformer shall be given in terms of the impulse-withstand voltage and the power-frequency withstand voltage. These insulation levels shall be tested according to SANS 60060-1.

5.5.2 The rated insulation levels of the voltage transformer shall be in accordance to Table 2 of SANS 61869-1.

5.5.4 The partial discharge level shall not exceed the limits specified in Table 3 of SANS 61869-1.

5.5.5 For outdoor instrument transformers with ceramic insulators susceptible to contamination, the creepage distances for given pollution levels are given in Table 6 of SANS 61869-1.

5.6 TEMPERATURE REQUIREMENTS OF PARTS AND COMPONENTS

5.6.1 The temperature rise of a voltage transformer at a specified voltage, at 50±2.5 Hz and highest rated burden with a power factor between 0.8 lagging and unity shall not exceed the values given in Table 5 of IEC 61869 part 1.

5.6.2 The temperature rise measured on the external surface of the core and other metallic parts of the voltage transformer where in contact with or adjacent to insulation shall not exceed the appropriate value in Table 5 of IEC 61869 part 1.

5.6.5 The temperature-rise of windings, magnetic circuits and any other parts of instrument transformers shall not exceed the appropriate value given in Table 5 of SANS 61869 part 1, when operating under the specified rated conditions. These values are based on the service conditions given in clause 4.2.1 of SANS 61869 part 1.

5.7 DESIGN AND CONSTRUCTION

5.7.1 Visual appearance shall remain acceptable.

5.7.2 Any enclosure used for the outdoor VT shall have a minimum IP rating of 65. This is to prevent any water from entering electrical connections within the enclosure.

5.7.3 Any enclosure shall be of sufficient mechanical strength. For outdoor installation without, the IK rating shall be determined by the client.

5.7.4 All bolted or screwed parts of the main circuit and enclosure shall remain easily demountable.

5.7.5 All coatings or steel used shall adhere to SANS 121.

5.7.6 Galvanic corrosion between materials in contact shall be considered as it can lead to the loss of tightness.

5.7.7 The frame of each equipment device, if intended to be earthed, shall be provided with a reliable earthing terminal for connection to an earthing conductor suitable for specified fault conditions. The connecting point shall be marked with the “earth” symbol.

5.7.8 All metal parts which do not belong to a main or an auxiliary circuit shall be earthed. The continuity of the earthing circuits shall be ensured taking into account the thermal and electrical stresses caused by the current they may have to carry.

5.8 TERMINAL MARKINGS

5.8.1 Capital letters A, B, C and N denote the primary-winding terminals and the lower case letters a, b, c and n denote the corresponding secondary terminals.

5.8.2 The markings used shall be in accordance to figures 301 to 310 of SANS 61869 part 3

5.8.3 Terminals having corresponding capital and lower case markings shall have the same polarity at the same instant.

5.9 RATING PLATE MARKINGS

5.9.1 All instrument transformers shall carry the markings given in clause 6.13 of SANS 61869 part 1. In addition to those markings stated in clause 6.13 of SANS 61869 part 1, all voltage transformers shall carry the following markings:

a) The rated primary and secondary voltage (e.g. 66/0,11 kV);
b) The rated output and the corresponding accuracy class (e.g. 50 VA Class 1.0);
c) The rated voltage factor and corresponding rated time.

NB: *When two separate secondary windings are provided, the marking should indicate the output range of each secondary winding in VA, the corresponding accuracy class and the rated voltage for each winding. For voltage transformers belonging to burden range I, this rating shall be indicated immediately before the accuracy class (e.g. 0 VA – 10 VA class 0.2)*

5.9.2 The transformers shall have a rating plate mounted onto the transformers with all the parameters mentioned in 5.9.1 of this specification. The rating plate may contain information concerning several combinations of output and accuracy class that the transformer can satisfy. The information to be provided by the tenderers/suppliers is given in Appendix B.

5.10 OTHER REQUIREMENTS

5.10.1 For oil-filled equipment, new insulating oil shall comply with IEC 60296. No liquid loss is permitted. Any liquid loss represents a danger of insulation contamination.

5.10.2 The manufacturer shall specify the type and the required quantity and quality of the gas to be used in equipment if any. New SF_6 (sulphur hexafluoride) shall comply with IEC 60376, while used SF_6 shall comply with IEC 60480. The measurement and determination of the dew point will be in accordance to IEC 60480.

6.0 TESTS

6.1 The following tests shall be conducted in accordance with Table 10 of SANS 61869 part 3 also given below:

TESTS	CLAUSE/SUB-CLAUSE
TYPE TESTS	**7.2**
Temperature-rise test	7.2.2
Impulse voltage test on primary terminals	7.2.3
Wet test for outdoor type transformers	7.2.4
Electromagnetic Compatibility tests	7.2.5
Test for accuracy	7.2.6
Verification of the degree of protection by enclosures	7.2.7
Enclosure tightness test at ambient temperature	7.2.8
Pressure test for the enclosure	7.2.9
Short Circuit Withstand Capability	7.2.301
ROUTINE TESTS	**7.3**
Power-frequency voltage withstand tests on primary terminals	7.3.1
Partial discharge measurement	7.3.2
Power-frequency voltage withstand tests between sections	7.3.3
Power-frequency voltage withstand tests on secondary terminals	7.3.4
Test for accuracy	7.3.5
Verification of markings	7.3.6
Enclosure tightness test at ambient temperature	7.3.7
Pressure test for the enclosure	7.3.8
SPECIAL TESTS	**7.4**
Chopped impulse voltage withstand test on primary terminals	7.4.1
Multiple chopped impulse test on primary terminals	7.4.2
Measurement of capacitance and dielectric dissipation factor	7.4.3
Transmitted overvoltage test	7.4.4
Mechanical tests	7.4.5
Internal arc fault test	7.4.6
Enclosure tightness test at low and high temperatures	7.4.7
Gas dew point test	7.4.8
Corrosion test	7.4.9
Fire hazard test	7.4.10
Sample Tests	7.5

APPENDIX A: MANUFACTURING SPECIFICATION

To be completed by Client (TFR)

PARAMETER	VALUE	UNIT
GENERAL DETAILS		
Transformer required for which substation		-
Nominal System Voltage		kV
Frequency		Hz
Maximum Length		mm
Maximum Breadth		mm
Maximum Height		mm
Type (Metering or Protection)		-
TECHNICAL DETAILS		
Maximum Weight		kg
Secondary Winding Configuration		-
Rated Power		MVA
Impedance		%
Primary Voltage Rating		kV
Secondary Voltage Rating		kV
Minimum Insulation Level (Frequency Withstand Voltage)		kV
Minimum Insulation Level (Impulse Voltage)		kV
Creepage Distance		mm
Ratio		
Class		
VA Rating		VA
SPECIAL REQUIREMENTS		

APPENDIX B: TRANSFORMER SPECIFICATION

To be completed by Tenderers

PARAMETER	VALUE	UNIT
Manufacturer's Name		-
Nominal System Voltage		kV
Frequency		Hz
Length		mm
Breadth		mm
Height		mm
Type (Metering or Protection)		-
Weight		kg
Winding Material (HV)		-
Winding Material (LV)		-
Secondary Winding Configuration		-
Rated Power		MVA
Impedance		%
Primary Voltage Rating		kV
Secondary Voltage Rating		kV
Minimum Insulation Level (Frequency Withstand Voltage)		kV
Minimum Insulation Level (Impulse Voltage)		kV
Creepage Distance		mm
Ratio		-
Class		-
VA Rating		VA

END

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ANNEXURE A7- SPECIFICATION CEE-0085 2010

TRANSNET
freight rail

A Division of Transnet Limited

TECHNOLOGY MANAGEMENT

SPECIFICATION

SELF-CONTAINED BATTERY AND CHARGER UNITS FOR ELECTRIC LIGHT AND POWER SUBSTATIONS

Appendix A – Schedule of requirements – to be filled in by Transnet freight rail

Author:	Chief Engineering Technician Technology Management	S.P. Rikhotso	
Approved:	Senior Engineer Technology Management	L.O. Borchard	
Authorised:	Principal Engineer Technology Management	W.A. Coetzee	

Date: 22 NOVEMBER 2010

Circulation Restricted To:

Transnet Freight Rail

Capital projects

Specification Change Summary

Title: Self-contained Battery and Charger units for electric and power

Scope: This specification covers the manufacture of self-contained low capacity battery and battery charger units, housed in steel cabinets, for providing direct supplies for high voltage switchgear closing and tripping.

Changes made to Specification

1. Converted the old SABS specifications to new SANS specification in the reference section in the document.

2. Tendering procedure was changed to new format and does not make reference to old document.

3. Service operating conditions was updated to new environmental conditions.

4. The inspection to be performed changed to Technology Management staff in the electrical section.

5. The entire document was reformatted in the new TFR format.

6. All reference to Spoornet was changed to Transnet Freight Rail.

7. CEE 0012 was replaced with Method of tendering in the document.

1.0. SCOPE

This specification covers Transnet Freight Rail's requirements for the supply and manufacture of self-contained low capacity battery and battery charger units, housed in steel cabinets, for providing direct supplies for high voltage switchgear closing and tripping.

2.0. STANDARDS AND PUBLICATIONS

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

2.1. SOUTH AFRICAN STANDARDS (SANS)

SANS 10064	: Code of practice for the preparation of steel surfaces for coatings.
SANS 1091	: National colour standard for paint
SANS 1274	: Coatings applied by powder coatings process
SANS 1652	: Battery charger- Industrial type
SANS 60335-2-29	: General purpose battery chargers
SANS 60623	: Secondary cells and batteries containing alkaline or other non-acid electrolyte – vented nickel-cadmium prismatic rechargeable single cells

TRANSNET FREIGHT RAIL

CEE.0045	: Specification for painting of steel components of electrical equipment.

3.0. APPENDICES

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

3.1 Appendix A: – **"SCHEDULE OF REQUIREMENTS"-** (To be filled in by Transnet freight rail).

This appendix details Transnet Freight Rail's specific requirements as required for a specific installation.

3.2. Appendix B – **"TECHNICAL DATA SHEET"**

This appendix calls for specific technical information to be furnished with tenders.

4.0. TENDERING PROCEDURES

4.1. The tenderers shall indicate clause by clause compliance with this specification. This shall take the form of a separate document listing all specification clause numbers indicating 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 tenderer form consideration.

5.0. SERVICE CONDITIONS

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

- Altitude : 0 to 1800m above sea level.
- Ambient temperature : -10°C to +50°C
- Relative humidity : 10% to 90%
- Lightning Conditions : 12 ground flashes per square kilometre per annum
- Pollution : Heavily salt laden or polluted with smoke from industrial sources.

6.0. GENERAL REQUIREMENTS

6.1. BATTERY AND BATTERY CHARGER CABINET

6.1.1. The cabinet shall be 1.6mm thick, sheet steel of rigid design and construction forming a self-contained unit and shall be designed for floor standing with the back of the cabinet against the wall.

6.1.2. The cabinet shall be painted in accordance to Transnet freight rail specification CEE.0045, the preparation for the coating surfaces shall be in accordance to SANS 10064, and coated in accordance to SANS 1274.

6.1.3. The finishing colour shall be Dove Grey in accordance to SANS 1091, under column colour name in Annexure B, Normative, table B.1.

6.1.4. The cabinet shall be adequately ventilated to eliminate heat built up and all possibility of hazardous conditions due to accumulation of gas.

6.1.5. The battery charger shall be housed in the same cabinet as the sealed batteries but in separate compartment.

6.1.6. The arrangement of the battery cell terminals in the battery compartment shall be readily visible and accessible from the front of the cabinet for inspection and maintenance.

6.1.7. Battery cells shall not be in physical contact or in close proximity to any component which is liable to generate heat.

6.2. BATTERY

6.2.1. The battery shall be as specified in APPENDIX 1 and shall comply with SANS 60623.

6.2.2. Nickel-Cadmium batteries shall be mounted on stepped shelves in the bottom of the charger cubicle. The shelves shall be painted with an alkaline resistant polyurethane paint.

6.2.3. The battery shall be capable to discharge and charge cycles without detrimental effects to its life.

6.2.4. The charging for battery types shall be in accordance with table 2 of SANS 1652.

6.2.5. The terminal posts must be clearly and indelibly marked to indicate their polarity.

6.3. BATTERY CONTAINER

6.3.1. Batteries containing liquid electrolyte, the cell containers shall be of transparent plastic.

6.3.2. Filter and vent plugs shall be provided to prevent spillage or creepage of electrolyte and allow easy exist of the gases during charging.

6.3.3. The normal electrolyte level and the recommended fully charged specific gravity shall be clearly embossed on the cell containers.

6.4. BATTERY CHARGER

6.4.1. The charger shall have a dual constant voltage characteristic for charging vented batteries and shall comply with SANS 60335-2-29.

6.4.2. The following facilities shall be provided:

- Automatic boost every 28 days
- Earth fault alarm
- Charge fail alarm
- Low voltage alarm
- High voltage alarm
- Automatic battery discharge test every 10 hours

6.4.3. Two sets of potential free change-over contacts shall be provided for each alarm and be rated at 1 amp with a switching capacity of 30 watts.

6.4.4. The maximum current drain on the battery from the alarm under charge fail conditions shall not exceed 60mA.

6.4.5. At the lowest rate of charge the charger shall supply the battery with the charge necessary to:

- maintain the battery in full state of charge and,
- re-charge the battery to 80% capacity within 8 hours after the battery has gone through the full discharge cycle as specified.

6.4.6. The higher rate of charge (output amps) shall not be less than 20% of the Ampere Hour (AH) capacity of the battery.

6.4.7. The charger shall incorporate the following features:

- A single phase, double wound, vacuum impregnated transformer, with an input voltage of 220/250V
- A full wave, silicon rectifier, with surge suppression,
- A flush mounted voltmeter to indicate battery voltage,
- A flush mounted ammeter to indicate charging current,
- A main switch, to isolate the AC input,
- A switch, to isolate the DC output circuit,
- A manual boost initiate, cancel pushbuttons and timer to reset to normal charging,
- Positive and negative earth fault indications and alarm with a sensitivity of 10mA.
- A charge fail alarm and indication,
- A low voltage alarm and indication operating at 85% of nominal battery voltage,
- A high voltage alarm initiated when the charging voltage exceeds 102% of float voltage for a period of 21 hours or instantaneously at 120% of nominal DC voltage,
- An automatic test facility to test the battery internal resistance every 10 hours.

6.4.8. Automatic boost charging shall be initiated every 28 days and terminated automatically 10 hours after reaching the knee point of the battery voltage charging characteristic.

- Boost charging shall also be initiated by a low voltage condition which must also be restart 28 day boost cycle.
- An override timer shall prevent boost charging for more than 21 hours.
- A red LED for boost charge indication shall be provided.

7.0. SPARES

7.1. The following accessories shall be supplied with each complete battery:

- two spares intercell connectors complete with bolts,
- one precision type hydrometer,
- thermometers, range 0˚C to 55˚C, suitable for taking cell electrolyte temperature,
- one portable type cell-testing voltmeter, with centre zero and range 3-0-3 volts.

7.2. 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,

7.3. A detailed description of each item including manufacturer's catalogue number where applicable shall be furnished.

7.4. The tenderer shall submit a separate quote for recommended spares for maintenance purposes,

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

8.0. PACKING

8.1. All equipment shall be packed in such a manner that it will be adequately protected against damage during handling and transport.

9.0. MAINTENANCE INSTRUCTIONS

9.0.1. A set of maintenance instructions for the battery including charged/discharged characteristics and wiring diagram of the equipment shall be packed with each unit and forwarded to TFR at no extra cost.

APPENDIX 1

"SCHEDULE OF REQUIREMENTS"-

(To be filled in by Transnet Freight Rail)

1.0. Item no.:……..

2.0. Required for:Traction Substation……...

3.0. System Voltage: 25KV AC……

4.0. Type of battery :

a) Open/Sealed Nickel Cadmium

b) ~~Open/Sealed Lead Acid~~

5.0. Nominal battery voltage:48v DC (as per site requirement)……...

6.0. Power and time for closing per breaker:20AH and 10A Charger……

7.0. Number of breaker to be tripped:Double Unit Substation……

8.0. Special Requirements:Transnet Frieght Rail Approved/ or comply with specification……

TECHNICAL DATA SHEET

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

1.0. Item no.:……

2.0. CABINET

2.1. Mounting:……

2.2. Dimensions:……

2.3. Type and thickness of material:……

2.4. Painting and protection against corrosion:……

2.5. Details of ventilation:……..

3.0. BATTERY

3.1. Type:……..……

3.2. Number of cells:……..

3.3. Capacity at 5-hour rate:……

3.4. Material and thickness of separators:……

3.5. Type of plates:……

3.6. Material of cell container:……..

3.7. Nominal battery voltage:……

3.8. Expected battery span:……..

4.0. BATTERY CHARGER

4.1. Lower rate of charge:……

4.2. Higher rate of charge:……

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ANNEXURE A8- SPECIFICATION CEE-0111_ISS_2019

TRANSNET
freight rail

A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT SPECIFICATION

25KV AC TRACTION SUBSTATIONS

Author:	Chief Engineering Technician Technology Management	B.L. Ngobeni	
Approved:	Senior Engineer Technology Management	S. Smit	
Authorised:	Senior Engineer Technology Management	L.O. Borchard	

Date: 18 June 2019

Circulation Restricted To:

Transnet Freight Rail

Transnet and Relevant Third Parties

"I acknowledge that this application contains personal information as defined in the Protection of Personal Information Act, 2013 (the "Act"). By accessing/using this application, I consent to the processing of my personal information in accordance with the requirements of the Act. I acknowledge that I cannot unreasonably withhold my consent. I acknowledge that the purpose for processing my personal information is in terms of this application."

INDEX

SECTION 1: SUBSTATION DESIGN INFORMATION

1.0 SCOPE

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

2.0 APPENDICES

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

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

APPENDIX 2: Schedule of requirements for AC traction substations.

APPENDIX 3: Schedule of drawings supplied by Transnet Freight Rail.

3.0 STANDARDS

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

The following publications are referred to in this specification:

3.2 BRITISH STANDARDS INSTITUTION

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

3.3 INTERNATIONAL ELECTROTECHNICAL COMMISIION

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

3.4 SOUTH AFRICAN NATIONAL STANDARDS

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

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

3.5 TRANSNET FREIGHT RAIL

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

4.0 DEFINITIONS

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

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

4.3 "Substation" refers to a traction substation.

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

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

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

4.7 A circuit breaker that is open and has an "operational inhibit" refers to a condition in which the breaker cannot be closed until certain conditions return to normal. (Thermal protection, under-voltage protection etc.)

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

4.9 "Senior Engineer" is the person appointed by Transnet Freight Rail to manage and administer the contract works.

5.0 TENDERING PROCEDURE

5.1 Tenderers shall indicate clause by clause compliance or non-compliance with the specification. This shall take the form of a separate document listing all the specifications clause numbers indicating the individual statement of compliance or non-compliance. This document can be used by tenderers to elaborate on their response to a clause.

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

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

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

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

6.0 SERVICE CONDITIONS

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

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

7.0 GENERAL REQUIREMENTS

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

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

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

7.4 Transnet Freight Rail reserves the right to subject material and equipment offered to test or inspection to check compliance with the clauses of this specification prior to adjudication or at any stage during manufacture.

7.5 The onus to prove compliance to the specification shall rest with the tenderer during the tender stage and with the successful tenderer once the contract has been awarded.

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

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

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

7.9 Any portion of the equipment which may be likely to cause injury to staff or fire by being overloaded or failing, or by an arc set up by the equipment in operation, shall be so arranged as to prevent the possibility of injury to staff as well as preventing damage to other equipment.

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

8.0 INSULATION LEVELS

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

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

8.3 Primary equipment (voltages phase to phase r.m.s) shall have a rated insulation level based on an equivalent 3 phase system as indicated in table 1:

Table 1: Insulation Levels.

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

9.0 CLEARANCES

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

Table 2: Earth Clearances

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

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

Table 3: Minimum Safety Clearances

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

10.0 CREEPAGE DISTANCES

10.1 The insulators or bushings provided on all high voltage AC disconnecting switches, circuit breakers and transformers shall comply with the requirements of SANS 60137.

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

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

Table 4: Creepage Distances

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

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

11.0 PREVENTION OF CORROSION

11.1 PREPARATION OF OUTDOOR STRUCTURAL STEELWORK.

11.1.1 Steelwork for outdoor installation in inland areas, i.e., at a distance greater than 20km from the coast, shall be hot-dip galvanised according to SANS 121 and SANS 32.

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

11.2 PREPARATION OF STEEL BUILDINGS.

Where it is impractical to galvanise large areas of sheet steel, surfaces for outdoor exposure in both inland and coastal areas shall be prepared in accordance with specification CEE0045.

11.3 HANDLING AND FINAL TREATMENT OF PAINTED STEELWORK.

11.3.1 Painted steel shall be handled with care and/or suitably packed to avoid damage during transport and installation.

11.3.2 Any damage to painted surfaces shall be repaired, after installation after which a final finish coat of the paint specified in specification CEE0045 shall be applied.

11.3.3 The following table specifies the colours in accordance with SANS 1091 to be used:

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

12.0 SUBSTATION OPERATIONAL PROTOCOLS

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

12.2 PRIMARY DISCONNECTOR

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

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

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

12.3 PRIMARY CIRCUIT BREAKERS

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

12.3.1.1 Inverse Definite Minimum time operation (Primary).

12.3.1.2 Instantaneous overcurrent operation.

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

12.3.1.4 Phase Under voltage and Overvoltage.

12.3.1.5 Utility No-Volt protection.

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

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

12.3.2.2 Transformer Buccholz first operation.

12.3.2.3 Transformer restricted earth fault.

12.3.2.4 Transformer biased differential.

12.4 SECONDARY DISCONNECTOR (25kV)

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

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

12.5 SECONDARY CIRCUIT BREAKERS (25kV)

12.5.1 **INCOMER CIRCUIT BREAKER**

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

12.5.2.1 Circuit breaker health failure.

12.5.2.2 Inverse Definite Minimum time operation (Secondary overcurrent).

12.5.2.3 Intertripping with the primary circuit breaker. If the primary circuit breaker is tripped by any of the transformer protection relays, then the incomer circuit breaker shall trip and shall not be able to close until the primary circuit breaker is closed.

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

12.5.3 It shall not be possible to parallel incoming 25kV supplies through a substation busbar coupler in double unit substations. (It must not be possible to close both Incomer circuit breakers with the Busbar coupler in the closed position) Where a busbar coupler is required in a single unit substation, this feature shall be provided for future use when the incoming supply is doubled.

12.5.4 The operation of the Busbar coupler (opening or closing) shall only be possible if all the Secondary Circuit Breakers (Incomers and Track feeders) are in the open position.

12.5.5 **TRACK FEEDER CIRCUIT BREAKERS**

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

12.5.6.1 Circuit breaker health failure.

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

12.5.6.3 Impedance distance protection operation. The breaker shall trip and the two shots auto reclose sequence will be initiated. Should the breaker trip again after the auto reclose sequence, it shall remain open. (No lockout or auto reclose)

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

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

SECTION 2: TRACTION SUBSTATION EQUIPMENT

13.0 STEELWORK

13.1 The design, supply and installation of all steel structures for the support of equipment and tensioning of conductors shall be the responsibility of the successful tenderer.

13.2 Structural steel shall comply with BS EN 10029.

13.3 All welded joints shall be seal welded with no gaps or blow holes.

13.4 All steelwork shall be hot-dip Galvanised to SANS 121.

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

- 25 kV disconnector
- 25 kV Busbar
- Lightning arrestors (for each feeder circuit)
- Auxiliary transformer
- Voltage transformer
- All Secondary Circuit Breakers (Incomer as well as the track feeders)
- All track feeder overhead feeders (500mm^2 Aluminium) shall be made off on this structure with the span length being the distance to the overhead track equipment switch structure which will be provided by others.

13.6 A typical layout of the above arrangement is shown in drawing CEE TBB 109 (Appendix 3).

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

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

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

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

14.0 PRIMARY AND SECONDARY DISCONNECTORS

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

14.2 Disconnectors and earthing switches shall be of the air break type suitable for outdoor installation and be designed for manual operation from ground level.

14.3 The primary disconnector shall be of the double pole type.

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

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

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

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

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

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

15.0 SURGE ARRESTERS

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

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

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

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

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

16.0 PRIMARY CIRCUIT BREAKERS

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

16.2 The circuit breaker shall be of the double pole type for outdoor operation.

16.3 The circuit breaker shall be suitably rated for electrical substation equipment.

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

16.5 The operating mechanism shall be provided with shunt release for both opening and closing.

16.6 The circuit breakers shall be designed for electrical operation at 110V DC from the substation battery supply.

16.7 Tension springs shall not be used for either closing or tripping mechanisms.

16.8 The circuit breaker shall be of the trip-free type.

16.9 A visual mechanical indicating device shall be provided to show whether the circuit breaker is closed or open.

16.10 The operating mechanism shall be constructed of non-ferrous material.

16.11 Auxiliary contacts shall be provided for operation in conjunction with the protection and other auxiliary circuits specified. At least one spare pair of normally open and one spare pair of normally closed contacts shall be provided.

16.12 The circuit breaker shall be provided with a control panel in the substation building on which are mounted the protection relays, control switches and associated equipment.

16.13 Circuit breaker control switches shall be provided on the control panel as well as on the circuit breaker mechanism. They shall return automatically to the neutral position when the handle is released after being turned to either the "close" or "trip" positions.

16.14 Local/Remote selector switches shall be provided on the control panel in the substation building as well as on the circuit breaker mechanism and shall be of the two-position type (no "off" or "neutral" position).

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

16.15 Mechanical operation shall be provided on the circuit breaker for any closing or trip release which is normally electrical operated.

16.16 The circuit breaker shall be provided with a no volt coil which will trip and lock out the breaker when the coil is de-energised. Drawing no. CEE-TBK-27 forming part of this specification, details control circuitry.

16.17 It shall be possible to close the circuit breaker only when the control voltage is above 85% of the nominal value, and the circuit breaker shall trip automatically when the control voltage falls below 70% of the nominal value.

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

16.19 Tenderers shall advise the number of circuit breaker operations under full load and fault conditions, after which maintenance and/or measurement of contact wear is recommended.

17.0 TRACTION TRANSFORMER

17.1 GENERAL

17.1.1 The transformer design shall be in accordance with Transnet Freight Rail's specification BBG2415.

17.1.2 Tenderers must comment on the ability of transformers offered to meet these requirements and provide this comment and the following details of transformers previously built for traction supplies with the tender: -

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

18.0 CURRENT TRANSFORMERS

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

18.2 If the primary supply voltage is 88 kV and below, then the current transformers for main transformer protection maybe installed in the transformer bushings. If the primary supply voltage exceeds 88 kV then only the current transformers on the secondary side of the main transformer shall be mounted in the transformer bushings, with the primary side's current transformers being of the post type.

18.3 Secondary protection current transformers shall be mounted in the transformer bushings.

18.4 Current transformers shall be installed on the load side of the associated circuit breaker. It shall be possible to remove the current transformers with the minimum of disturbance to other equipment.

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

18.6 Since the accurate measurement of harmonics in the traction supply will be necessary from time to time, current transformers offered shall be suitable for these purposes.

19.0 VOLTAGE TRANSFORMERS

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

19.2 Voltage transformers shall be outdoor structure mounted, oil filled type.

19.3 The return side of the primary winding shall have a bushing insulated for 3,3kV and must not be connected to the Voltage Transformer's tank.

19.4 The secondary winding shall be terminated in a cable box.

20.0 AUXILIARY POWER TRANSFORMERS

20.1 Unless otherwise stated two 16kVA, 27500V/240V single phase transformers mounted on the substation portal structure shall be provided by the successful tenderer.

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

20.3 The transformers and the connected equipment shall be capable of operating satisfactorily for a supply voltage varying between 27,5kV and 22,5kV. Main transformer secondary voltage under traction no-load conditions will normally be 27,5kV and auxiliary equipment shall be capable of operating continuously at this voltage.

20.4 Each transformer shall be provided with a suitably rated drop-out fuse link provided in the high voltage supply conductor.

21.0 BUSBAR COUPLER

21.1 The 25 kV busbars of each unit at all double unit traction substations shall be connected together by means of a busbar coupler. A busbar coupler shall be provided in single unit substations where specified in the Schedule of Requirements – Appendix 2.

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

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

22.0 SECONDARY CIRCUIT BREAKERS

GENERAL REQUIREMENTS

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

22.2 Circuit breakers of a service proven design are required and full-supporting details in this respect shall be furnished with tenders. The circuit breakers shall be single pole.

22.3 Circuit breakers shall be of the outdoor structure mounted type and shall be mounted on a suitably designed structure, in the manner indicated on drawing No's CEE-TDB-41 sht's 1 & 2

22.4 The mounting method of the circuit breaker and the operating mechanism shall be adjustable to allow for alignment.

22.5 The circuit breakers shall have a rated voltage of 44 kV, and the system frequency is 50Hz.

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

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

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

22.9 Opening time on low impedance track faults including relay operating time shall not exceed 0,1 second, for track feeder circuit breakers.

22.10 Tenderers shall advise the capability of circuit breakers offered to interrupt:-

- Capacitive currents.
- Currents with a high harmonic content.

22.11 Tenderers shall advise the chopping current levels of the circuit breaker offered and what steps are taken to keep these values to a minimum.

22.12 Tenderers shall also advise whether special precautions are required to limit the effects of chopped current and to give details.

22.13 The operating mechanism shall be constructed of non-ferrous material or cadmium plated steel.

22.14 The operating voltage shall be 110 V DC.

22.15 The circuit breaker operating mechanism shall be housed in a weatherproof enclosure, and shall be accessible by means of a lockable door.

22.16 The following shall be provided within the enclosure:

- A thermostatically controlled anti-condensation heater.
- A fluorescent light operated by a door switch.
- A 15 A, 220 V AC socket outlet in accordance with SANS 10142.

22.17 The circuit breaker mechanism shall be of the spring operated type with shunt release for both opening and closing. The closing operation shall charge the tripping spring.

22.18 It shall not be possible for the circuit breakers to close while the spring is being charged.

22.19 The spring shall be fully charged before it can be released to close the circuit breaker.

22.20 It shall be possible to charge the spring when the circuit breaker is closed and if the spring can be, and is released, the circuit breaker shall not open.

22.21 There shall not be any danger of a fully charged spring being released by vibration caused by the opening of the circuit breaker under any condition.

22.22 A visual mechanical indicating device shall be provided to indicate the state of the spring and shall be inscribed "Spring Charged" when the mechanism is in the condition to close the circuit breaker and "Spring Free" when it is in any other condition.

22.23 Means shall be provided for charging the spring by hand.

22.24 Means shall be provided for discharging the spring when the circuit breaker is in the "open" position without the circuit breaker attempting to close.

22.25 Facilities shall be provided for locking of the local manual release of the closing spring mechanism.

22.26 The closing springs shall recharge automatically after the completion of a closing operation.

22.27 Tension spring shall not be used for either closing or tripping mechanisms.

22.28 Facilities shall be provided to permit manual slow closing of the circuit breaker for maintenance purposes

22.29 The mechanism shall be trip-free. The contacts shall make before the breaker starts to open.

22.30 If the circuit breaker fails to latch on closing it shall trip before any significant damage can occur.

22.31 A visual mechanical indicating device shall be provided to indicate whether the circuit breaker is closed or open.

22.32 Unless the design of the circuit breaker mechanism is such that compensation for interrupter contact wear is provided automatically, a visible indication shall be provided to show when adjustment is needed. In the case of circuit breakers incorporating more than one interrupter it shall be possible to make such adjustments individually to suit the requirements of each interrupter.

22.33 Auxiliary contacts shall be provided for operation in conjunction with the protection and other auxiliary circuits specified. At least one spare pair of normally open and one spare pair of normally closed contacts shall be provided.

22.34 Local/Remote selector switches on the circuit breaker equipment shall be of the two-position type (no "off" or "neutral" position).

22.35 Circuit breaker control switches shall be arranged to return automatically to the neutral position when the handle is released after being turned to either the "close" or "trip" positions.

22.36 A counter shall be provided on each circuit breaker to indicate the total number of operations of the breaker.

22.37 Tenderers shall advise the number of circuit breaker operations under the following conditions, after which maintenance and/or measurement of contact wear is recommended:-

- Rated breaking capacity.
- Breaking 6 kA.
- Breaking 1500 A.

23.0 TRACTION SUBSTATION BUILDING

23.1 The building to be provided shall be of the prefabricated steel modular type. It shall be robust, waterproof, vermin proof and of sufficiently strong construction to resist all weather conditions encountered in South Africa.

23.2 Details of a suggested design are shown on Drawing No. CEE-TEC-28. This design or variations thereof may be used but tenderers are free to offer alternatives that comply with this specifications requirement.

23.3 When a single unit substation is required, the building design shall facilitate extension to accommodate equipment for a double unit substation in the future.

23.4 Steelwork shall be treated in accordance with the prevention of corrosion requirements specified in clause 11.

23.5 The building shall have a "double-skinned" roof construction to allow a free circulation of air between the skins.

23.6 The outer skin shall be of flat sheet steel of the same thickness as the building.

23.7 The inside walls shall be thermally insulated to the equivalent of 40mm of glass-fibre. The tenderer shall give full details of the material he intends to use as well as the fixing method of the material to the walls (Glue is not acceptable). Protection against mechanical damage to the insulation shall be provided.

23.8 The building shall be large enough to accommodate all equipment that will be contained within the building with enough space for comfortable maintenance of the equipment. The following major items of equipment as called for in this specification must be accommodated within the building:

- An aluminium self-supporting ladder with a height of 1.2m.
- A wall mounted metal key box with a lid and provision for at least 20 keys as shown on Drawing CEE-TCA-92.
- Suitable brackets and/or storage for ladder, special tools and earthing apparatus.
- Suitable bracket on the wall immediately adjacent to the annex door for mounting of a fire extinguisher. (Fire extinguisher will be provided by others).
- Suitable brackets for mounting of a control selector telephone and telecommunications distribution board.
- A complete set of wiring and circuit diagrams for the substation.
- A steel cabinet / desk combination approximately 1150mm wide, 600mm deep and 1 000mm high.
- Tele-control cabinets (provided by others).
- Battery tripping unit.
- Primary Circuit Breaker control panels.
- Secondary Circuit Breaker control panels.
- Low voltage distribution board.

23.9 One door is required for entrance into the building. The door shall be situated in the narrow wall opposite that which contains the ventilation fan. Another door is required at the end of the building which shall only be opened from inside the building. It must be located at the left end of the building from the main entrance door. This door will be used for maintenance purposes.

23.10 It shall be possible to remove, without dismantling, any equipment contained within the building through the door provided.

23.11 The door shall be fitted with a robust locking mechanism capable of being locked by means of a stout padlock provided by Transnet Freight Rail.

23.12 Door hinges shall be robust with hardened steel pins. Doors shall be fitted with a suitable stay to hold them in the open position.

23.13 A foundation and plinth of concrete for the support of the building and its equipment and for the maintenance and handling of all indoor equipment shall be provided.

23.14 The plinth shall be so designed as to eliminate the possibility of water standing in contact with the base of the building.

23.15 Tenderers shall give details of the measures they propose taking to seal the base of the building to the concrete plinth.

23.16 The finished level of the plinth shall not be less than 250mm above ground level .

23.17 The floor surfaces shall be durable non-slip and of pleasing appearance and shall not be subject to damage or marking by normal maintenance activities. In the case of a concrete floor it shall be coated with "Solidkote" or similar.

23.18 Provision shall be made for the entry of cables from the outdoor yard into the building.

23.19 The building design shall be such as to provide the necessary trunking for cable entry to all equipment which will be top entry. (No under floor trunking)

23.20 HEATING AND VENTILATION

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

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

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

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

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

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

23.20.7 Details of the type and rating of heaters must be supplied by tenderers.

24.0 AUXILIARY POWER SUPPLIES

24.1 All low voltage power and lighting circuits shall comply with the requirements of SANS 10142.

24.2 Under traction load conditions the substation supply voltage will have a high harmonic content and equipment supplied from the auxiliary transformer shall be capable of satisfactory operation under these conditions.

24.3 A low voltage distribution board shall be provided in the substation building. The output of the auxiliary transformers shall be connected to two 80A double pole miniature circuit breakers (MCB's) on the distribution board. The MCB's shall be withdrawal or lockable.

24.4 The output from the auxiliary transformers shall be connected to an automatic change-over contactor which must not allow the supplies to be paralleled under any circumstances.

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

24.6 The distribution board shall be provided with MCB'S to protect and control all lighting, heating, ventilation, socket outlets, control circuits, and supplies to the Eskom equipment. MCB'S shall comply with SANS 156.

24.7 Provision shall be made for six single MCB spare cut-outs for future additions.

24.8 The distribution board must provide for a 110V, 10A DC supply and a 220V, 20A AC supply to be cabled to the Eskom equipment in the Eskom yard. AC and DC circuits shall be physically separated either by means of a partition or separate distribution boards.

24.9 At least two 15A, 220V 3 pin socket outlets shall be provided in the building as well as one outlet mounted in the control panels.

24.10 LIGHTING – Eco Friendly Lighting

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

24.10.2 Two outdoor Eco friendly fluorescent lights shall be provided on the outside of the control equipment building. One shall be mounted above the buildings door and the other shall be mounted on the long side of the building facing the track. These lights shall be controlled by light sensitive switch.

24.10.3 Outdoor Eco friendly fluorescent lighting shall be provided in at least two positions to provide a general level of illumination of 20 lux in the substation yard. These lights shall be controlled from within the control equipment building. Care shall be taken to avoid glare in the eyes of train drivers and the layout must be approved by the Senior Engineer.

25.0 REQUIREMENTS FOR TELECONTROL

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

25.2 The Tele-control equipment cabinet, the size of which is approx. 1600x800x800 (hwd), will be housed in the substation control equipment building. Transnet Freight Rail will deliver this cabinet to site, with the installation thereof being the responsibility of the successful tenderer.

25.3 A "Klippon" or similar terminal strip with 250 terminals shall be provided to act as the interface between the substation equipment and the Tele-control equipment. This terminal strip can be housed in one of the switchgear control panels (space permitting) or housed in a dedicated enclosure. The successful tenderer shall terminate all conductors for the Tele-control functions required on one side of this terminal strip. The successful tenderer shall supply and install the cable required to connect the Tele-control equipment cabinet (supplied by Transnet Freight Rail) to the terminal strip. One side of this cable will be connected to the terminal strip with the other side being made off in the Tele-control equipment cabinet for connection by others.

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

25.5 Indication for Tele-control purposes shall be provided by means of voltage free open and closed contacts on the switchgear.

25.6 Provision shall be made for the following principal Tele-control operations indications and alarms: -

- Open and close command function for all circuit breakers.
- Open and close indication for all circuit breakers.
- Lockout indication for all circuit breakers.
- Indication of failure of voltage transformer output (protection reference voltage).
- Indication of failure of distance protection relay supply voltage. Detection must take place at each relay.
- Indication of charger failure for DC control batteries.
- Indication of transformer pressure relief device operation.

- Indication of low gas (SF6 breakers, Primary and Secondary).

25.7 The following transducers capable of measuring true RMS values of distorted waveforms shall be provided:-

25.7.1 A current transducer to monitor each main transformer secondary current.

25.7.2 A voltage transducer to monitor each secondary busbar voltage.

25.8 The output of these transducers shall be wired to the Tele-control terminal strip.

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

25.10 Any additional Tele-control functions that might be necessary due to the supply and installation of any specialised equipment offered shall be provided.

25.11 A detailed list of Tele-control commands, indications and alarms shall be submitted for approval by the Senior Engineer.

26.0 CONTROL PANELS

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

26.1 PANEL CONSTRUCTION

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

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

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

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

26.2 EQUIPMENT INSTALLED IN THE PANELS

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

26.2.2 Relays shall be completely sealed against the ingress of dust and dirt by means of non-inflammable covers which are easily removable. The relays shall have a protection rating of IP34 as defined in SANS 60529.

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

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

26.2.5 The control equipment provided shall be capable of correct operation within the voltage limits specified in SANS 62271-100. In addition the coils of all devices operated from the substation auxiliary transformer AC supply shall be capable of satisfactorily operating under the harmonic voltage conditions encountered in an AC traction system.

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

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

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

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

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

26.2.11 All cables shall be marked at both ends with markings the same as that which appears on the wiring schematics and diagrams.

26.2.12 All relays, cables, terminal strips, switches, lamps, push buttons etc. which are mounted on panels, shall be labelled to clearly indicate their function.

26.2.13 An annunciator indicating panel giving visual (LED display) indication of the reason for the circuit breaker's trip shall be provided on the circuit breaker control panel.

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

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

26.2.16 No anti condensation heaters are required inside the panels.

26.2.17 Each panel shall have and interior fluorescent lamp which will be switched by a door switch.

26.3 INDICATING INSTRUMENTS

26.3.1 All indicating instruments shall be designed, manufactured and tested in accordance with IEC 60051-1 and shall be flush mounted.

26.3.2 The dials of instruments shall be marked with the ratio of the associated instrument transformers.

26.3.3 The full-scale deflection of instruments shall be not less than 85mm and the scales shall be:

- Voltmeters 0 – 30 kV
- Ammeters 0 - 1 500 A

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

26.3.5 An ammeter shall be provided to indicate the primary and secondary current.

27.0 DC BATTERY AND CHARGER

27.1 The DC control battery and charger shall comply with specification No.CEE.0085 except where special arrangements are necessary to suit the design of equipment offered. The Tenderer shall complete appendix No.2 of that specification.

27.2 The rating of the battery and charger to be installed in each substation shall be based on the burden of the equipment to be supplied.

27.3 The nominal voltage of the battery shall be 110 V.

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

28.0 PROTECTION

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

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

28.2 PRIMARY CIRCUIT BREAKER TRIPPING

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

28.2.1.1 Buchholz.

28.2.1.2 Restricted earth fault on both primary and secondary windings.

28.2.1.3 Transformer percentage biased differential.

28.2.1.4 Primary circuit breakers SF6 low gas.

28.2.1.5 Traction transformer pressure relief valve.

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

28.2.2.1 Transformer winding and oil temperature.

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

28.2.2.3 Circuit breaker tripping supply under voltage and overvoltage detection.

28.2.2.4 Instantaneous overcurrent.

28.2.2.5 Utility No-Volt protection.

28.3 SECONDARY CIRCUIT BREAKER TRIPPING

28.3.1 Secondary circuit breaker protection relays shall be circuit specific:

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

28.3.3 Incomer circuit breaker

28.3.3.1 Inverse Definite Minimum Time (IDMT) overcurrent relay.

28.3.3.2 Instantaneous overcurrent.

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

28.3.4 Track feeder circuit breaker

28.3.4.1 Single phase Distance Impedance relay shall be in accordance with TFR specification BBG 5003. A track feeder circuit breaker will normally be the only feed into a section of railway line and will therefore not be required to discriminate with other track feeder circuit breakers.

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

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

28.3.4.4 Circuit breaker health detection.

28.4 AUXILIARY TRANSFORMER PROTECTION

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

28.5 RELAYS AND CIRCUITRY PROTECTION

28.5.1 All circuits supplied by the auxiliary transformers shall be protected by an earth leakage relay.

28.5.2 All circuits, regardless of source of supply shall be protected by suitably rated miniature circuit breakers. (MCB's)

28.5.3 Due to the susceptibility of protection relays to damage due to poor quality of supply as well as lightning surges, the tenderer must state what measures will be implemented to safeguard this equipment.

29.0 CONDUCTORS, CABLES, AND SMALL WIRING

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

Table 5: Electrical conductors

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

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

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

29.4 All low voltage cables shall be 600/1 000 Volt PVC insulated sheathed in terms of specification SANS 1507.

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

29.6 Small wiring and terminations shall comply with SANS 10142 and SANS 61936-1. The current ratings for the various sizes of conductors shall not be exceeded.

29.7 All instrument and control wiring shall be a minimum size of 2.5 mm^2 cross-section with stranded copper conductors. Wires connected to the current transformers shall have a minimum cross-section of 4 mm^2.

SECTION 3: - INSTALLATION OF EQUIPMENT

30.0 SUBSTATION SITES

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

30.1 SITE PREPARATION

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

30.2 SITE LEVELS

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

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

30.2.3 The site must be flat.

30.3 MATERIAL

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

30.3.2 Material of quality G5 must be used for earthworks in accordance with SAPEM – standards chapter 4.

30.4 COMPACTION

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

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

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

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

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

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

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

30.4.8 After treatment with the weed killer, a 100mm layer of 25mm crusher stone shall be laid over the whole area of the Transnet Freight Rail yard (within the kerbing).

30.4.9 Access to the sites shall be by means of Transnet Freight Rail maintenance roads. Should the tenderer feel that these roads are not adequate, a separate quotation for any work deemed necessary shall be submitted with the tender.

31.0 FOUNDATIONS

31.1 The successful tenderer shall be responsible for the design and installation of foundations for all the structures, equipment and buildings within the substation yard.

31.2 The successful tenderer shall carry out his/her own survey in regard to soil types and their load bearing capabilities.

31.3 Tenderers must ensure that provision (financial as well as time) for excavations in a range of soil types is allowed for in their tenders.

31.4 Equipment support foundations shall be finished off 200mm above the finished earth level of the yard. The design must be such as to prevent standing water.

31.5 All foundations edges shall be bevelled and the surfaces must be float finished.

31.6 All support foundations shall be at the same level.

31.7 An earth mat conductor shall be cast in the concrete foundation for the connection of support steelwork to the earth mat. This shall be done in accordance with Drawing No. CEE-TEE-173 sht's 1-3.

31.8 This earth conductor shall be electrically connected to the foundation bolt group such that in the event of the visible earth connection being removed, an earth connection via the bolt group is maintained. This shall be done in accordance with Drawing No CEE-TEE-173 sht's 1 - 3.

31.9 A plastic pipe shall be cast into all concrete foundations for earth/control cabling to be taken up the structure and shall be done in accordance with Drawing No CEE-TEE-173 sht's 1-3.

31.10 If the foundation for the main traction transformer is larger than the transformer base plate, then a portion of the foundation the exact size of the base plate must be raised at least 50mm to prevent the possibility of standing water against the transformers base plate.

32.0 CONCRETE

32.1 The 28-day strength of all concrete used shall be a minimum of 20Mpa.

32.2 The successful tenderer shall arrange for sampling and testing of all concrete used, and shall submit full records to the Senior Engineer. Transnet Freight Rail reserves the right to undertake testing of concrete samples and the successful tenderer shall furnish test cubes if requested by the Senior Engineer.

32.3 Hand mixed concrete is not acceptable, it must be mechanically mixed.

32.4 The addition of water to a concrete mix reduces the strength of that concrete very significantly and on no account shall water be added to a mix after test cubes have been taken.

32.5 There shall be a minimum of 100 mm concrete cover for all steel reinforcing.

33.0 INSTALLATION OF SUBSTATION EQUIPMENT

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

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

Requirements for the installation of substation equipment are as follows:

33.4 PRIMARY ISOLATOR

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

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

33.5 MAIN TRANSFORMER

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

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

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

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

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

33.6 VOLTAGE TRANSFORMER

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

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

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

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

33.7 AUXILIARY TRANSFORMER

33.7.1 The primary positive pole of the auxiliary transformer shall be connected on the traction transformer side of the secondary isolator and should a second auxiliary transformer connected to the 25 kV supply be required, its primary positive pole shall be connected to the overhead track equipment on the load side of the track feeder switch (see drawing No. CEE - TBB -109).

33.7.2 The auxiliary transformer connected to the main transformer side of the disconnector shall be mounted on the 25 kV gantry. It shall be mounted in such a manner as to allow space for the drop out fuse to be mounted and to function safely, above the auxiliary transformer.

33.7.3 The second 25 kV auxiliary transformer (see schedule of requirements) shall be mounted on one leg of the overhead track equipment track switch structure. (see drawing No. CEE-PFB-30 for typical mounting details)

33.7.4 The neutral of the primary winding of each 25 kV Auxiliary transformer shall be connected to the overhead neutral return current conductor.

33.7.6 The secondary output of the auxiliary transformers shall be cabled to a distribution board in the substation building.

33.8 SECONDARY ISOLATOR

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

33.9 SECONDARY CIRCUIT BREAKERS

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

33.9.2 The outdoor switchgear shall be mounted on suitably designed horizontal steel beams forming part of the 25 kV gantry structure (see Drawing No's CEE-TDB-41 sht's 1 & 2)

33.9.3 The outdoor switchgear mounting arrangement shall allow for lateral and vertical adjustment to enable proper alignment of switchgear to take place.

33.9.4 The switchgear shall be mounted in such a manner as to allow an isolating gap of not less than 300 mm between the circuit breaker terminals and the 25 kV busbar should the jumper be removed.

33.10 SECONDARY LIGHTNING ARRESTORS

33.10.1 All secondary lightning arrestors shall be mounted on the 25 kV gantry and shall be connected in the circuit in accordance with Drawing No. CEE-TBB-109.

33.10.2 The earth connection of all the secondary lightning arrestors shall be connected to the substation earth mat by means of the specified earthing conductor.

33.11 25 kV BUSBAR

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

33.12 BUSBAR COUPLER (DOUBLE UNIT TRACTION SUBSTATIONS)

33.12.1 For secondary circuit breakers of the outdoor structure mounted type the busbar coupler shall be mounted on the 25 kV gantry structure as per drawing no. CEE-TDB-41 sht 1. The two additional isolation MOD's on a bus coupler shall be interlocked.

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

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

33.13 SUBSTATION BUILDING

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

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

33.14 EQUIPMENT INSTALLED IN THE SUBSTATION BUILDING

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

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

33.15 CABLES

33.15.1 Cable trenches shall have a minimum depth of 500mm measured from ground level. All trenches shall be backfilled and compacted in layers to the compaction of the surrounding yard.

33.15.2 The exact position and size of each cable in the yard shall be shown on the cable layout plan. These drawings shall be submitted for approval prior to installation.

33.15.3 Asbestos free-cement cable pipes shall be installed beneath any roadway, where the crossing of a roadway by cables is required. These pipes shall be not less than 150mm in diameter and shall protrude at least 500mm on either side of the roadway. The pipes shall be graded 1:400 for water drainage.

33.15.4 All cables entering the control equipment building shall be block jointed (50mm of armouring to be removed) above the ground. The block jointing shall be done before the cables are installed into the control equipment building. The block joint shall be covered by a heatshrink sleeve.

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

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

33.15.7 Cables and earthing conductors connected to equipment installed on steel support structures shall be supported on the steel structure vertically and horizontally by means of a cable tray. This cable tray shall be of the O-Line GS50 Gridspan Wire Mesh type or similar with the wire mesh having a diameter of 4mm and a hot dip galvanised finish.

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

33.15.9 Should the cable termination box of an item of equipment overhang the vertical steel support structure, the cable can be installed directly from the cable trench to the terminal box provided a hot dip galvanised steel cable support is provided. This support must either be securely attached to the terminal box or be concreted into the ground. (see drawing No. CEE-TDC-10)

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

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

33.16 INTERCONNECTION OF EQUIPMENT

33.16.1 Conductors between separately mounted outdoor equipment shall incorporate a degree of flexibility to avoid any stressing of these connections due to foundation movement or conductor expansion/contraction and to facilitate alignment of equipment.

33.16.2 All connections to the overhead conductors shall be made using clamps that are specifically designed and manufactured to make that particular connection (ad hoc fabricated clamps are not acceptable).

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

33.16.4 All dissimilar metal connections (Cu to Al) shall be made using bi-metallic clamps that are specifically designed and manufactured to make that particular connection (ad hoc fabricated clamps are not acceptable).

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

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

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

33.16.8 The overhead track feeder conductors complete with insulation and fitted with suitable bi-metallic clamps for the connection of two 160mm^2 Cu conductors (provided by others), shall be supplied and made off on the track switch portal by the contractor. Others shall do the connection of these conductors to the track switches. This forms the substation/overhead track equipment contract boundary.

33.17 FENCING AND KERBING

33.17.1 The boundary/stock fence, security fence and concrete kerbing shall only be installed once all major items of equipment and steelwork have been delivered and installed and all overhead conductors stringing is complete.

33.17.2 The extent of Boundary/stock fencing, security fencing as well as kerbing for each substation site is shown on the substation layout drawings listed in Appendix No. 1.

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

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

33.18 "RETURN" CURRENT AND SUBSTATION EARTHING

33.18.1 RETURN CURRENT

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

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

33.18.2 SUBSTATION EARTH

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

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

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

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

33.18.2.5 The earth mat connections to structural support steel as called for on drawing No. CEE-TBD - 8 shall be made via the copper earth connection cast into the associated foundations.

The earth mat shall be brazed to the tails protruding from the support foundations at a depth of 600mm.

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

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

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

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

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

33.18.3 EARTHING DEVICES

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

33.18.3.2 The clamps for the connection of the overhead feeder to the load side of the secondary switchgear shall be designed such that a suitable attachment for the earthing harness is provided.

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

33.18.3.4 In a single unit substation a portable earthing harness shall be provided for connecting all secondary switchgear outdoor bushing terminals simultaneously to the substation main earth mat.

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

33.19 NAMEPLATES AND LABELS

33.19.1 A substation nameplate shall be provided. The names of the substations shall be as specified in Appendix No. 1. The nameplate shall be manufactured in accordance with Drawing No. CEE-TEA-2.

33.19.2 Danger warning notices as per Drawing CEE TA-196 shall be supplied and fitted to the substation building access door, on each half of the substation gate, one notice on the narrow side substation fence and two notices on the long side substation fence.

33.19.3 All nameplates and labels shall be in English.

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

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

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

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

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

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

33.19.10 The proposed labelling scheme must be submitted to the Senior Engineer for approval prior to the manufacture of the labels.

SECTION 4: TESTING AND COMMISSIONING

34.0 TYPE AND ROUTINE TESTING REQUIREMENTS

34.1 Type and routine tests shall be conducted on the equipment to be supplied. These tests shall be carried out at the successful tenderers expense.

34.2 Test certificates in respect of type tests conducted on identical equipment may be accepted in lieu of type tests at the discretion of Transnet Freight Rail.

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

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

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

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

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

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

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

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

34.11 Transnet Freight Rail staff will conduct an out of tank inspection of the transformer prior to the transformer being tanked as well as witnessing all the routine manufacturers tests carried out at the works. The co-ordination of manufacturers testing shall be the responsibility of the successful tenderer.

34.12 Type test certificates of the transformer design offered shall be submitted with the tender. Should type test certificates not be available, the required tests shall be carried out, the cost of which must be included in the tender price quoted as a separate item.

34.13 Should the transformer offered not have a short circuit type test certificate available, a simulated computer model of this test may be submitted for Transnet Freight Rail's approval, but should this model be unacceptable short circuit tests will be required and shall be conducted in accordance with Transnet specification BBG2415. An out of tank inspection shall be carried out after completion of the tests. The tests shall comprise two short circuits on each of the extreme and centre tapings. The short circuits on each tapping shall be of opposite asymmetry. Short circuit duration shall not be less than 0,5 seconds. Short circuit current shall not be less than that calculated for a fault on the secondary terminals of the transformer with rated voltage on the primary terminals from a supply of not less than 2 500 MVA.

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

34.15 The following equipment shall be inspected by Transnet Freight Rail staff at the place of manufacture prior to delivery to the successful tenderers works or to site:

- All structural steelwork
- The substation building
- Battery tripping unit
- All control panels

35.0 SITE TESTS AND COMMISSIONING

The successful tenderer shall be responsible for carrying out on-site tests and commissioning of all equipment supplied and installed in terms of this specification and the contractual agreement.

35.1 ON-SITE TESTS

35.1.1 Functional on-site tests shall be conducted on all items of equipment and circuitry to prove the proper functioning and installation thereof.

35.1.2 The successful tenderer shall submit a detailed list of on-site tests for the approval of the Senior Engineer at least six weeks before tests are due to commence at the first substation.

35.1.3 The successful tenderer shall arrange for the Senior Engineer or his representative to be present to witness the on-site tests at each substation.

35.1.4 The on-site tests and subsequent commissioning will not commence until all construction work has been completed. Construction staff, material and equipment shall be removed from site prior to the commencement of testing. Testing and commissioning of the substation equipment will not be allowed to take place in a construction site environment.

35.1.5 On-site tests shall include the following;

- Polarity tests on all VT's and CT's
- Ratio tests on all VT's and CT's
- Magnetising current of all CT's
- Secondary injection of all relays
- Trip testing, all relays must be checked for correct operation.
- The functionality of all electrical circuitry must be tested.
- A power frequency voltage test on all 25 kV equipment at 57 kV for one minute.

- A power frequency voltage test on all small wiring at 2 kV for one minute.
- Millivolt-drop test on 25 kV circuits with a current of not less than 200 A.
- A proof of vacuum test on vacuum circuit breakers.
- Tests on primary circuit breakers and other primary equipment in accordance with manufacturer's instructions.

35.1.6 At the completion of the on-site tests the Senior Engineer or his representative, shall either sign the test sheets (supplied by the successful tenderer) as having witnessed the satisfactory completion thereof, or hand to the successful tenderer a list of defects requiring rectification.

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

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

35.2 COMMISSIONING OF EQUIPMENT

35.2.1 Commissioning will include the energising of equipment from the primary isolator to the track feeder circuits. The successful tenderer must prove the satisfactory operation of all equipment under live conditions.

35.2.2 On completion of commissioning the successful tenderer will hand the substation over to the Senior Engineer in terms of the relevant instructions.

35.2.3 Tenderers shall allow a period of at least three days per substation between satisfactory completion of on-site tests and commissioning of equipment.

35.2.4 During this period the Transnet Freight Rail's Test staff will test the operation of all protective relays and circuits and set the protection relays at each substation.

35.2.5 The successful tenderer installation staff shall be present during the testing and setting of the protection to rectify any faults found.

35.2.6 On-site testing of the first substation must therefore commence ahead of the contract completion date, by a period not shorter than a total of three days per substation.

35.2.7 The commissioning of the protection equipment by Transnet Freight Rail will in no way absolve the successful tenderer from any of his responsibilities during the guarantee period. It is the successful tenderers responsibility to satisfy himself/herself that the commissioning of the protection equipment has been carried out in a satisfactory manner and in no way compromises the proper operation of the equipment supplied in terms of the contract.

35.2.8 The commissioning dates for the substations will be dependent on the availability of power supplies from the supply utility as well as Transnet Freight Rail's electrification program and will be defined by the Transnet Freight Rail Senior Engineer.

36.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS

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

36.1 DRAWINGS

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

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

36.1.3 The following drawings are required for approval prior to construction and submission in as built form at the completion of the works:

- Electrical schematic diagrams
- Detailed electrical wiring diagrams
- Foundation design drawings (for all foundations)
- Structural support steelwork design drawings
- Site equipment layout plan showing equipment and conductor profiles.
- Earth mat layout plan showing position of buried conductors.
- Buried cable layout plan showing position of buried cables.
- Substation control equipment building plans.

36.1.4 A complete set (paper copies bound in book form) of the electrical schematic and detailed wiring diagrams shall be provided for each substation and shall be in the substation at the commissioning stage.

36.2 INSTRUCTION MANUALS

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

36.3 SPARES LISTS

36.3.1 The successful tenderer shall submit details of spares required in accordance with specification No. CEE.0224.

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

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

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

37.0 SPECIAL TOOLS AND/OR SERVICING AIDS

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

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

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

38.0 TRAINING

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

39.0 GUARANTEE AND DEFECTS

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

39.2 The guarantee period for all substations shall expire after: -

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

39.2.2 A period of 12 months commencing on the date of commissioning of the last substation, whichever is the later date.

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

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

40.0 APPENDIX 1

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

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

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

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

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

41.0 APPENDIX 2

SCHEDULE OF REQUIREMENTS FOR AC TRACTION SUBSTATIONS

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

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

41.1.2 The following table must be completed quantifying the major items of equipment required at each traction substation:

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

Table 1: Substation equipment

Note:
- P.I Primary isolator
- P.C.B Primary Circuit Breaker
- M.T Main Transformer
- S.I Secondary Isolator
- I.F Incoming Feeder
- T.F Track Feeder
- B.C Bus Coupler
- A.T Auxiliary Transformer
- V.T Voltage Transformer

42.0 APPENDIX 3

SCHEDULE OF DRAWINGS SUPPLIED BY TRANSNET FREIGHT RAIL

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

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ANNEXURE A9- SPECIFICATION CEE-0111_ISS_2019 - INCOMMER

TRANSNET
freight rail

A Division of Transnet SOC Limited

TECHNOLOGY MANAGEMENT SPECIFICATION

25KV AC TRACTION SUBSTATIONS

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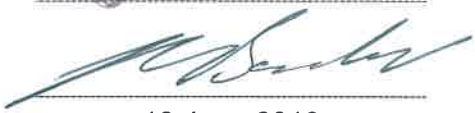
Authorised:	Senior Engineer Technology Management	L.O. Borchard	

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Transnet Freight Rail

Transnet and Relevant Third Parties

INDEX

SECTION 1: SUBSTATION DESIGN INFORMATION

1.0 SCOPE

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

2.0 APPENDICES

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

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

APPENDIX 2: Schedule of requirements for AC traction substations.

APPENDIX 3: Schedule of drawings supplied by Transnet Freight Rail.

3.0 STANDARDS

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

The following publications are referred to in this specification:

3.2 BRITISH STANDARDS INSTITUTION

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

3.3 INTERNATIONAL ELECTROTECHNICAL COMMISIION

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

3.4 SOUTH AFRICAN NATIONAL STANDARDS

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

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

3.5 TRANSNET FREIGHT RAIL

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

4.0 DEFINITIONS

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

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

4.3 "Substation" refers to a traction substation.

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

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

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

4.7 A circuit breaker that is open and has an "operational inhibit" refers to a condition in which the breaker cannot be closed until certain conditions return to normal. (Thermal protection, under-voltage protection etc.)

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

4.9 "Senior Engineer" is the person appointed by Transnet Freight Rail to manage and administer the contract works.

5.0 TENDERING PROCEDURE

5.1 Tenderers shall indicate clause by clause compliance or non-compliance with the specification. This shall take the form of a separate document listing all the specifications clause numbers indicating the individual statement of compliance or non-compliance. This document can be used by tenderers to elaborate on their response to a clause.

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

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

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

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

6.0 SERVICE CONDITIONS

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

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

7.0 GENERAL REQUIREMENTS

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

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

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

7.4 Transnet Freight Rail reserves the right to subject material and equipment offered to test or inspection to check compliance with the clauses of this specification prior to adjudication or at any stage during manufacture.

7.5 The onus to prove compliance to the specification shall rest with the tenderer during the tender stage and with the successful tenderer once the contract has been awarded.

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

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

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

7.9 Any portion of the equipment which may be likely to cause injury to staff or fire by being overloaded or failing, or by an arc set up by the equipment in operation, shall be so arranged as to prevent the possibility of injury to staff as well as preventing damage to other equipment.

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

8.0 INSULATION LEVELS

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

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

8.3 Primary equipment (voltages phase to phase r.m.s) shall have a rated insulation level based on an equivalent 3 phase system as indicated in table 1:

Table 1: Insulation Levels.

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

9.0 CLEARANCES

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

Table 2: Earth Clearances

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

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

Table 3: Minimum Safety Clearances

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

10.0 CREEPAGE DISTANCES

10.1 The insulators or bushings provided on all high voltage AC disconnecting switches, circuit breakers and transformers shall comply with the requirements of SANS 60137.

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

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

Table 4: Creepage Distances

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

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

11.0 PREVENTION OF CORROSION

11.1 PREPARATION OF OUTDOOR STRUCTURAL STEELWORK.

11.1.1 Steelwork for outdoor installation in inland areas, i.e., at a distance greater than 20km from the coast, shall be hot-dip galvanised according to SANS 121 and SANS 32.

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

11.2 PREPARATION OF STEEL BUILDINGS.

Where it is impractical to galvanise large areas of sheet steel, surfaces for outdoor exposure in both inland and coastal areas shall be prepared in accordance with specification CEE0045.

11.3 HANDLING AND FINAL TREATMENT OF PAINTED STEELWORK.

11.3.1 Painted steel shall be handled with care and/or suitably packed to avoid damage during transport and installation.

11.3.2 Any damage to painted surfaces shall be repaired, after installation after which a final finish coat of the paint specified in specification CEE0045 shall be applied.

11.3.3 The following table specifies the colours in accordance with SANS 1091 to be used:

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

12.0 SUBSTATION OPERATIONAL PROTOCOLS

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

12.2 PRIMARY DISCONNECTOR

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

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

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

12.3 PRIMARY CIRCUIT BREAKERS

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

12.3.1.1 Inverse Definite Minimum time operation (Primary).

12.3.1.2 Instantaneous overcurrent operation.

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

12.3.1.4 Phase Under voltage and Overvoltage.

12.3.1.5 Utility No-Volt protection.

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

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

12.3.2.2 Transformer Buccholz first operation.

12.3.2.3 Transformer restricted earth fault.

12.3.2.4 Transformer biased differential.

12.4 SECONDARY DISCONNECTOR (25kV)

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

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

12.5 SECONDARY CIRCUIT BREAKERS (25kV)

12.5.1 **INCOMER CIRCUIT BREAKER**

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

12.5.2.1 Circuit breaker health failure.

12.5.2.2 Inverse Definite Minimum time operation (Secondary overcurrent).

12.5.2.3 Intertripping with the primary circuit breaker. If the primary circuit breaker is tripped by any of the transformer protection relays, then the incomer circuit breaker shall trip and shall not be able to close until the primary circuit breaker is closed.

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

12.5.3 It shall not be possible to parallel incoming 25kV supplies through a substation busbar coupler in double unit substations. (It must not be possible to close both Incomer circuit breakers with the Busbar coupler in the closed position) Where a busbar coupler is required in a single unit substation, this feature shall be provided for future use when the incoming supply is doubled.

12.5.4 The operation of the Busbar coupler (opening or closing) shall only be possible if all the Secondary Circuit Breakers (Incomers and Track feeders) are in the open position.

12.5.5 **TRACK FEEDER CIRCUIT BREAKERS**

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

12.5.6.1 Circuit breaker health failure.

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

12.5.6.3 Impedance distance protection operation. The breaker shall trip and the two shots auto reclose sequence will be initiated. Should the breaker trip again after the auto reclose sequence, it shall remain open. (No lockout or auto reclose)

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

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

SECTION 2: TRACTION SUBSTATION EQUIPMENT

13.0 STEELWORK

13.1 The design, supply and installation of all steel structures for the support of equipment and tensioning of conductors shall be the responsibility of the successful tenderer.

13.2 Structural steel shall comply with BS EN 10029.

13.3 All welded joints shall be seal welded with no gaps or blow holes.

13.4 All steelwork shall be hot-dip Galvanised to SANS 121.

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

- 25 kV disconnector
- 25 kV Busbar
- Lightning arrestors (for each feeder circuit)
- Auxiliary transformer
- Voltage transformer
- All Secondary Circuit Breakers (Incomer as well as the track feeders)
- All track feeder overhead feeders (500mm^2 Aluminium) shall be made off on this structure with the span length being the distance to the overhead track equipment switch structure which will be provided by others.

13.6 A typical layout of the above arrangement is shown in drawing CEE TBB 109 (Appendix 3).

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

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

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

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

14.0 PRIMARY AND SECONDARY DISCONNECTORS

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

14.2 Disconnectors and earthing switches shall be of the air break type suitable for outdoor installation and be designed for manual operation from ground level.

14.3 The primary disconnector shall be of the double pole type.

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

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

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

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

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

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

15.0 SURGE ARRESTERS

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

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

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

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

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

16.0 PRIMARY CIRCUIT BREAKERS

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

16.2 The circuit breaker shall be of the double pole type for outdoor operation.

16.3 The circuit breaker shall be suitably rated for electrical substation equipment.

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

16.5 The operating mechanism shall be provided with shunt release for both opening and closing.

16.6 The circuit breakers shall be designed for electrical operation at 110V DC from the substation battery supply.

16.7 Tension springs shall not be used for either closing or tripping mechanisms.

16.8 The circuit breaker shall be of the trip-free type.

16.9 A visual mechanical indicating device shall be provided to show whether the circuit breaker is closed or open.

16.10 The operating mechanism shall be constructed of non-ferrous material.

16.11 Auxiliary contacts shall be provided for operation in conjunction with the protection and other auxiliary circuits specified. At least one spare pair of normally open and one spare pair of normally closed contacts shall be provided.

16.12 The circuit breaker shall be provided with a control panel in the substation building on which are mounted the protection relays, control switches and associated equipment.

16.13 Circuit breaker control switches shall be provided on the control panel as well as on the circuit breaker mechanism. They shall return automatically to the neutral position when the handle is released after being turned to either the "close" or "trip" positions.

16.14 Local/Remote selector switches shall be provided on the control panel in the substation building as well as on the circuit breaker mechanism and shall be of the two-position type (no "off" or "neutral" position).

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

16.15 Mechanical operation shall be provided on the circuit breaker for any closing or trip release which is normally electrical operated.

16.16 The circuit breaker shall be provided with a no volt coil which will trip and lock out the breaker when the coil is de-energised. Drawing no. CEE-TBK-27 forming part of this specification, details control circuitry.

16.17 It shall be possible to close the circuit breaker only when the control voltage is above 85% of the nominal value, and the circuit breaker shall trip automatically when the control voltage falls below 70% of the nominal value.

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

16.19 Tenderers shall advise the number of circuit breaker operations under full load and fault conditions, after which maintenance and/or measurement of contact wear is recommended.

17.0 TRACTION TRANSFORMER

17.1 GENERAL

17.1.1 The transformer design shall be in accordance with Transnet Freight Rail's specification BBG2415.

17.1.2 Tenderers must comment on the ability of transformers offered to meet these requirements and provide this comment and the following details of transformers previously built for traction supplies with the tender: -

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

18.0 CURRENT TRANSFORMERS

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

18.2 If the primary supply voltage is 88 kV and below, then the current transformers for main transformer protection maybe installed in the transformer bushings. If the primary supply voltage exceeds 88 kV then only the current transformers on the secondary side of the main transformer shall be mounted in the transformer bushings, with the primary side's current transformers being of the post type.

18.3 Secondary protection current transformers shall be mounted in the transformer bushings.

18.4 Current transformers shall be installed on the load side of the associated circuit breaker. It shall be possible to remove the current transformers with the minimum of disturbance to other equipment.

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

18.6 Since the accurate measurement of harmonics in the traction supply will be necessary from time to time, current transformers offered shall be suitable for these purposes.

19.0 VOLTAGE TRANSFORMERS

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

19.2 Voltage transformers shall be outdoor structure mounted, oil filled type.

19.3 The return side of the primary winding shall have a bushing insulated for 3,3kV and must not be connected to the Voltage Transformer's tank.

19.4 The secondary winding shall be terminated in a cable box.

20.0 AUXILIARY POWER TRANSFORMERS

20.1 Unless otherwise stated two 16kVA, 27500V/240V single phase transformers mounted on the substation portal structure shall be provided by the successful tenderer.

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

20.3 The transformers and the connected equipment shall be capable of operating satisfactorily for a supply voltage varying between 27,5kV and 22,5kV. Main transformer secondary voltage under traction no-load conditions will normally be 27,5kV and auxiliary equipment shall be capable of operating continuously at this voltage.

20.4 Each transformer shall be provided with a suitably rated drop-out fuse link provided in the high voltage supply conductor.

21.0 BUSBAR COUPLER

21.1 The 25 kV busbars of each unit at all double unit traction substations shall be connected together by means of a busbar coupler. A busbar coupler shall be provided in single unit substations where specified in the Schedule of Requirements – Appendix 2.

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

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

22.0 SECONDARY CIRCUIT BREAKERS

GENERAL REQUIREMENTS

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

22.2 Circuit breakers of a service proven design are required and full-supporting details in this respect shall be furnished with tenders. The circuit breakers shall be single pole.

22.3 Circuit breakers shall be of the outdoor structure mounted type and shall be mounted on a suitably designed structure, in the manner indicated on drawing No's CEE-TDB-41 sht's 1 & 2

22.4 The mounting method of the circuit breaker and the operating mechanism shall be adjustable to allow for alignment.

22.5 The circuit breakers shall have a rated voltage of 44 kV, and the system frequency is 50Hz.

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

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

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

22.9 Opening time on low impedance track faults including relay operating time shall not exceed 0,1 second, for track feeder circuit breakers.

22.10 Tenderers shall advise the capability of circuit breakers offered to interrupt:-

- Capacitive currents.
- Currents with a high harmonic content.

22.11 Tenderers shall advise the chopping current levels of the circuit breaker offered and what steps are taken to keep these values to a minimum.

22.12 Tenderers shall also advise whether special precautions are required to limit the effects of chopped current and to give details.

22.13 The operating mechanism shall be constructed of non-ferrous material or cadmium plated steel.

22.14 The operating voltage shall be 110 V DC.

22.15 The circuit breaker operating mechanism shall be housed in a weatherproof enclosure, and shall be accessible by means of a lockable door.

22.16 The following shall be provided within the enclosure:

- A thermostatically controlled anti-condensation heater.
- A fluorescent light operated by a door switch.
- A 15 A, 220 V AC socket outlet in accordance with SANS 10142.

22.17 The circuit breaker mechanism shall be of the spring operated type with shunt release for both opening and closing. The closing operation shall charge the tripping spring.

22.18 It shall not be possible for the circuit breakers to close while the spring is being charged.

22.19 The spring shall be fully charged before it can be released to close the circuit breaker.

22.20 It shall be possible to charge the spring when the circuit breaker is closed and if the spring can be, and is released, the circuit breaker shall not open.

22.21 There shall not be any danger of a fully charged spring being released by vibration caused by the opening of the circuit breaker under any condition.

22.22 A visual mechanical indicating device shall be provided to indicate the state of the spring and shall be inscribed "Spring Charged" when the mechanism is in the condition to close the circuit breaker and "Spring Free" when it is in any other condition.

22.23 Means shall be provided for charging the spring by hand.

22.24 Means shall be provided for discharging the spring when the circuit breaker is in the "open" position without the circuit breaker attempting to close.

22.25 Facilities shall be provided for locking of the local manual release of the closing spring mechanism.

22.26 The closing springs shall recharge automatically after the completion of a closing operation.

22.27 Tension spring shall not be used for either closing or tripping mechanisms.

22.28 Facilities shall be provided to permit manual slow closing of the circuit breaker for maintenance purposes

22.29 The mechanism shall be trip-free. The contacts shall make before the breaker starts to open.

22.30 If the circuit breaker fails to latch on closing it shall trip before any significant damage can occur.

22.31 A visual mechanical indicating device shall be provided to indicate whether the circuit breaker is closed or open.

22.32 Unless the design of the circuit breaker mechanism is such that compensation for interrupter contact wear is provided automatically, a visible indication shall be provided to show when adjustment is needed. In the case of circuit breakers incorporating more than one interrupter it shall be possible to make such adjustments individually to suit the requirements of each interrupter.

22.33 Auxiliary contacts shall be provided for operation in conjunction with the protection and other auxiliary circuits specified. At least one spare pair of normally open and one spare pair of normally closed contacts shall be provided.

22.34 Local/Remote selector switches on the circuit breaker equipment shall be of the two-position type (no "off" or "neutral" position).

22.35 Circuit breaker control switches shall be arranged to return automatically to the neutral position when the handle is released after being turned to either the "close" or "trip" positions.

22.36 A counter shall be provided on each circuit breaker to indicate the total number of operations of the breaker.

22.37 Tenderers shall advise the number of circuit breaker operations under the following conditions, after which maintenance and/or measurement of contact wear is recommended:-

- Rated breaking capacity.
- Breaking 6 kA.
- Breaking 1500 A.

23.0 TRACTION SUBSTATION BUILDING

23.1 The building to be provided shall be of the prefabricated steel modular type. It shall be robust, waterproof, vermin proof and of sufficiently strong construction to resist all weather conditions encountered in South Africa.

23.2 Details of a suggested design are shown on Drawing No. CEE-TEC-28. This design or variations thereof may be used but tenderers are free to offer alternatives that comply with this specifications requirement.

23.3 When a single unit substation is required, the building design shall facilitate extension to accommodate equipment for a double unit substation in the future.

23.4 Steelwork shall be treated in accordance with the prevention of corrosion requirements specified in clause 11.

23.5 The building shall have a "double-skinned" roof construction to allow a free circulation of air between the skins.

23.6 The outer skin shall be of flat sheet steel of the same thickness as the building.

23.7 The inside walls shall be thermally insulated to the equivalent of 40mm of glass-fibre. The tenderer shall give full details of the material he intends to use as well as the fixing method of the material to the walls (Glue is not acceptable). Protection against mechanical damage to the insulation shall be provided.

23.8 The building shall be large enough to accommodate all equipment that will be contained within the building with enough space for comfortable maintenance of the equipment. The following major items of equipment as called for in this specification must be accommodated within the building:

- An aluminium self-supporting ladder with a height of 1.2m.
- A wall mounted metal key box with a lid and provision for at least 20 keys as shown on Drawing CEE-TCA-92.
- Suitable brackets and/or storage for ladder, special tools and earthing apparatus.
- Suitable bracket on the wall immediately adjacent to the annex door for mounting of a fire extinguisher. (Fire extinguisher will be provided by others).
- Suitable brackets for mounting of a control selector telephone and telecommunications distribution board.
- A complete set of wiring and circuit diagrams for the substation.
- A steel cabinet / desk combination approximately 1150mm wide, 600mm deep and 1 000mm high.
- Tele-control cabinets (provided by others).
- Battery tripping unit.
- Primary Circuit Breaker control panels.
- Secondary Circuit Breaker control panels.
- Low voltage distribution board.

23.9 One door is required for entrance into the building. The door shall be situated in the narrow wall opposite that which contains the ventilation fan. Another door is required at the end of the building which shall only be opened from inside the building. It must be located at the left end of the building from the main entrance door. This door will be used for maintenance purposes.

23.10 It shall be possible to remove, without dismantling, any equipment contained within the building through the door provided.

23.11 The door shall be fitted with a robust locking mechanism capable of being locked by means of a stout padlock provided by Transnet Freight Rail.

23.12 Door hinges shall be robust with hardened steel pins. Doors shall be fitted with a suitable stay to hold them in the open position.

23.13 A foundation and plinth of concrete for the support of the building and its equipment and for the maintenance and handling of all indoor equipment shall be provided.

23.14 The plinth shall be so designed as to eliminate the possibility of water standing in contact with the base of the building.

23.15 Tenderers shall give details of the measures they propose taking to seal the base of the building to the concrete plinth.

23.16 The finished level of the plinth shall not be less than 250mm above ground level .

23.17 The floor surfaces shall be durable non-slip and of pleasing appearance and shall not be subject to damage or marking by normal maintenance activities. In the case of a concrete floor it shall be coated with "Solidkote" or similar.

23.18 Provision shall be made for the entry of cables from the outdoor yard into the building.

23.19 The building design shall be such as to provide the necessary trunking for cable entry to all equipment which will be top entry. (No under floor trunking)

23.20 HEATING AND VENTILATION

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

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

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

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

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

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

23.20.7 Details of the type and rating of heaters must be supplied by tenderers.

24.0 AUXILIARY POWER SUPPLIES

24.1 All low voltage power and lighting circuits shall comply with the requirements of SANS 10142.

24.2 Under traction load conditions the substation supply voltage will have a high harmonic content and equipment supplied from the auxiliary transformer shall be capable of satisfactory operation under these conditions.

24.3 A low voltage distribution board shall be provided in the substation building. The output of the auxiliary transformers shall be connected to two 80A double pole miniature circuit breakers (MCB's) on the distribution board. The MCB's shall be withdrawal or lockable.

24.4 The output from the auxiliary transformers shall be connected to an automatic change-over contactor which must not allow the supplies to be paralleled under any circumstances.

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

24.6 The distribution board shall be provided with MCB'S to protect and control all lighting, heating, ventilation, socket outlets, control circuits, and supplies to the Eskom equipment. MCB'S shall comply with SANS 156.

24.7 Provision shall be made for six single MCB spare cut-outs for future additions.

24.8 The distribution board must provide for a 110V, 10A DC supply and a 220V, 20A AC supply to be cabled to the Eskom equipment in the Eskom yard. AC and DC circuits shall be physically separated either by means of a partition or separate distribution boards.

24.9 At least two 15A, 220V 3 pin socket outlets shall be provided in the building as well as one outlet mounted in the control panels.

24.10 LIGHTING – Eco Friendly Lighting

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

24.10.2 Two outdoor Eco friendly fluorescent lights shall be provided on the outside of the control equipment building. One shall be mounted above the buildings door and the other shall be mounted on the long side of the building facing the track. These lights shall be controlled by light sensitive switch.

24.10.3 Outdoor Eco friendly fluorescent lighting shall be provided in at least two positions to provide a general level of illumination of 20 lux in the substation yard. These lights shall be controlled from within the control equipment building. Care shall be taken to avoid glare in the eyes of train drivers and the layout must be approved by the Senior Engineer.

25.0 REQUIREMENTS FOR TELECONTROL

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

25.2 The Tele-control equipment cabinet, the size of which is approx. 1600x800x800 (hwd), will be housed in the substation control equipment building. Transnet Freight Rail will deliver this cabinet to site, with the installation thereof being the responsibility of the successful tenderer.

25.3 A "Klippon" or similar terminal strip with 250 terminals shall be provided to act as the interface between the substation equipment and the Tele-control equipment. This terminal strip can be housed in one of the switchgear control panels (space permitting) or housed in a dedicated enclosure. The successful tenderer shall terminate all conductors for the Tele-control functions required on one side of this terminal strip. The successful tenderer shall supply and install the cable required to connect the Tele-control equipment cabinet (supplied by Transnet Freight Rail) to the terminal strip. One side of this cable will be connected to the terminal strip with the other side being made off in the Tele-control equipment cabinet for connection by others.

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

25.5 Indication for Tele-control purposes shall be provided by means of voltage free open and closed contacts on the switchgear.

25.6 Provision shall be made for the following principal Tele-control operations indications and alarms: -

- Open and close command function for all circuit breakers.
- Open and close indication for all circuit breakers.
- Lockout indication for all circuit breakers.
- Indication of failure of voltage transformer output (protection reference voltage).
- Indication of failure of distance protection relay supply voltage. Detection must take place at each relay.
- Indication of charger failure for DC control batteries.
- Indication of transformer pressure relief device operation.

- Indication of low gas (SF6 breakers, Primary and Secondary).

25.7 The following transducers capable of measuring true RMS values of distorted waveforms shall be provided:-

25.7.1 A current transducer to monitor each main transformer secondary current.

25.7.2 A voltage transducer to monitor each secondary busbar voltage.

25.8 The output of these transducers shall be wired to the Tele-control terminal strip.

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

25.10 Any additional Tele-control functions that might be necessary due to the supply and installation of any specialised equipment offered shall be provided.

25.11 A detailed list of Tele-control commands, indications and alarms shall be submitted for approval by the Senior Engineer.

26.0 CONTROL PANELS

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

26.1 PANEL CONSTRUCTION

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

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

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

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

26.2 EQUIPMENT INSTALLED IN THE PANELS

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

26.2.2 Relays shall be completely sealed against the ingress of dust and dirt by means of non-inflammable covers which are easily removable. The relays shall have a protection rating of IP34 as defined in SANS 60529.

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

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

26.2.5 The control equipment provided shall be capable of correct operation within the voltage limits specified in SANS 62271-100. In addition the coils of all devices operated from the substation auxiliary transformer AC supply shall be capable of satisfactorily operating under the harmonic voltage conditions encountered in an AC traction system.

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

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

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

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

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

26.2.11 All cables shall be marked at both ends with markings the same as that which appears on the wiring schematics and diagrams.

26.2.12 All relays, cables, terminal strips, switches, lamps, push buttons etc. which are mounted on panels, shall be labelled to clearly indicate their function.

26.2.13 An annunciator indicating panel giving visual (LED display) indication of the reason for the circuit breaker's trip shall be provided on the circuit breaker control panel.

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

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

26.2.16 No anti condensation heaters are required inside the panels.

26.2.17 Each panel shall have and interior fluorescent lamp which will be switched by a door switch.

26.3 INDICATING INSTRUMENTS

26.3.1 All indicating instruments shall be designed, manufactured and tested in accordance with IEC 60051-1 and shall be flush mounted.

26.3.2 The dials of instruments shall be marked with the ratio of the associated instrument transformers.

26.3.3 The full-scale deflection of instruments shall be not less than 85mm and the scales shall be:

- Voltmeters 0 – 30 kV
- Ammeters 0 - 1 500 A

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

26.3.5 An ammeter shall be provided to indicate the primary and secondary current.

27.0 DC BATTERY AND CHARGER

27.1 The DC control battery and charger shall comply with specification No.CEE.0085 except where special arrangements are necessary to suit the design of equipment offered. The Tenderer shall complete appendix No.2 of that specification.

27.2 The rating of the battery and charger to be installed in each substation shall be based on the burden of the equipment to be supplied.

27.3 The nominal voltage of the battery shall be 110 V.

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

28.0 PROTECTION

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

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

28.2 PRIMARY CIRCUIT BREAKER TRIPPING

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

28.2.1.1 Buchholz.

28.2.1.2 Restricted earth fault on both primary and secondary windings.

28.2.1.3 Transformer percentage biased differential.

28.2.1.4 Primary circuit breakers SF6 low gas.

28.2.1.5 Traction transformer pressure relief valve.

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

28.2.2.1 Transformer winding and oil temperature.

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

28.2.2.3 Circuit breaker tripping supply under voltage and overvoltage detection.

28.2.2.4 Instantaneous overcurrent.

28.2.2.5 Utility No-Volt protection.

28.3 SECONDARY CIRCUIT BREAKER TRIPPING

28.3.1 Secondary circuit breaker protection relays shall be circuit specific:

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

28.3.3 Incomer circuit breaker

28.3.3.1 Inverse Definite Minimum Time (IDMT) overcurrent relay.

28.3.3.2 Instantaneous overcurrent.

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

28.3.4 Track feeder circuit breaker

28.3.4.1 Single phase Distance Impedance relay shall be in accordance with TFR specification BBG 5003. A track feeder circuit breaker will normally be the only feed into a section of railway line and will therefore not be required to discriminate with other track feeder circuit breakers.

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

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

28.3.4.4 Circuit breaker health detection.

28.4 AUXILIARY TRANSFORMER PROTECTION

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

28.5 RELAYS AND CIRCUITRY PROTECTION

28.5.1 All circuits supplied by the auxiliary transformers shall be protected by an earth leakage relay.

28.5.2 All circuits, regardless of source of supply shall be protected by suitably rated miniature circuit breakers. (MCB's)

28.5.3 Due to the susceptibility of protection relays to damage due to poor quality of supply as well as lightning surges, the tenderer must state what measures will be implemented to safeguard this equipment.

29.0 CONDUCTORS, CABLES, AND SMALL WIRING

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

Table 5: Electrical conductors

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

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

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

29.4 All low voltage cables shall be 600/1 000 Volt PVC insulated sheathed in terms of specification SANS 1507.

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

29.6 Small wiring and terminations shall comply with SANS 10142 and SANS 61936-1. The current ratings for the various sizes of conductors shall not be exceeded.

29.7 All instrument and control wiring shall be a minimum size of 2.5 mm^2 cross-section with stranded copper conductors. Wires connected to the current transformers shall have a minimum cross-section of 4 mm^2.

SECTION 3: - INSTALLATION OF EQUIPMENT

30.0 SUBSTATION SITES

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

30.1 SITE PREPARATION

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

30.2 SITE LEVELS

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

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

30.2.3 The site must be flat.

30.3 MATERIAL

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

30.3.2 Material of quality G5 must be used for earthworks in accordance with SAPEM – standards chapter 4.

30.4 COMPACTION

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

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

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

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

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

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

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

30.4.8 After treatment with the weed killer, a 100mm layer of 25mm crusher stone shall be laid over the whole area of the Transnet Freight Rail yard (within the kerbing).

30.4.9 Access to the sites shall be by means of Transnet Freight Rail maintenance roads. Should the tenderer feel that these roads are not adequate, a separate quotation for any work deemed necessary shall be submitted with the tender.

31.0 FOUNDATIONS

31.1 The successful tenderer shall be responsible for the design and installation of foundations for all the structures, equipment and buildings within the substation yard.

31.2 The successful tenderer shall carry out his/her own survey in regard to soil types and their load bearing capabilities.

31.3 Tenderers must ensure that provision (financial as well as time) for excavations in a range of soil types is allowed for in their tenders.

31.4 Equipment support foundations shall be finished off 200mm above the finished earth level of the yard. The design must be such as to prevent standing water.

31.5 All foundations edges shall be bevelled and the surfaces must be float finished.

31.6 All support foundations shall be at the same level.

31.7 An earth mat conductor shall be cast in the concrete foundation for the connection of support steelwork to the earth mat. This shall be done in accordance with Drawing No. CEE-TEE-173 sht's 1-3.

31.8 This earth conductor shall be electrically connected to the foundation bolt group such that in the event of the visible earth connection being removed, an earth connection via the bolt group is maintained. This shall be done in accordance with Drawing No CEE-TEE-173 sht's 1 - 3.

31.9 A plastic pipe shall be cast into all concrete foundations for earth/control cabling to be taken up the structure and shall be done in accordance with Drawing No CEE-TEE-173 sht's 1-3.

31.10 If the foundation for the main traction transformer is larger than the transformer base plate, then a portion of the foundation the exact size of the base plate must be raised at least 50mm to prevent the possibility of standing water against the transformers base plate.

32.0 CONCRETE

32.1 The 28-day strength of all concrete used shall be a minimum of 20Mpa.

32.2 The successful tenderer shall arrange for sampling and testing of all concrete used, and shall submit full records to the Senior Engineer. Transnet Freight Rail reserves the right to undertake testing of concrete samples and the successful tenderer shall furnish test cubes if requested by the Senior Engineer.

32.3 Hand mixed concrete is not acceptable, it must be mechanically mixed.

32.4 The addition of water to a concrete mix reduces the strength of that concrete very significantly and on no account shall water be added to a mix after test cubes have been taken.

32.5 There shall be a minimum of 100 mm concrete cover for all steel reinforcing.

33.0 INSTALLATION OF SUBSTATION EQUIPMENT

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

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

Requirements for the installation of substation equipment are as follows:

33.4 PRIMARY ISOLATOR

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

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

33.5 MAIN TRANSFORMER

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

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

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

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

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

33.6 VOLTAGE TRANSFORMER

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

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

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

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

33.7 AUXILIARY TRANSFORMER

33.7.1 The primary positive pole of the auxiliary transformer shall be connected on the traction transformer side of the secondary isolator and should a second auxiliary transformer connected to the 25 kV supply be required, its primary positive pole shall be connected to the overhead track equipment on the load side of the track feeder switch (see drawing No. CEE - TBB -109).

33.7.2 The auxiliary transformer connected to the main transformer side of the disconnector shall be mounted on the 25 kV gantry. It shall be mounted in such a manner as to allow space for the drop out fuse to be mounted and to function safely, above the auxiliary transformer.

33.7.3 The second 25 kV auxiliary transformer (see schedule of requirements) shall be mounted on one leg of the overhead track equipment track switch structure. (see drawing No. CEE-PFB-30 for typical mounting details)

33.7.4 The neutral of the primary winding of each 25 kV Auxiliary transformer shall be connected to the overhead neutral return current conductor.

33.7.6 The secondary output of the auxiliary transformers shall be cabled to a distribution board in the substation building.

33.8 SECONDARY ISOLATOR

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

33.9 SECONDARY CIRCUIT BREAKERS

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

33.9.2 The outdoor switchgear shall be mounted on suitably designed horizontal steel beams forming part of the 25 kV gantry structure (see Drawing No's CEE-TDB-41 sht's 1 & 2)

33.9.3 The outdoor switchgear mounting arrangement shall allow for lateral and vertical adjustment to enable proper alignment of switchgear to take place.

33.9.4 The switchgear shall be mounted in such a manner as to allow an isolating gap of not less than 300 mm between the circuit breaker terminals and the 25 kV busbar should the jumper be removed.

33.10 SECONDARY LIGHTNING ARRESTORS

33.10.1 All secondary lightning arrestors shall be mounted on the 25 kV gantry and shall be connected in the circuit in accordance with Drawing No. CEE-TBB-109.

33.10.2 The earth connection of all the secondary lightning arrestors shall be connected to the substation earth mat by means of the specified earthing conductor.

33.11 25 kV BUSBAR

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

33.12 BUSBAR COUPLER (DOUBLE UNIT TRACTION SUBSTATIONS)

33.12.1 For secondary circuit breakers of the outdoor structure mounted type the busbar coupler shall be mounted on the 25 kV gantry structure as per drawing no. CEE-TDB-41 sht 1. The two additional isolation MOD's on a bus coupler shall be interlocked.

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

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

33.13 SUBSTATION BUILDING

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

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

33.14 EQUIPMENT INSTALLED IN THE SUBSTATION BUILDING

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

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

33.15 CABLES

33.15.1 Cable trenches shall have a minimum depth of 500mm measured from ground level. All trenches shall be backfilled and compacted in layers to the compaction of the surrounding yard.

33.15.2 The exact position and size of each cable in the yard shall be shown on the cable layout plan. These drawings shall be submitted for approval prior to installation.

33.15.3 Asbestos free-cement cable pipes shall be installed beneath any roadway, where the crossing of a roadway by cables is required. These pipes shall be not less than 150mm in diameter and shall protrude at least 500mm on either side of the roadway. The pipes shall be graded 1:400 for water drainage.

33.15.4 All cables entering the control equipment building shall be block jointed (50mm of armouring to be removed) above the ground. The block jointing shall be done before the cables are installed into the control equipment building. The block joint shall be covered by a heatshrink sleeve.

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

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

33.15.7 Cables and earthing conductors connected to equipment installed on steel support structures shall be supported on the steel structure vertically and horizontally by means of a cable tray. This cable tray shall be of the O-Line GS50 Gridspan Wire Mesh type or similar with the wire mesh having a diameter of 4mm and a hot dip galvanised finish.

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

33.15.9 Should the cable termination box of an item of equipment overhang the vertical steel support structure, the cable can be installed directly from the cable trench to the terminal box provided a hot dip galvanised steel cable support is provided. This support must either be securely attached to the terminal box or be concreted into the ground. (see drawing No. CEE-TDC-10)

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

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

33.16 INTERCONNECTION OF EQUIPMENT

33.16.1 Conductors between separately mounted outdoor equipment shall incorporate a degree of flexibility to avoid any stressing of these connections due to foundation movement or conductor expansion/contraction and to facilitate alignment of equipment.

33.16.2 All connections to the overhead conductors shall be made using clamps that are specifically designed and manufactured to make that particular connection (ad hoc fabricated clamps are not acceptable).

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

33.16.4 All dissimilar metal connections (Cu to Al) shall be made using bi-metallic clamps that are specifically designed and manufactured to make that particular connection (ad hoc fabricated clamps are not acceptable).

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

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

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

33.16.8 The overhead track feeder conductors complete with insulation and fitted with suitable bi-metallic clamps for the connection of two 160mm^2 Cu conductors (provided by others), shall be supplied and made off on the track switch portal by the contractor. Others shall do the connection of these conductors to the track switches. This forms the substation/overhead track equipment contract boundary.

33.17 FENCING AND KERBING

33.17.1 The boundary/stock fence, security fence and concrete kerbing shall only be installed once all major items of equipment and steelwork have been delivered and installed and all overhead conductors stringing is complete.

33.17.2 The extent of Boundary/stock fencing, security fencing as well as kerbing for each substation site is shown on the substation layout drawings listed in Appendix No. 1.

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

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

33.18 "RETURN" CURRENT AND SUBSTATION EARTHING

33.18.1 RETURN CURRENT

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

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

33.18.2 SUBSTATION EARTH

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

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

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

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

33.18.2.5 The earth mat connections to structural support steel as called for on drawing No. CEE-TBD - 8 shall be made via the copper earth connection cast into the associated foundations.

The earth mat shall be brazed to the tails protruding from the support foundations at a depth of 600mm.

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

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

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

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

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

33.18.3 EARTHING DEVICES

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

33.18.3.2 The clamps for the connection of the overhead feeder to the load side of the secondary switchgear shall be designed such that a suitable attachment for the earthing harness is provided.

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

33.18.3.4 In a single unit substation a portable earthing harness shall be provided for connecting all secondary switchgear outdoor bushing terminals simultaneously to the substation main earth mat.

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

33.19 NAMEPLATES AND LABELS

33.19.1 A substation nameplate shall be provided. The names of the substations shall be as specified in Appendix No. 1. The nameplate shall be manufactured in accordance with Drawing No. CEE-TEA-2.

33.19.2 Danger warning notices as per Drawing CEE TA-196 shall be supplied and fitted to the substation building access door, on each half of the substation gate, one notice on the narrow side substation fence and two notices on the long side substation fence.

33.19.3 All nameplates and labels shall be in English.

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

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

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

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

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

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

33.19.10 The proposed labelling scheme must be submitted to the Senior Engineer for approval prior to the manufacture of the labels.

SECTION 4: TESTING AND COMMISSIONING

34.0 TYPE AND ROUTINE TESTING REQUIREMENTS

34.1 Type and routine tests shall be conducted on the equipment to be supplied. These tests shall be carried out at the successful tenderers expense.

34.2 Test certificates in respect of type tests conducted on identical equipment may be accepted in lieu of type tests at the discretion of Transnet Freight Rail.

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

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

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

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

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

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

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

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

34.11 Transnet Freight Rail staff will conduct an out of tank inspection of the transformer prior to the transformer being tanked as well as witnessing all the routine manufacturers tests carried out at the works. The co-ordination of manufacturers testing shall be the responsibility of the successful tenderer.

34.12 Type test certificates of the transformer design offered shall be submitted with the tender. Should type test certificates not be available, the required tests shall be carried out, the cost of which must be included in the tender price quoted as a separate item.

34.13 Should the transformer offered not have a short circuit type test certificate available, a simulated computer model of this test may be submitted for Transnet Freight Rail's approval, but should this model be unacceptable short circuit tests will be required and shall be conducted in accordance with Transnet specification BBG2415. An out of tank inspection shall be carried out after completion of the tests. The tests shall comprise two short circuits on each of the extreme and centre tapings. The short circuits on each tapping shall be of opposite asymmetry. Short circuit duration shall not be less than 0,5 seconds. Short circuit current shall not be less than that calculated for a fault on the secondary terminals of the transformer with rated voltage on the primary terminals from a supply of not less than 2 500 MVA.

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

34.15 The following equipment shall be inspected by Transnet Freight Rail staff at the place of manufacture prior to delivery to the successful tenderers works or to site:

- All structural steelwork
- The substation building
- Battery tripping unit
- All control panels

35.0 SITE TESTS AND COMMISSIONING

The successful tenderer shall be responsible for carrying out on-site tests and commissioning of all equipment supplied and installed in terms of this specification and the contractual agreement.

35.1 ON-SITE TESTS

35.1.1 Functional on-site tests shall be conducted on all items of equipment and circuitry to prove the proper functioning and installation thereof.

35.1.2 The successful tenderer shall submit a detailed list of on-site tests for the approval of the Senior Engineer at least six weeks before tests are due to commence at the first substation.

35.1.3 The successful tenderer shall arrange for the Senior Engineer or his representative to be present to witness the on-site tests at each substation.

35.1.4 The on-site tests and subsequent commissioning will not commence until all construction work has been completed. Construction staff, material and equipment shall be removed from site prior to the commencement of testing. Testing and commissioning of the substation equipment will not be allowed to take place in a construction site environment.

35.1.5 On-site tests shall include the following;

- Polarity tests on all VT's and CT's
- Ratio tests on all VT's and CT's
- Magnetising current of all CT's
- Secondary injection of all relays
- Trip testing, all relays must be checked for correct operation.
- The functionality of all electrical circuitry must be tested.
- A power frequency voltage test on all 25 kV equipment at 57 kV for one minute.

- A power frequency voltage test on all small wiring at 2 kV for one minute.
- Millivolt-drop test on 25 kV circuits with a current of not less than 200 A.
- A proof of vacuum test on vacuum circuit breakers.
- Tests on primary circuit breakers and other primary equipment in accordance with manufacturer's instructions.

35.1.6 At the completion of the on-site tests the Senior Engineer or his representative, shall either sign the test sheets (supplied by the successful tenderer) as having witnessed the satisfactory completion thereof, or hand to the successful tenderer a list of defects requiring rectification.

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

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

35.2 COMMISSIONING OF EQUIPMENT

35.2.1 Commissioning will include the energising of equipment from the primary isolator to the track feeder circuits. The successful tenderer must prove the satisfactory operation of all equipment under live conditions.

35.2.2 On completion of commissioning the successful tenderer will hand the substation over to the Senior Engineer in terms of the relevant instructions.

35.2.3 Tenderers shall allow a period of at least three days per substation between satisfactory completion of on-site tests and commissioning of equipment.

35.2.4 During this period the Transnet Freight Rail's Test staff will test the operation of all protective relays and circuits and set the protection relays at each substation.

35.2.5 The successful tenderer installation staff shall be present during the testing and setting of the protection to rectify any faults found.

35.2.6 On-site testing of the first substation must therefore commence ahead of the contract completion date, by a period not shorter than a total of three days per substation.

35.2.7 The commissioning of the protection equipment by Transnet Freight Rail will in no way absolve the successful tenderer from any of his responsibilities during the guarantee period. It is the successful tenderers responsibility to satisfy himself/herself that the commissioning of the protection equipment has been carried out in a satisfactory manner and in no way compromises the proper operation of the equipment supplied in terms of the contract.

35.2.8 The commissioning dates for the substations will be dependent on the availability of power supplies from the supply utility as well as Transnet Freight Rail's electrification program and will be defined by the Transnet Freight Rail Senior Engineer.

36.0 DRAWINGS, INSTRUCTION MANUALS AND SPARES LISTS

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

36.1 DRAWINGS

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

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

36.1.3 The following drawings are required for approval prior to construction and submission in as built form at the completion of the works:

- Electrical schematic diagrams
- Detailed electrical wiring diagrams
- Foundation design drawings (for all foundations)
- Structural support steelwork design drawings
- Site equipment layout plan showing equipment and conductor profiles.
- Earth mat layout plan showing position of buried conductors.
- Buried cable layout plan showing position of buried cables.
- Substation control equipment building plans.

36.1.4 A complete set (paper copies bound in book form) of the electrical schematic and detailed wiring diagrams shall be provided for each substation and shall be in the substation at the commissioning stage.

36.2 INSTRUCTION MANUALS

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

36.3 SPARES LISTS

36.3.1 The successful tenderer shall submit details of spares required in accordance with specification No. CEE.0224.

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

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

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

37.0 SPECIAL TOOLS AND/OR SERVICING AIDS

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

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

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

38.0 TRAINING

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

39.0 GUARANTEE AND DEFECTS

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

39.2 The guarantee period for all substations shall expire after: -

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

39.2.2 A period of 12 months commencing on the date of commissioning of the last substation, whichever is the later date.

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

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

40.0 APPENDIX 1

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

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

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

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

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

41.0 APPENDIX 2

SCHEDULE OF REQUIREMENTS FOR AC TRACTION SUBSTATIONS

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

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

41.1.2 The following table must be completed quantifying the major items of equipment required at each traction substation:

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

Table 1: Substation equipment

Note:
- P.I Primary isolator
- P.C.B Primary Circuit Breaker
- M.T Main Transformer
- S.I Secondary Isolator
- I.F Incoming Feeder
- T.F Track Feeder
- B.C Bus Coupler
- A.T Auxiliary Transformer
- V.T Voltage Transformer

42.0 APPENDIX 3

SCHEDULE OF DRAWINGS SUPPLIED BY TRANSNET FREIGHT RAIL

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

HOAC-HO-52920

ANNEXURE A10- DRAWINGS ELECTRICAK DRAWING- INCOMER PANEL

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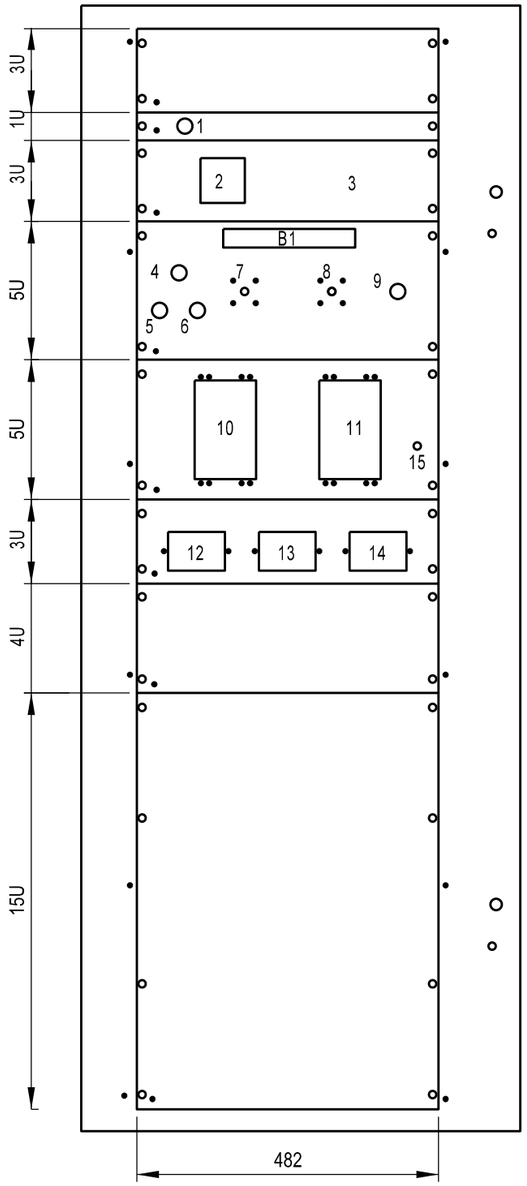
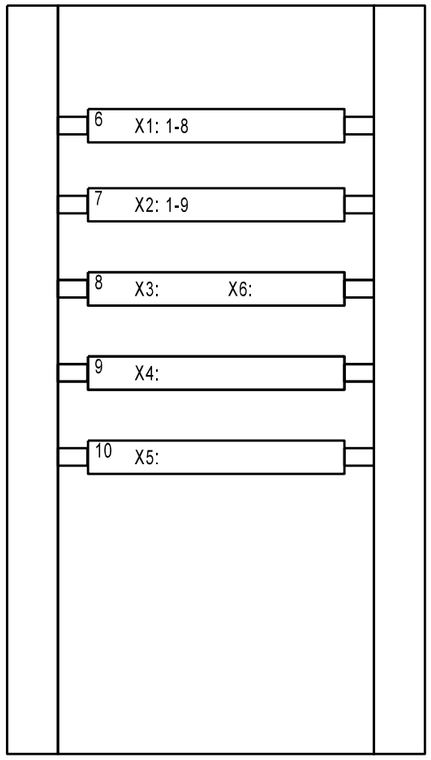
FRONT VIEW



TERMINAL PLATE



POSITION	DESIGNATION	DESCRIPTION	MANUFACTURER CATALOG NUMBER	MANUFACTURER
FRONT VIEW OF PANEL				
B1	LABEL	25kV TSS VCB V37		
1	PNH	PROTECTION NOT HEALTHY LAMP		AC/DC
2	A	AMMETER		AC/DC
3	V	VOLTMETER		AC/DC
4	READY	MV CIRCUIT BREAKER LAMP (READY)		AC/DC
5	OPEN	MV CIRCUIT BREAKER LAMP (OPEN)		AC/DC
6	CLOSED	HV CIRCUIT BREAKER LAMP (CLOSED)		AC/DC
7	CB CONTR	MV CIRCUIT BREAKER CONTROL SWITCH		KRAUS
8	LOCAL/REMOTE	LOCAL REMOTE SWITCH		KRAUS
9	LAMP TEST	LAMP TEST PUSH BUTTON		AC/DC
11	P122	OVER CURRENT RELAY		SCHNEIDER
12	VTTB	VOLTAGE TRANSFORMER TEST BLOCK		ALBRO
13	METTB	METERING TEST BLOCK		ALBRO
14	CTTB	CURRENT TRANSFORMER TEST BLOCK		ALBRO
15	ESD	ELECTROSTATIC DISCHARGE CONNECTION		AC/DC
REAR VIEW OF PANEL				
X1				
1	MCB1	MINIATURE CIRCUIT BREAKER (CONTROL)		GE
2	MCB2	MINIATURE CIRCUIT BREAKER (TRIP & ALARMS)		GE
3	MCB3	MINIATURE CIRCUIT BREAKER (INDICATION LIGHTS)		GE
4	MCB4	MINIATURE CIRCUIT BREAKER (PANEL LIGHT)		GE
5	MCB5	MINIATURE CIRCUIT BREAKER (VOLTAGE TRFR)		GE
6	DEHNGUARD	SURGE PROTECTION POSITVE TO NEGATIVE		DEHN
7	DEHNGUARD	SURGE PROTECTION POSITIVE TO NEGATIVE		DEHN
8	DEHNGUARD	SURGE PROTECTION NEGATIVE TO EARTH		DEHN
9	DEHNGAP	SURGE PROTECTION LIVE - NEUTRAL		DEHN
10	DEHNGAP	SURGE PROTECTION LIVE - EARTH		DEHN
11	DEHNGAP	SURGE PROTECTION NEUTRAL - EARTH		DEHN
X2				
1	ST-X	SUPERVISORY TRIP AUXILIARY RELAY		RELE
2	SC-X	SUPERVISORY CLOSE AUXILIARY RELAY		RELE
3	DCF-X	DC FAIL AUXILIARY RELAY		RELE
4	U/V	110VDC UNDERVOLTAGE RELAY		RHOMBERG
5	PNH-X	PROTECTION NOT HEALTHY AUXILIARY RELAY		RELE
6	CH-X	CLOSE INHIBIT AUXILIARY RELAY		RELE
7	VCB-X	MV CIRCUIT BREAKER OPEN AUXILIURY RELAY		RELE
8	L/R-X	LOCAL REMOTE AUX RELAY		RELE
X3				
	CT & VT	CURRENT & VOLTAGETRANSFORMER TERMINALS		VIKING
X4				
	CON & IND	220VAC & 48VDC CONTROLS & INDICATIONS TERMINALS		VIKING
X5				
	TELE	TELE CONTROL TERMINALS		VIKING
	DIODE	DIODE BOARD D1 - D12		IST
X6	TRANSCUDERS	M1416 VOLTAGE AC TRANSD		
		M1418 CURRENT AC TRANSD		

NOTE:
1. DRAWINGS ARE DEVELOPED BASED ON CURRENT TECHNOLOGY.
   PLEASE CONTACT TECHNOLOGY MANAGEMENT FOR SITE SPECIFIC DRAWINGS.
2. 1U = 44.45mm
   THE SCHEME IS DESIGNED FPR MOUNTING A 19 INCH RACK SYSTEM AS PER IEC 60297
   THE MODULE AND BACK PLATE ARE 482.6mm WIDE. THE MODULE IS 600mm DEEP.

DIMENSIONS : mm SCALE : -
TOLERANCE : LIN± - ANG± - ITEM NO : -
MATERIAL : -
VERSION INFO : REDRAWN INTO TRANSNET DRAWINGS

+ 23/04/2024
APPROVED

+
AUTHORISED

25kV INCOMER RELAY PANEL
PANEL EQUIPMENT LAYOUT

TRANSNET freight rail

BBH6954 SHT 1 OF 9
VERSION 1 A3

DO REF: CDO/ E0529 ECP REF: - DRAWN: L.S KEKANE DESIGNED: - CHECKED: X.R BHOMELA

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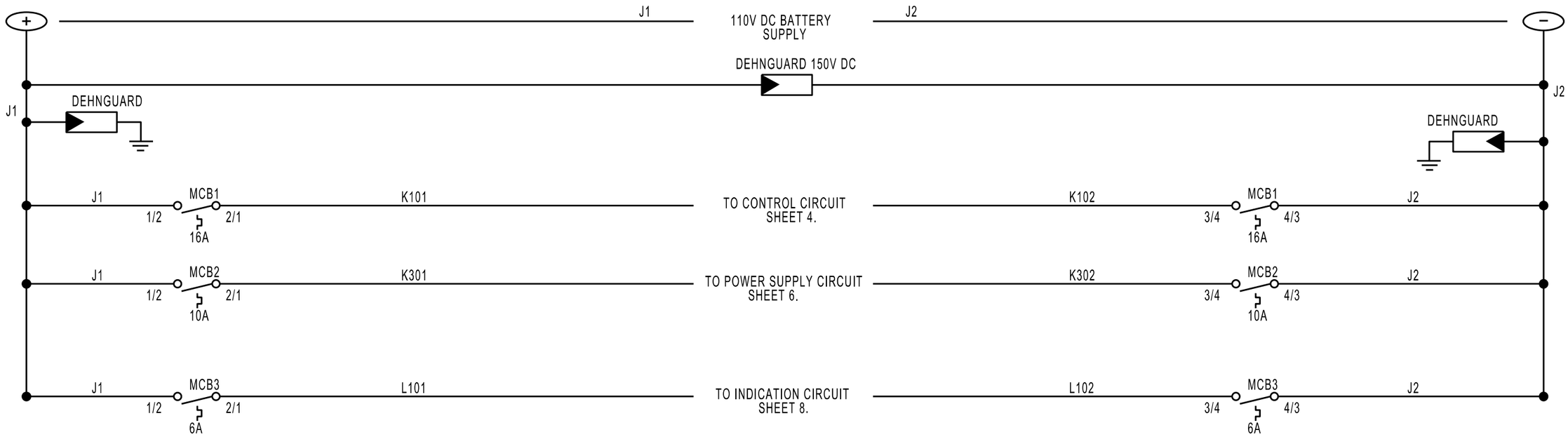

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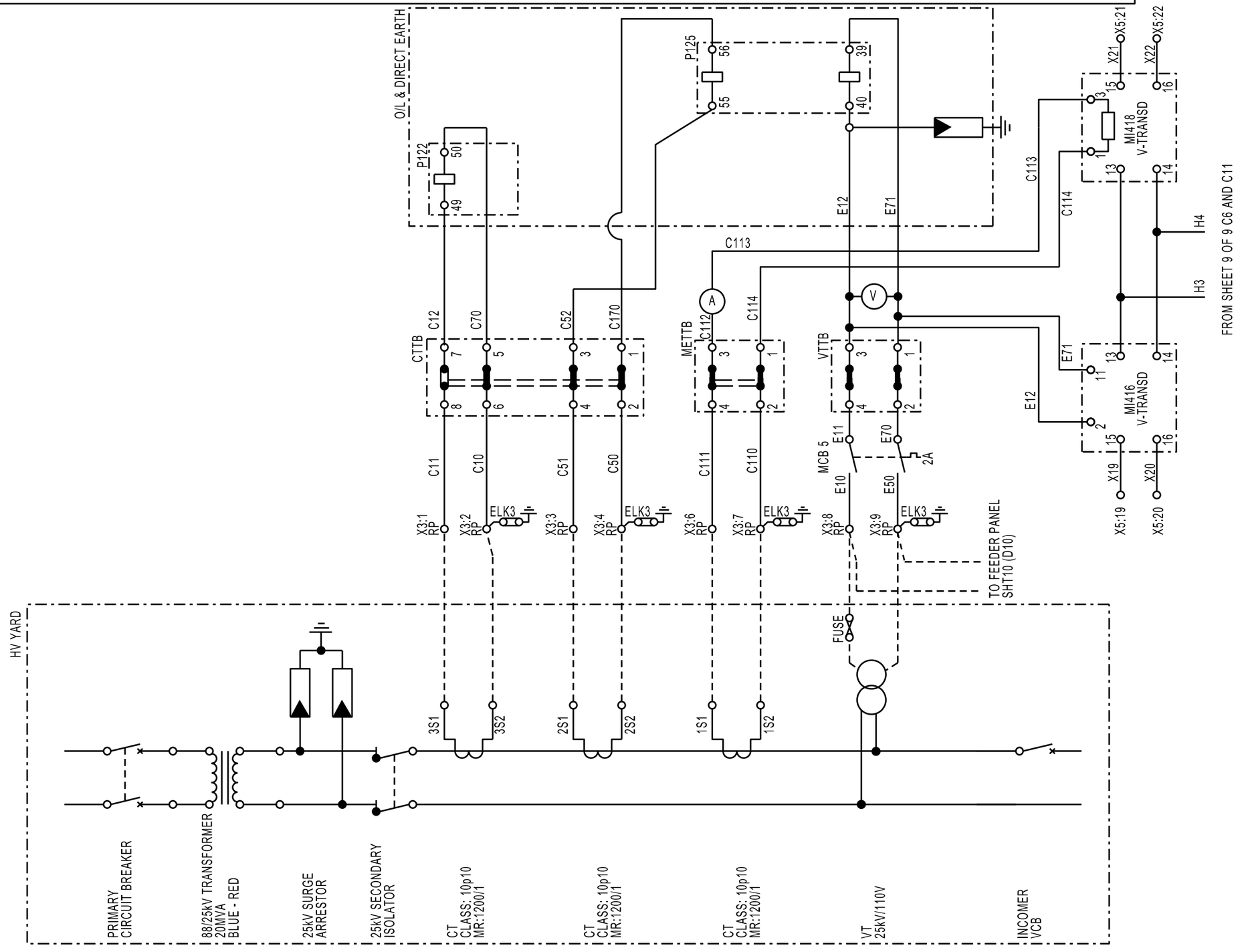

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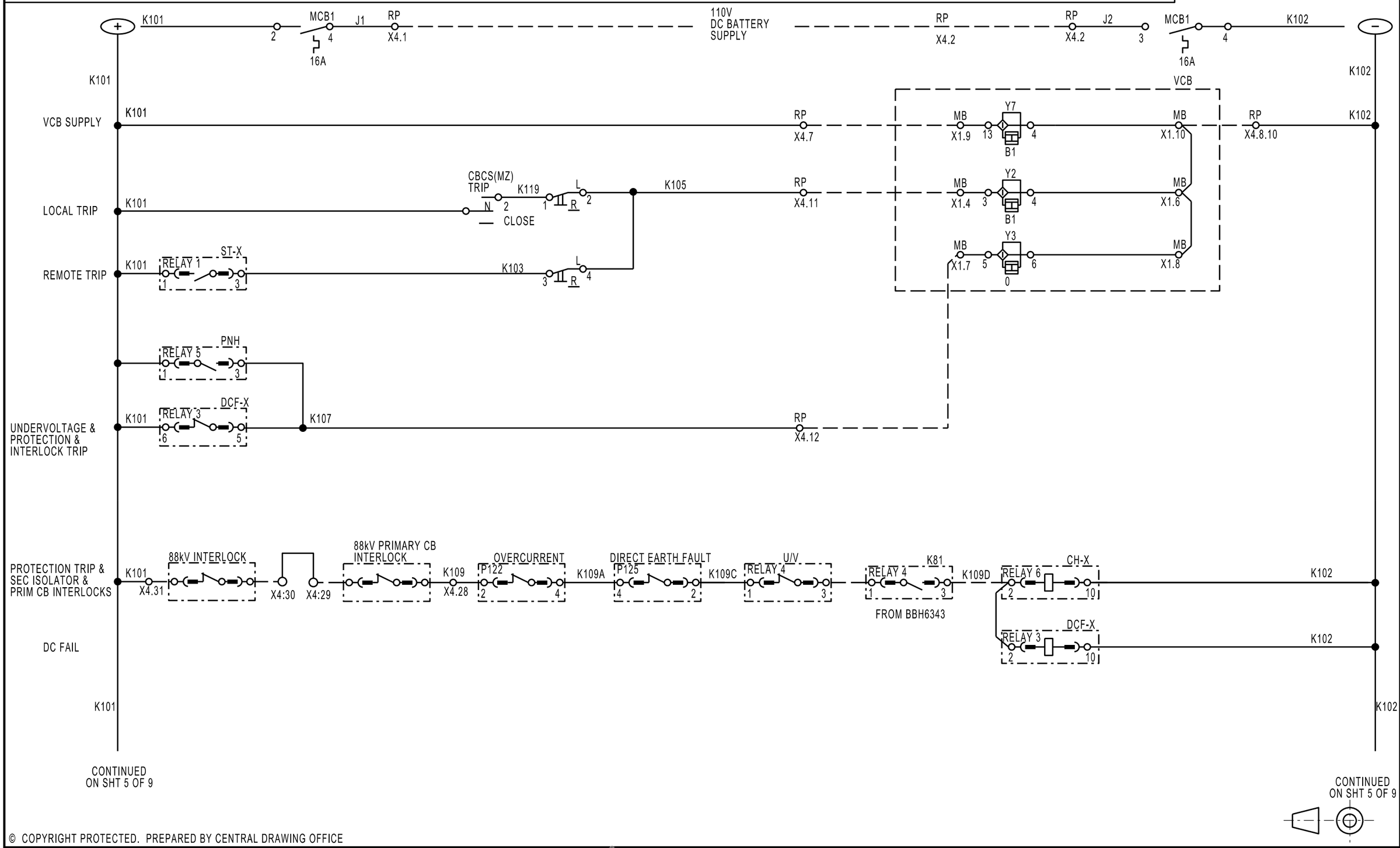

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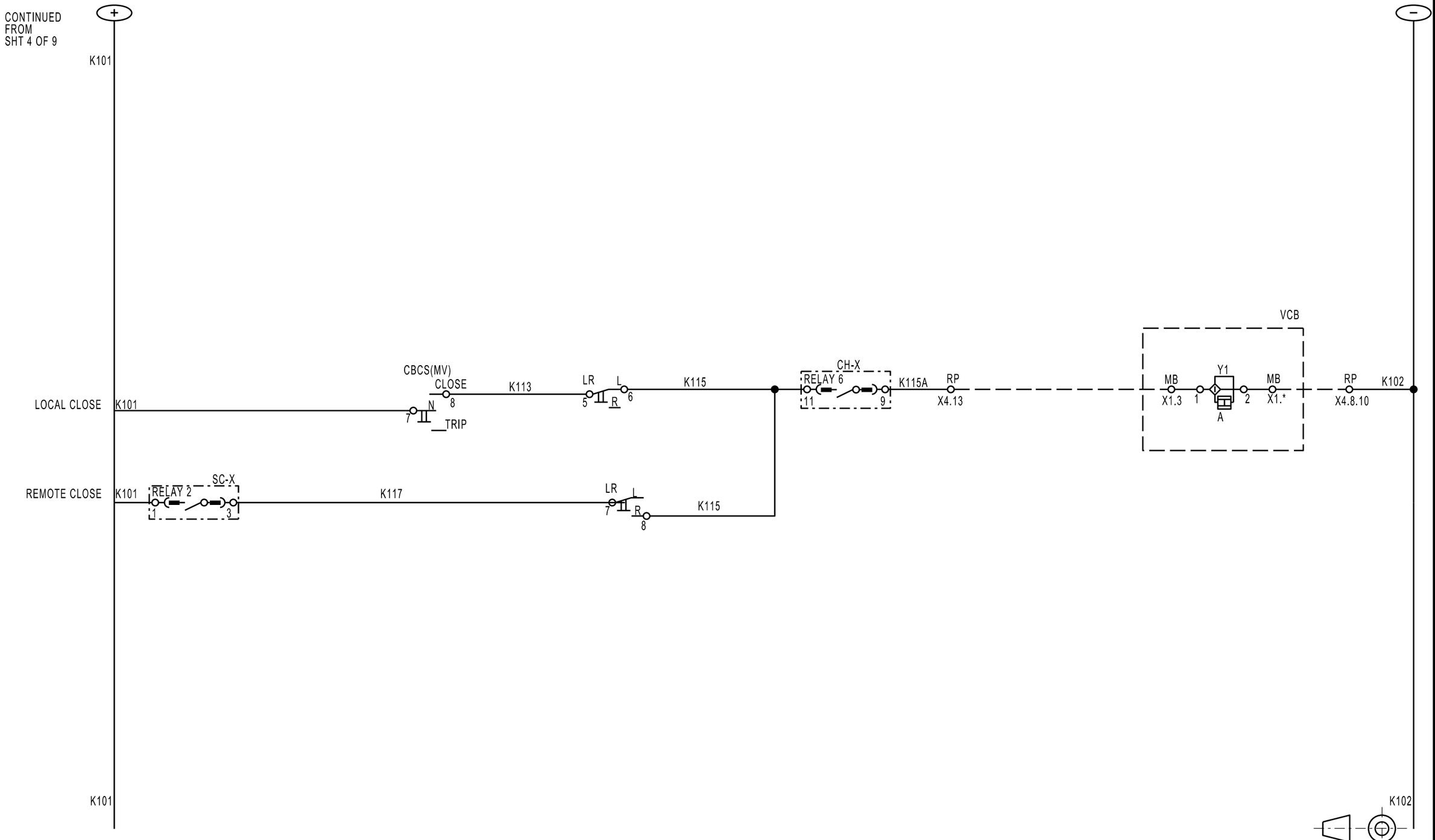

DIMENSIONS : mm TOLERANCE : LIN± - ANG± - MATERIAL : - VERSION INFO : REDRAWN INTO TRANSNET DRAWINGS	+ 23/04/2024 APPROVED	+ AUTHORISED	25kV INCOMER RELAY PANEL CLOSE DC LINE DIAGRAM	TRANSNET freight rail BBH6954 SHT 5 OF 9 VERSION 1 A3

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+ K301 — 2 — MCB2 — 10A — J1 — 110V DC LOOP SUPPLY — J2 — MCB2 — 10A — K302 —

OVERCURRENT RELAY POWER SUPPLY: K301 — 50/51 P122 (33–34) — K302

REVERSE POWER RELAY POWER SUPPLY: K301 — 67N P125 (33–34) — K302

LOCAL REMOTE AUX RELAY CONTROL: K301 — L/R (9–10) — K313 — L/R-X RELAY 8 (2–10) — K302

110VDC SUPPLY TO TELECONTROL TERMINALS X5: K301 — SHT.7 - 17

P122 RELAY FAULTY: K301 — P122 (36–35) — K307 — PNH-X RELAY 5 (2–10) — K302

P125 RELAY FAULTY: K301 — P125 (36–35)

VCB

25kV CB NOT HEALTHY: K301 — RP X4.16 — MB X1.13 — VCBF 52b (25–23) — MB X4.14 — RP X4.18 — K307

25kV CB OPEN: MB X1.43 — VCBO 52b (19–20) — MB X4.44 — RP X4.21 — K209 — VCB-X RELAY 8 (2–10) — K302

SUPERVISOR TRIP 110V DC: K301 — RP X5.12 — TELECONTROL TRIP — RP X5.13 — K305 — ST-X RELAY 1 (2–10) — K302

SUPERVISOR CLOSE 110V DC: TELECONTROL CLOSE — RP X5.14 — K311 — SC-X RELAY 2 (2–10) — K302

UNDERVOLTAGE MONITOR RELAY: K301 — U/V SP-201 4 (2–10, 5) — K302

DIMENSIONS : mm SCALE : - TOLERANCE : LIN± - ANG± - ITEM NO : - MATERIAL : - VERSION INFO : REDRAWN INTO TRANSNET DRAWINGS	+ 23/04/2024 APPROVED	+ AUTHORISED	25kV INCOMER RELAY PANEL TRIP & ALARMS DC DIAGRAM	TRANSNET freight rail BBH6954 SHT 6 OF 9 VERSION 1 A3

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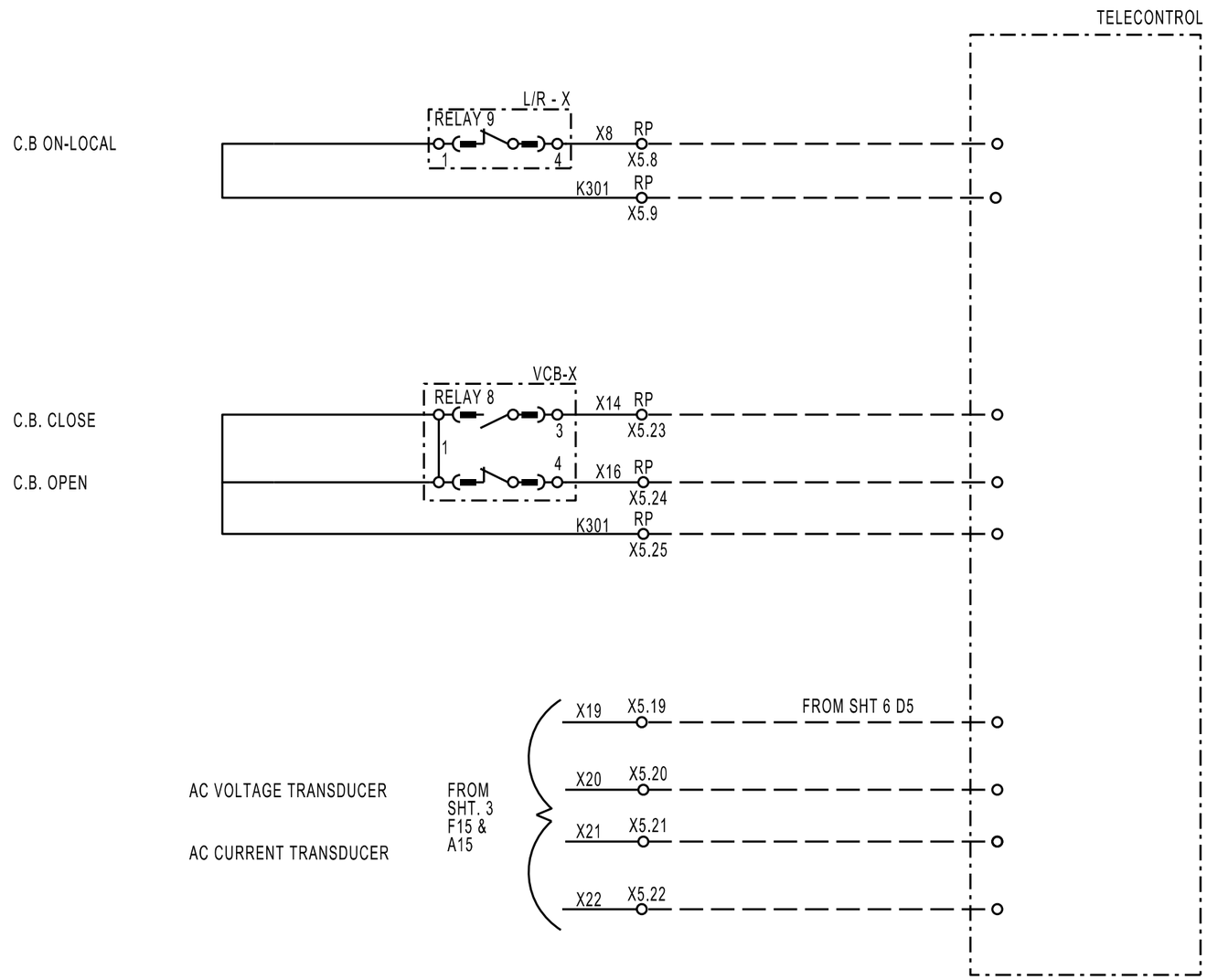

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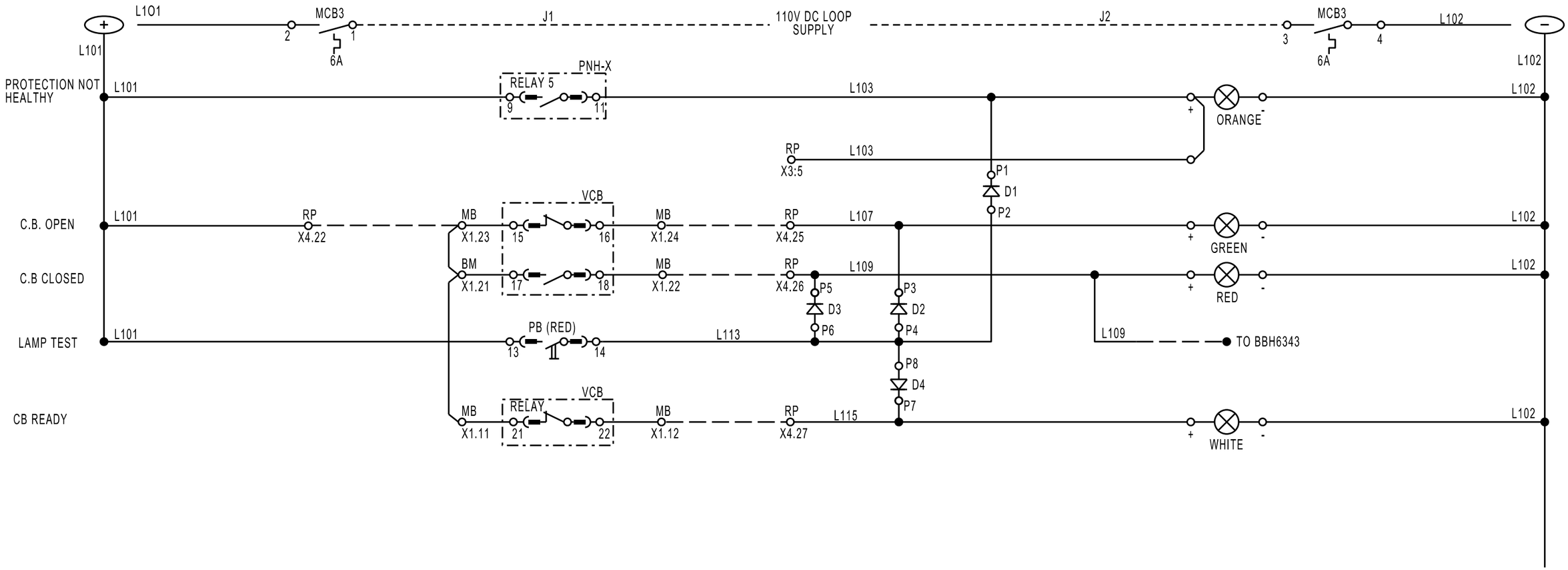

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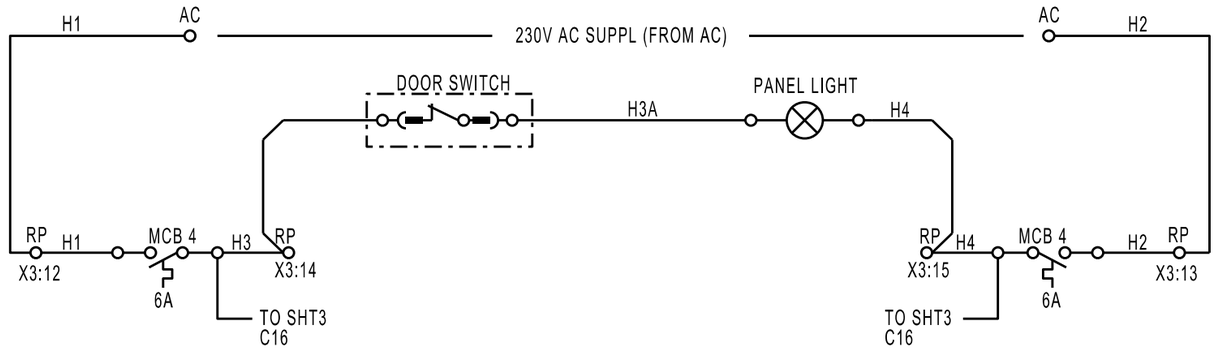

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HOAC-HO-52920

ANNEXURE A11- MOD DRAWING

TRANSNET freight rail

TECHNOLOGY MANAGEMENT.

SPECIFICATION.

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

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

Date: 21st September 2009

Circulation Restricted To:

Transnet Freight Rail – Chief Engineer Infrastructure
- Technology Management

INDEX

1.0 SCOPE

1.1 This specification covers Transnet freight rail requirements for the design, manufacture, testing and supply of outdoor Alternating Current (AC) circuit breakers in accordance to SANS 62271-100.

1.2 The alternating current circuit breakers shall be suitable rated for nominal phase to phase r.m.s voltages ranging from 22 kV to 220 kV.

2.0 STANDARDS, PUBLICATIONS AND DRAWINGS

2.1 Unless otherwise specified all materials and equipment supplied shall comply with the applicable and latest editions of SANS or Transnet freight rail publication.

2.2 The following publications are referred to in this specification:

2.2.1 SOUTH AFRICAN NATIONAL STANDARDS

SANS 121:	-	Hot-dip Galvanized coatings for fabricated iron or steel articles.
SANS 1431:	-	Weldable structural steels.
SANS 60529:	-	Degrees of protection provided by enclosures (IP code).
SANS 60694:	-	Common Specifications for high-voltage switchgear and controlgear standards.
SANS 60815	-	Guide for the selection of insulators in respect of polluted conditions
SANS 62271-100:	-	High Voltage Alternating Current Circuit Breakers.

2.2.2 TRANSNET FREIGHT RAIL SPECIFICATIONS.

CEE.0045:	Painting of Steel Components of Electrical Equipment.
CEE.0224:	Drawings, Catalogues, Instruction Manuals and Spares.

2.2.3 Occupational Health and Safety Act No 85 of 1993.

2.2.4 TRANSNET FREIGHT RAIL DRAWINGS

CEE-TBK-0027:	-	Control circuit diagram. No-volt coil protection.

2.3 Any items offered in accordance with other standards will be considered at the sole discretion of Transnet freight rail. The tenderer shall supply full details stating where the item differs from these specifications as well as supplying a copy (in English) of the recognised standard specification(s) with which it complies.

3.0 TENDERING PROCEDURE

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

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

3.3 Tenderers shall complete Appendix 2. " Information to be provided by tenderers".

3.4 Tenderers shall submit detailed technical literature of the current transformers offered together with drawings showing, general constructional details and principal dimensions.

3.5 Any items offered in accordance with other standards will be considered at the sole discretion of Transnet freight rail. The tenderer shall supply full details stating where the item differs from these specifications as well as supplying a copy (in English) of the recognised specification(s) with which it complies.

3.6 Failure to comply with clauses 3.1, 3.2, 3.3, 3.4 and 3.5 could preclude a tenderer from consideration.

4.0 APPENDICES

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

4.1 Appendix 1 -"Schedule of Requirements".

This appendix details the specific requirements for this application.

4.2 Appendix 2 - " Information to be provided by tenderers".

This appendix calls for specific technical information to be furnished by tenderers.

5.0 SERVICE CONDITIONS.

The current circuit breaker shall be designed to operate under the following conditions.

5.1 ATMOSPHERIC CONDITIONS

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

5.2 ELECTRICAL CONDITIONS

5.2.1	Supply voltage:	The incoming AC voltage can vary ± 5% of the nominal system r.m.s voltage.
5.2.2	Frequency:	Frequency of the supply voltage is 50 ± 2.5 Hz.

6.0 REQUIREMENTS FOR ALTERNATING CURRENT CIRCUIT BREAKERS.

6.1 The AC circuit breakers shall be designed, manufactured and tested in accordance with the requirements of specifications SANS 62271-100 and SANS 60694.

6.2 The circuit breakers shall be of the outdoor type suitable for operation under the nominal phase to phase voltages or phase to neutral voltages specified in Appendix 1.

6.3 The insulating medium of the primary circuit breakers shall be SF6 gas or vacuum, depending on the supply voltage. (Refer to Appendix 1)

6.3.1 Vacuum circuit breakers may be used for voltages ranging from 22 kV up to 33 kV

6.4 The AC circuit breakers used on Transnet freight rail may the single, double or triple pole type.

6.4.1 Double or triple pole type circuit breakers shall be ganged operated.

6.5 The circuit breakers shall be rated at the highest r.m.s. voltage for equipment operating at the nominal system voltage specified in Appendix 1.

6.6 The minimum rupturing capacities for the respective voltages and current ratings for the circuit breakers shall be in accordance to the SANS 62271-100. The rated short–circuit breaking current shall be at least 20kA.

6.7 The circuit breakers shall be rated for a continuous current of at least 1250 Ampere

6.8 The circuit breakers shall have a first pole to clear factor of 1.5.

6.9 The circuit breakers shall have a making time not greater than 1 second.

6.10 The circuit breakers shall be capable of twice rupturing the specified fault current at the specified voltages, with a one minute interval between operations and then shall be in a condition to be closed and carry the rated current without it being necessary to inspect or make adjustments.

6.11 The circuit breaker shall be electrically operated from a nominal 110 Volt DC control voltage unless otherwise specified in Appendix 1.

6.12 It shall be possible to close the circuit breaker only when the control voltage is above 85% of the nominal voltage. The circuit breaker shall trip automatically when the control voltage falls below 70% of the nominal voltage.

6.13 The circuit breaker shall have a motor wound spring operating mechanism.

6.14 The operating mechanism shall be provided with shunt release for both opening and closing.

6.15 Pneumatic, hydraulic or gas control for tripping and closing the primary circuit breakers are not acceptable.

6.16 The operating mechanism shall be so designed so that the breaker may be closed manually from ground level by means of a suitable detachable handle.

6.17 The operating mechanism shall be constructed of non-ferrous material.

6.18 The operating springs shall recharge automatically after the completion of a closing operation.

6.19 The circuit breaker shall be of the trip-free type.

6.20 A visual mechanical indicating device shall be provided to indicate the state of the spring and shall be inscribed "Spring Charged" when the mechanism is in the condition to close the circuit breaker and "Spring Free" when it is in any other condition.

6.20.1 One pair of normally open and normally closed contacts shall be provided for the indication circuitry to the substation control panel for indication of the "Spring Charged" and "Spring Discharged" conditions.

6.21 Auxiliary contacts shall be provided for operation in conjunction with the protection and other auxiliary circuits specified. At least one spare pair of normally open and one spare pair of normally closed contacts shall be provided.

6.22 Circuit breaker control switches shall be provided on the circuit breaker mechanism. They shall return automatically to the neutral position when the handle is released after being turned to either the "close" or "trip" positions.

6.23 Local/Remote selector switches shall be provided on the circuit breaker mechanism and shall be of the two-position type. The switch shall have no "off" or "neutral" position.

6.23.1 Provision shall be made that when the circuit breaker is switched to the local position, the protection and trip circuitry to the circuit breaker shall not in any way be by-passed.

6.24 Mechanical operation shall be provided on the circuit breaker for any closing or trip release, which is normally electrically operated.

6.25 The circuit breaker shall be provided with a no volt coil with a mechanical latching mechanism, which will trip, lockout and inhibit the circuit breaker from closing when the no volt coil is de-energised. Refer to Transnet Freight Rail's drawing No. CEE-TBK-27 which forms part of this specification, for details of the control circuitry for the no volt protection.

6.25.1 The no volt coil circuitry with its associated mechanical latching mechanism shall operate separately from the trip coil circuitry.

6.26 A counter shall be provided on the circuit breaker to indicate the total number of operations of the breaker.

6.27 Tenderers shall advise the number of circuit breaker operations under full load and fault conditions, after which maintenance and/or measurement of contact wear is recommended.

6.28 The circuit breaker operating mechanism including its controls and relays shall be housed in a metal enclosure.

6.29 The enclosure housing shall be manufactured from stainless steel or hot dipped galvanised steel.

6.30 The coating of the enclosure if galvanised shall comply with the requirements of Transnet freight rail's specification CEE.0045.

6.31 The degree of protection of the enclosure shall be in accordance with SANS 60529 and shall be IP 55.

6.32 Provision shall be made for the enclosure to be pad-lockable.

6.33 The enclosure shall be provided with a gland plate for bottom entry of the control cables.

6.34 VACUUM CIRCUIT BREAKERS.

6.34.1 Vacuum switching devices shall be evacuated and sealed in accordance with the latest technology and accepted practice.

6.34.2 The pre striking and chopping current shall be kept below 5 amperes. Tenderers shall give full details regarding these characteristics.

6.34.3 Where vacuum circuit breakers are specified in Appendix 1 they shall be either of the motor wound spring operating mechanism or magnetic actuator operating mechanism type.

6. 35 SULPHUR HEXAFLOURIDE CIRCUIT BREAKERS. (SF6)

6.35.1 The SF6 circuit breaker shall be fitted with a pressure gauge/densiometer to monitor the gas pressure.

6.35.2 The pressure gauge/densiometer circuit shall be provided with a minimum of two sets of contacts for alarm and indication for the substation's annunciator or flag circuit.

6.35.3 The supplier shall wire the SF6 circuit breaker local control circuit, such that in the event of a gas leakage or drop in gas pressure, the SF6 circuit breaker will trip and lockout.

6.35.4 A set of normally closed contacts shall be provided in the circuit breaker mechanism control box for the low gas trip circuitry.

6.35.5 The SF6 circuit breaker shall trip and lockout before the minimum safe SF6 gas pressure is reached.

6.35.6 In terms of the Occupational Health and Safety Act No 85 of 1993. Code 1704 (pressure vessels) the successful tenderer shall furnish a certificate of manufacture complying with the terms of the Act for the circuit breakers.

6.36 INSULATION LEVELS, CREEPAGE DISTANCES AND CLEARANCES

6.36.1 INSULATION LEVELS

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

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

Highest phase-to-phase r.m.s voltage for equipment. (Um)	Nominal system phase-to-phase r.m.s. voltage	Rated lightning impulse withstand voltage peak.	Rated short duration power- frequency withstand r.m.s voltage.
24 kV	22 kV	150kV	50 kV
36 kV	33 kV	200 kV	70 kV
52 kV	44 kV	250 kV	95 kV
72,5 kV	66 kV	350 kV	140 kV
100 kV	88kV	380 kV 450 kV	150 kV 185 kV
145 kV	132 kV	550 kV 650kV	230 kV 275 kV
245 kV	220 kV	850 kV 950 kV	360 kV 395 kV
Insulation levels for highest voltage for equipment U_m < 100 kV are based on an earth fault factor equal to $\sqrt{3}$ and for U_m > 100 kV an earth fault factor equal to $0,8\sqrt{3}$. Where more than one insulation level is given per voltage system, the higher level is appropriate for equipment where the earth fault factor is greater than 1,4			

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

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

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

6.36.2 CREEPAGE DISTANCES

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

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

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

6.36.3 CLEARANCES

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

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

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

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

6.37 SUPPORT STEELWORK.

6.37.1 The circuit breaker shall be provided with its own support steelwork, which shall be hot- dip galvanised in accordance with specification SANS 121 and shall comply to requirements of SANS 1431: for weldable structural steels.

6.37.2 Support steelwork exposed to a high pollution/corrosive atmosphere shall be painted in accordance with specification CEE.0045.

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

7.1 The tenderers shall submit a separate offer for special tools and servicing aids necessary for the servicing and maintenance of SF6 circuit breakers.

7.2 Three copies of instruction/maintenance manuals, spares list's and wiring diagrams of the circuit breakers in accordance with Transnet freight rail's specification CEE.0224. shall be supplied upon delivery.

8.0 TRAINING.

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

9.0 TEST CERTIFICATES.

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

10.0 GUARANTEE AND DEFECTS.

10.1 The contractor shall guarantee the satisfactory operation of the circuit breaker supplied and accept liability for maker's defects, which may appear in design, materials and workmanship.

10.2 The guarantee period shall expire after: -

A period of 12 months commencing on the date of energising of the circuit breaker.

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

11.0 INSPECTION.

11.1 Transnet freight rail reserves the right to carry out inspection and any tests on the equipment at the works of the supplier/ manufacture.

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

12.0 PACKAGING AND TRANSPORT.

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

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

13.0 BIBLIOGRAPHY

[1] SANS 1019: 2008. Edition 2.5

END

SCHEDULE OF REQUIREMENTS
(To be completed by client)

1.0 SYSTEM DETAIL

1.1 AC Circuit Breakers: _____ substation/location.

1.2 Pollution level: Heavy_____ Very Heavy _____

1.2 Quantity of AC Circuit Breakers. _____

1.1 Nominal phase to phase voltage for 3 phase system: _____ kV.

1.2 Nominal phase to neutral voltage for single phase systems: _____ kV.

1.3 Frequency: _____ Hz

1.4 Circuit breaker control DC voltage: _____ V

1.5 Circuit breakers to be used for the following:

- 3 kV DC Traction substations. Yes/No
- Distribution substations. Yes/No
- 25 kV AC Traction substations. Yes/No
- 50 kV AC Traction substation. Yes/No

DETAIL OF AC CIRCUIT BREAKERS.

2.0 Type of circuit breakers required:

Vacuum: Yes / No

Gas (SF6): Yes / No _____

2.2 Number of circuit breakers required: _____

2.3 Number of poles: _____

2.4 Rated Voltage: _____ kV

2.5 Rated short-circuit breaking current: _____kA

2.6 Rated normal current: _____ Ampere.

END

TECHNICAL DATA SHEET
(To be completed by tenderer)

DETAIL OF CIRCUIT BREAKER

1.1 Make and manufacturer _____

1.2 Rated Voltage _____ kV.
(Highest rated voltage for equipment)

1.3 Rated Insulation level _____ kV.
(Rated lightning withstand Voltage)

1.4 Number of Poles: _____

1.6 Rated short circuit breaking current _____ kA.

1.7 Rated normal current: _____ Ampere.

1.6 Breaker operating time:

1.6.1 Closing: _____ ms.

1.6.2 Opening: _____ ms.

1.7 Number of operations after which breaker contact maintenance / measurement is required:

1.7.1 Under full load conditions_____

1.7.2 Under fault conditions _____

1.8 First Pole to Clear Factor_____

1.9 DC control voltage: _____ V

HOAC-HO-52920

ANNEXURE A12- BBB1267 VERSION 10

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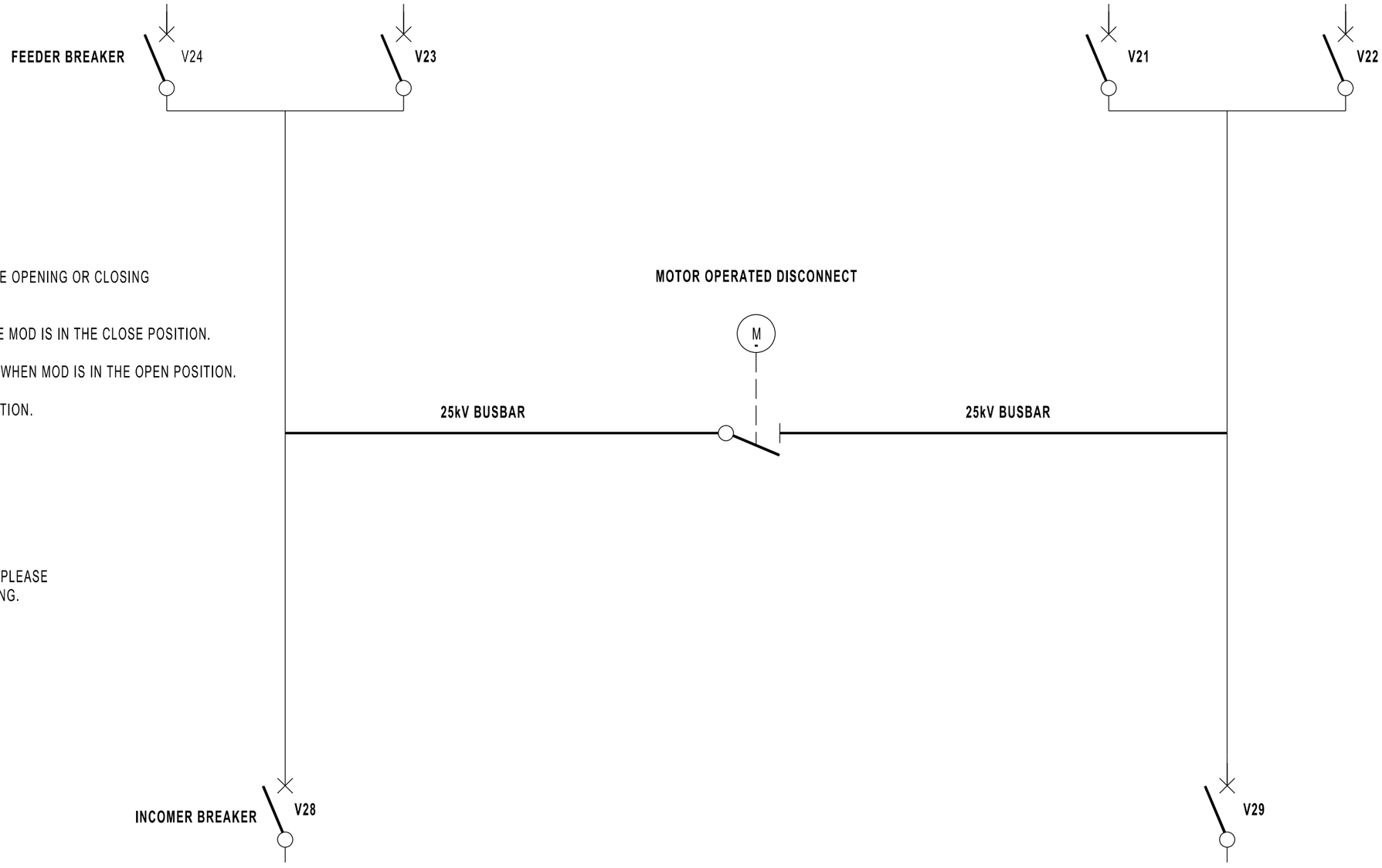

SWITCHGEAR INTERLOCKING RULES:

1. TRIP ALL INCOMER AND FEEDER BREAKERS WHEN STARTING THE OPENING OR CLOSING OPERATION OF THE MOD.
2. ONLY ONE INCOMER BREAKER IS ALLOWED TO CLOSE WHEN THE MOD IS IN THE CLOSE POSITION.
3. BOTH INCOMER AND FEEDER BREAKERS CAN BE CLOSED ONLY WHEN MOD IS IN THE OPEN POSITION.
4. MOD CANNOT CLOSE IF BOTH INCOMERS ARE IN A CLOSED POSITION.

NOTES:
1. DRAWING ARE DEVELOPED BASED ON CURRENT TECHNOLOGY, PLEASE CONTACT TECHNOLOGY MANAGEMENT FOR SITE SPECIFIC DRAWING.

DIMENSIONS : mm SCALE : NTS
TOLERANCE : LIN± - ANG± - ITEM NO : -
MATERIAL : -
VERSION INFO : DIODE D3 AND D4 ADDED TO SHEET 3. OPERATING OF THE MOD AND SUBSTATION BREAKERS ADDED TO SHEET 1. AC/DC SUPPLY DIAGRAM(SHEET 2) & HEATER 230V SUPPLY CIRCUIT (SHEET 5) ADDED.

APPROVED: TJ SELEMELA

AUTHORISED: T CHETTY

25kV MOD BUS COUPER
(SINGLE LINE DIAGRAM FOR MOD AT WILDRAND)

TRANSNET freight rail

BBH6343 SHT 1 OF 5
VERSION 2 A3

DO REF: CDO/ E0539 ECP REF: - DRAWN: XR BHOMELA DESIGNED: - CHECKED: LS KEKANE

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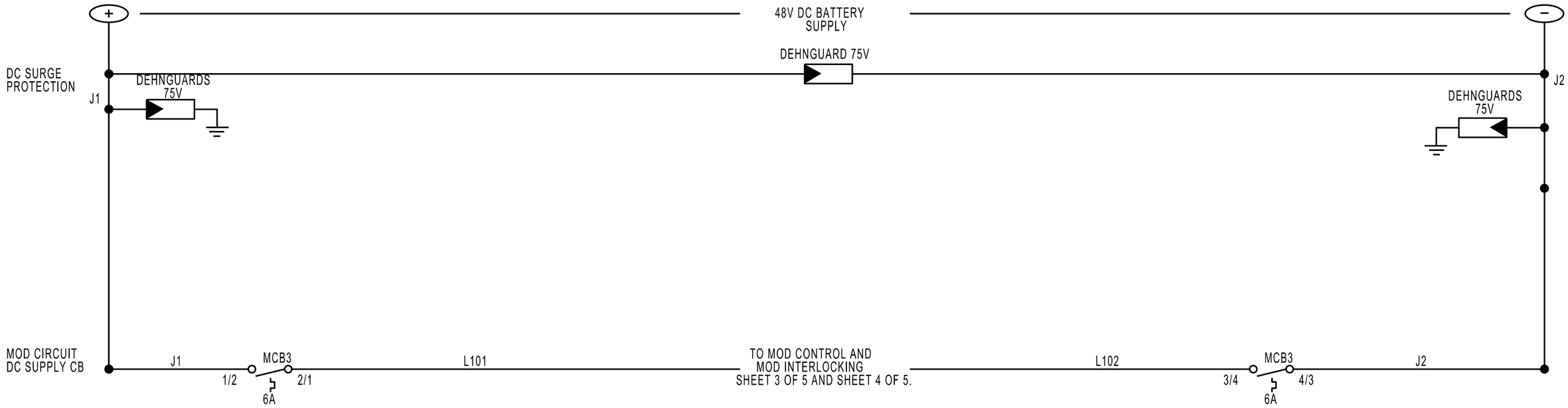

DIMENSIONS : mm TOLERANCE : LIN± - ANG± - MATERIAL : -	SCALE : NTS	25kV MOD BUS COUPLER (AC/DC SUPPLY DIAGRAM)
DRAWN : XR BHOMELA	CHECKED : LS KEKANE	TRANSNET freight rail BBH6343 SHT 2 OF 5 VERSION 2 A3

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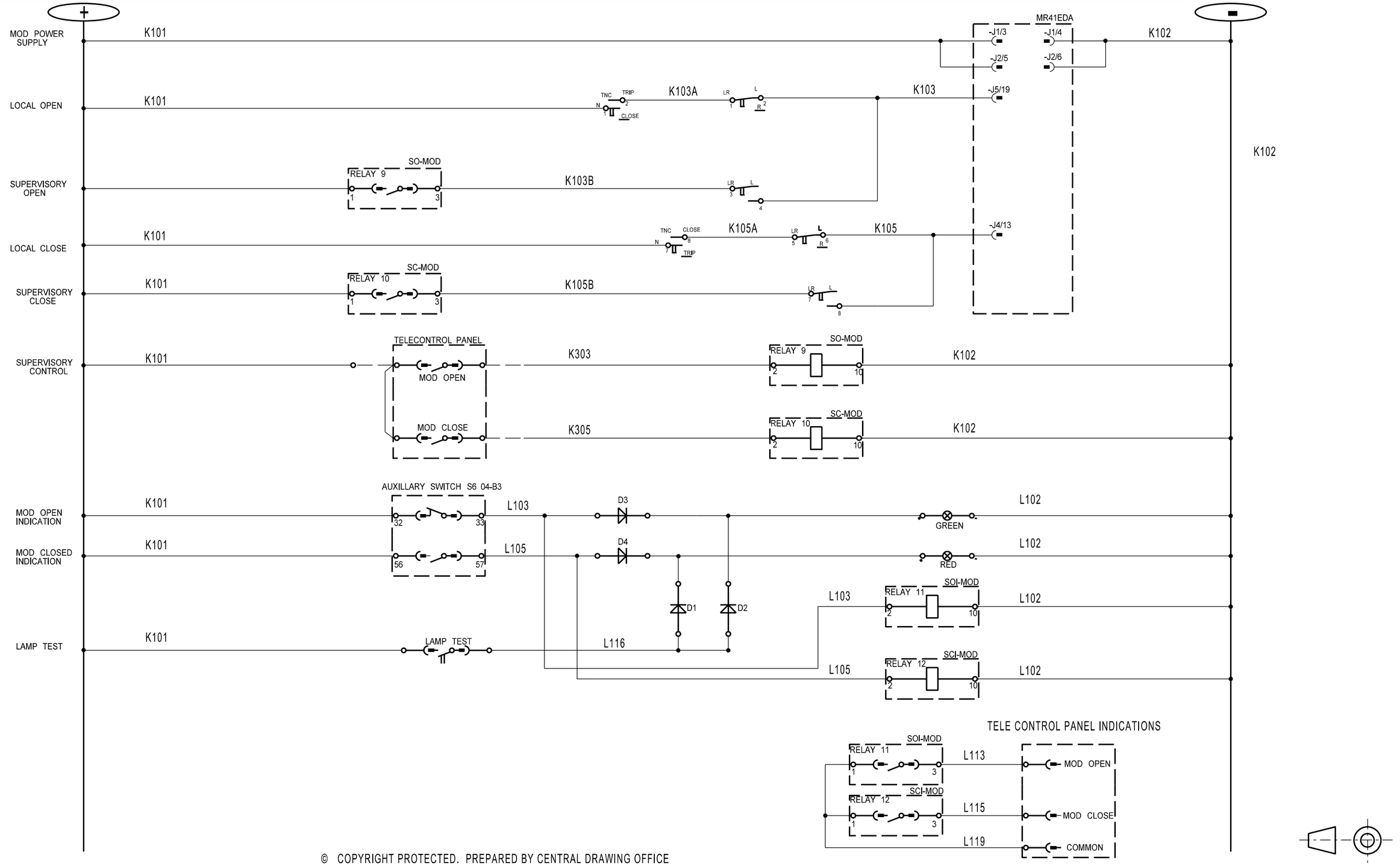

DIMENSIONS : mm	SCALE : -
TOLERANCE : LIN± - ANG± -	
MATERIAL : -	
DRAWN : XR BHOMELA	CHECKED : LS KEKANE

25kV MOD BUS COUPLER
(MOD CONTROL CIRCUIT).

TRANSNET freight rail

BBH6343 SHT 3 OF 5

VERSION 2 A3

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MOD OPERATION START CIRCUIT

AUXILLIARY SWITCH K101 -S6 04-B3 (30, 51)

AUXILLIARY SWITCH K101 -S6 04-B3 (30, 31)

K121

K81A RELAY 1 (2, 10)

K81 RELAY 2 (2, 10)

K102

INCOMER V28 TRIP CIRCUIT

K101 — K81 RELAY 2 (9)

25kV INCOMER PANEL (V28) SHEET 4 OF 9

88kV PRIMARY CB

K109E — INTERLOCK — K109 X4:28 — OVERCURRENT P122 (2, 4) — K109A — DIRECT EARTH FAULT -S6 04-B3 (4, 2) — K109C — U/V (9, 3)

K109D — K86 RELAY 7 (1, 4) — K109F

K87 RELAY 8 (1, 4)

CH-X RELAY 6 (2, 10) — K102

DCF-X RELAY 3 (2, 10) — K102

INCOMER V29 TRIP CIRCUIT

K101 — K81 RELAY 2 (6)

88kV PRIMARY CB

INTERLOCK — K109 X4:28 — OVERCURRENT P122 (2, 4) — K109A — DIRECT EARTH FAULT P125 (4, 2) — K109C — U/V RELAY 4 (1, 3)

K109D — K85 RELAY 6 (1, 4) — K109F

K87 RELAY 8 (6, 5)

CH-X RELAY 6 (2, 10) — K102

DCF-X RELAY 3 (2, 10) — K102

25kV INCOMER PANEL (V29) SHEET 4 OF 9

FEEDER V21 & V22 TRIP CIRCUIT

K101 — K81A RELAY 1 (1, 4)

TO DUAL FEEDER PANEL (V21) SHEET 4 OF 9 — K109 — CH-X RELAY 6 (2, 10) — K102

TO DUAL FEEDER PANEL (V22) SHEET 4 OF 9 — K109 — CH-X RELAY 6 (2, 10) — K102

FEEDER V23 & V24 TRIP CIRCUIT

K101 — K81A RELAY 1 (5, 6)

TO DUAL FEEDER PANEL (V23) SHEET 4 OF 9 — K109 — CH-X RELAY 6 (2, 10) — K102

TO DUAL FEEDER PANEL (V24) SHEET 4 OF 9 — K109 — CH-X RELAY 6 (2, 10) — K102

AUXILLIARY SWITCH K101 -S6 04-B3 (52, 53) — K82 RELAY 3 (2, 10) — K102

K101 — K82 RELAY 3 (1, 3) — K131 — K83 RELAY 4 (1, 3) — K131A — K85 RELAY 6 (2, 10) — K102

K101 — K82 RELAY 3 (6, 7) — K151 — K84 RELAY 5 (1, 3) — K151A — K86 RELAY 7 (2, 10) — K102

BYPASS CIRCUIT

AUXILLIARY SWITCH K101 -S6 04-B3 (54, 55) — K87 RELAY 8 (2, 10) — K102

INCOMER V28 CLOSED CIRCUIT

L109 — K83 RELAY 4 (2, 10) — K102

FROM 25kV INCOMER PANEL (V28) SHEET 8 OF 9

INCOMER V29 CLOSED CIRCUIT

L109 — K84 RELAY 5 (2, 10) — K102

FROM 25kV INCOMER PANEL (V29) SHEET 8 OF 9

DIMENSIONS : mm	SCALE : -
TOLERANCE : LIN± - ANG± -	
MATERIAL : -	
DRAWN : XR BHOMELA	CHECKED : LS KEKANE

25 kV MOD BUS COUPLER (MOD INTERLOCKING CIRCUIT)

TRANSNET freight rail

BBH6343 SHT 4 OF 5

VERSION 2 A3

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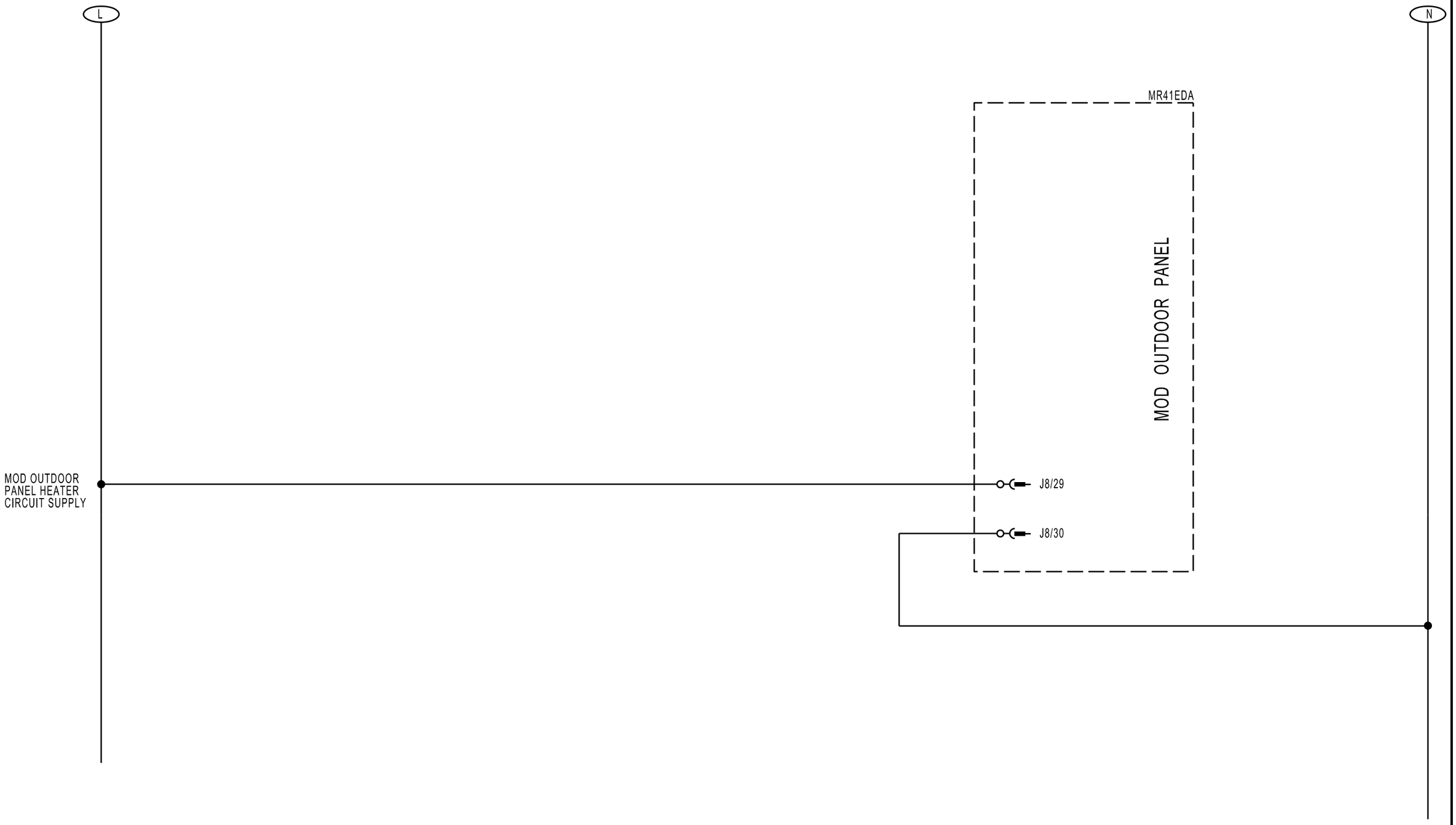

DIMENSIONS : mm TOLERANCE : LIN± - ANG± - MATERIAL : -	SCALE : NTS	25kV MOD BUS COUPLER (230V HEATER CIRCUIT SUPPLY)
DRAWN : XR BHOMELA	CHECKED : LS KEKANE	TRANSNET freight rail BBH6343 SHT 5 OF 5 VERSION 2 A3