



Technical Specification  
Specification No. TPD: 007-MVSWITCHSPEC

## **SPECIFICATION FOR INDOOR MEDIUM/ HIGH VOLTAGE (1KV TO 33 KV) ALTERNATING CURRENT SWITCHGEAR AND CONTROL GEAR**

<b>REVISIONS</b>		
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	<b>INDEX</b>
<b>SECTION</b>	<b>CONTENTS</b>
1.	SCOPE
2.	REFERENCE LIST
3.	INFORMATION AND METHOD OF TENDERING
4.	APPENDICES
5.	AMBIENT AND ENVIRONMENTAL CONDITIONS
6.	DRAWINGS AND INSTRUCTION MANUALS
7.	SWITCHGEAR AND CONTROLGEAR
8.	WITHDRAWABLE SWITCHGEAR AND CONTROLGEAR
9.	SWITCHING DEVICES
10.	BUSBARS
11.	BUSHINGS
12.	CABLE BOXES, GLANDS AND TERMINATIONS
13.	INSULATING MEDIUM
14.	HIGH-VOLTAGE FUSES
15.	CURRENT TRANSFORMERS
16.	VOLTAGE TRANSFORMERS
17.	INDICATING INSTRUMENTS
18.	ENERGY METERS
19.	PROTECTIVE SYSTEMS AND RELAYS
20.	CLOSING AND TRIPPING SUPPLIES
21.	TEST TERMINAL BLOCKS
22.	CONTROL SWITCHES
23.	MINIATURE CIRCUIT BREAKERS
24.	LOW VOLTAGE WIRING

SECTION	CONTENTS	INDEX
25.	REMOTE CONTROL	
26.	ARC DUCTING	
27.	NAMEPLATES AND LABELS	
28.	PAINTING	
29.	TESTS	
30.	INSPECTION	
31.	TOOLS AND APPLIANCES	
32.	SPARES	
33.	PACKING	
34.	GUARANTEE	
35.	<b>Annexure 1 Schedule of Requirements.</b>	
36.	<b>Annexure 2 Technical Data Sheet.</b>	
37.	<b>Annexure 3 Electrical Drawings List</b>	
38.	<b>Annexure 4 Test Requirements</b>	
39.	<b>Annexure 5 – Statement of Compliance</b>	

## 1. SCOPE

This specification covers Transnet Projects requirements for the supply, delivery and installation of indoor, high voltage, 3 phase, 50-hertz switchgear and control gear in the range 1 kV to 36 kV as detailed in **Appendix 1** "Schedule of Requirements".

## 2. REFERENCE LIST

The following publications and documents (latest edition) are referred to herein.

*Note: We suggest that latest IEC standards are used, which allows the greatest selection of reputable suppliers and does not favour any particular supplier. For voltages above 11kV most switchgear is in any case imported and standards other than IEC standards are generally excluded.*

### 2.1 International Electro Technical Commission

IEC PUBLICATION 62271-100 High-voltage alternating current circuit breakers.

IEC PUBLICATION 60060 High-voltage test techniques.

IEC PUBLICATION 62271 Specification for AC metal enclosed switchgear and control gear, for voltages above 1kV up to and including 52kV

Part:

- 1 Common specifications for HV switchgear and control gear standards (IEC 60694)
- 100 Alternating current Circuit breakers (IEC60056)
- 102 Alternating current disconnectors and earthing switches (IEC 60129)
- 103 Switches for rated voltages above 1kV and less than 52kV (IEC60265-1)
- 106 Alternating current contactors and contactor-based motor-starters (IEC60470)
- 200 AC metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV

IEC PUBLICATION 60027-7 Electrical drawing symbols used.

IEC PUBLICATION 60243 Recommended methods of test for electric strength of solid insulating materials at power frequencies.

IEC PUBLICATION 60282 High-voltage fuses.

IEC PUBLICATION 62271-200 High-voltage metal enclosed switchgear and control gear.

IEC PUBLICATION 62271-103 High-voltage alternating current fuse-switch combinations and fuse-circuit-breaker combinations.

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

IEC PUBLICATION 62271 -106 High-voltage switchgear and control gear - Part 106: Alternating current contactors, contactor-based controllers and motor-starters

IEC PUBLICATION 60071 Insulation coordination

- IEC PUBLICATION 60282-1 Protection fuses
- IEC PUBLICATION 60529 Degree of protection (IP rating)
- IEC PUBLICATION 60044-1 Current transformer
- IEC PUBLICATION 60044-2 Voltage transformer
- IEC PUBLICATION 60044-8 Current sensors
- IEC PUBLICATION 60044-7 Voltage sensors

IEC PUBLICATION 61343-5	Voltage detection system VDS
IEC PUBLICATION 60071-1	Insulation coordination
IEC PUBLICATION 60125	Protection relays
IEC PUBLICATION 60376	SF6 gas

- 2.2 The equipment offered shall comply with the latest editions of the relevant International Electro-technical Commission.
- 2.3 Users of this specification must ensure that they are in possession of the latest issues of the above-mentioned standards.

### 3. INFORMATION AND METHOD OF TENDERING

- 3.1 Tenderers shall submit their main offers in accordance with the requirements of this specification. Deviations from the requirements of this specification which are of a minor nature and do not depart materially, will be considered at the discretion of Transnet Projects. The acceptance of alternative tenders will be considered only if a main tender is submitted as per this specification.
- 3.2 The "Technical Data Sheet" forming Appendix 2 of this specification shall be completed in detail, for each offer. Alternative offers shall be clearly marked "Alternative Offer No. \_\_\_\_\_".
- 3.3 Failure to comply with the above requirements may preclude a tender from consideration.
- 3.4 All tender documents shall be presented in a clear format with index, uniquely numbered pages and cross-referenced. The total number of pages shall be clearly stated in the index.
- 3.5 **Type test reports/certificates shall be issued or certified by the appropriate test authority, that is accredited according to ISO/IEC 17025.**

### 4. 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 special requirements.
- 4.2 **Appendix 2 - Technical Data Sheet.**  
This appendix calls, for specific technical information to be furnished with tenders. All Technical Data Sheets shall be signed by the Tenderer and returned as part of the tender. Failure to comply may result in a tender being excluded.
  - 4.2.1 Equipment offered in this appendix shall be supplied in terms of this specification and no changes or substitutes will be allowed without the written consent from Transnet Projects.
  - 4.2.2 Acceptance by Transnet Projects of the equipment offered in this appendix, in no way relieves the tenderer of his obligation to fulfil his statement of compliance with the specification.
  - 4.2.3 This appendix is used during adjudication of tenders to assess the equipment offered.

4.2.4 The tenderer is responsible for the accuracy of information submitted in this appendix.

4.3 **Appendix 3 – Scope of Work**

This appendix details the scope of work associated with this tender.

4.4 **Appendix 4 - Electrical Drawings**

This appendix lists the electrical drawings associated with this tender.

4.5 **Appendix 5 - "Statement of Compliance"**

This appendix shall be completed by all tenderers and signed. Where tenderers do not fully comply, all deviations shall be clearly indicated in the space provided or by means of a covering letter. **Failure to complete the statement of compliance will result in tenders being excluded.**

5. **AMBIENT/ENVIRONMENTAL CONDITIONS:**

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

Altitude....	Sea level.
Ambient temperature....	-5 C to +40 C (daily average +35 C).
Relative humidity....	As high as 95%.
Lightning conditions .	Severe, with a maximum lightning ground flash density of 11 flashes per km <sup>2</sup> per annum.
Atmospheric conditions....	Salt laden as well as industrial atmosphere. Electrolytic corrosion conditions prevail in all areas owing to the proximity of direct current traction systems and cathodic protection schemes.

6. **DRAWINGS AND INSTRUCTION MANUALS**

6.1 All drawings shall be in accordance with SANS 10111 – Engineering Drawings.

6.2 The successful tenderer shall supply the following instruction manuals, all of which shall be included in the tender price and be to the satisfaction of Transnet Projects:

6.2.1 Structural Drawings

Structural drawings shall be completely dimensioned, showing:

- Arrangement.
- Plan, front view, and other elevation views if pertinent.
- Required clearances for opening doors and for removing breakers.
- Conduit or cable entrance locations for bottom entrance.
- Busbar locations and configurations.
- Incoming and outgoing cable termination positions.
- Anchor bolt locations.
- Earthing connections.

- Mass of equipment. Individual mass of stationary units and breakers, if shipped separately.
- Foundation holding down bolting details showing mounting rails and run-out rails for draw-out circuit-breakers.

#### 6.2.2 One Line Diagrams

One line diagrams shall show:

- Instrument transformers
- Relays with their ANSI device numbers.
- Meters and meter switches.
- Other pertinent devices.

#### 6.2.3 Schematic Diagrams

Schematic wiring diagrams shall be furnished for each different electrically operated breaker control scheme and show the following:

- All control devices and device contacts, each of which shall be labelled with its correct ANSI device function number, or reference.
- Device terminal numbers, terminal block numbers and terminal numbers.
- All internal interconnections, bus wiring, inter panel wiring and connections to external equipment.
- Relay internal logic configuration
- Protection relay setting sheet

#### 6.2.4 As-Built Drawings

- 6.2.4.1 On completion of installation and commissioning of the relevant equipment, the originals of the above drawings shall be updated by the equipment supplier to reflect the as-built status.
- 6.2.4.2 The supplier shall then also provide Transnet Projects with three copies of all relevant CAD data for drawing records and drawing reproduction. The drawings must be in a format that can be read by AutoCAD 2000, format (“dwg” or “dxf” format).

#### 6.2.5 Maintenance Manuals

- 6.2.5.1 On completion of installation and commissioning of the relevant equipment, the contractor shall submit three copies of the equipment maintenance manuals in both hard copy and electronic format. (The electronic format must be in Microsoft “Word”, or .pdf format)

- 6.3 The maintenance manuals shall include all the necessary information on electrical and electronic equipment to enable the maintenance staff to fully comprehend the function of the equipment and to maintain service and repair the equipment. In order to comply with this condition the following information (as applicable) shall be included in the manuals:

#### 6.2.6 Complete circuit diagrams.

#### 6.2.7 System Block or Logic Diagrams.

- 6.2.8 Test Procedures (Flow Chart form preferred) and information to enable testing such as voltage values and tolerances, waveforms, polarities etc.

- 6.2.9 Component lists, which shall contain complete electrical information and standard identification in respect of all components, unless this is indicated directly on diagrams.
- 6.2.10 A complete description of the electronic equipment, including the function of all input and output points, maintenance and calibration procedures, reference to special test instruments required, etc.
- 6.3 All symbols used on diagrams shall be in accordance with IEC Publication 60027-7 wherever possible. A legend shall be supplied for all symbols that do not appear in the IEC Publications.
- 6.4. All information submitted in manuals should be clearly cross-referenced, indexed and accurately descriptive of the equipment provided. All filed changes to equipment shall be incorporated in the updated diagrams/sheets before expiry of the guarantee period.
- 6.5 Photocopies of original material shall only be acceptable if these are clearly legible and preferably colour copies.
- 6.6 A preliminary copy of the maintenance manual shall be forwarded to Transnet Projects for approval prior to issue and in advance of the delivery of equipment.
- 6.7 **Late submission of drawings, manuals and instructions shall incur delivery penalties on the full contract price. The contract will only be deemed to be complete on reception of all drawings, manuals and instructions.**

## 7. SWITCHGEAR AND CONTROLGEAR

### 7.1 General

- 7.1.1 All switchgear and control gear shall be designed, manufactured and tested in accordance with the recommendations of IEC PUBLICATION 298, IEC 62271-100, IEC 62271-200 and IEC 62271-102. The switchgear panels shall be of arc proof, metal clad, air insulated, free standing, extensible type, containing power busses, earthing bus, draw out type switching devices, auxiliary control devices, instrument transformers, protection relays and control switches. They shall be supplied complete with all necessary terminal plates, cable glands for cable entry, wiring trunking for LV wiring and multi core cables.
- 7.1.3 The switchgear and control gear shall be of the air-insulated, indoor, modular, free standing, metal clad, cubicle type housing with a minimum Aluzinc sheet metal thickness of 2mm, powder coated with a minimum thickness of 50µm to the colour as specified in the detail specification.
- 7.1.3 The switchgear and control gear panels shall be bolted together to form a continuous, self-supporting and self-contained switchgear and control gear board of uniform appearance capable for extension at both ends with similar panels.
- 7.1.4 Access to the current transformer and cable terminations shall be from the rear of the panels.
- 7.1.5 All cubicles shall be so constructed by means of modular design to ensure inter-changeability of all components of the same type between different panels.
- 7.1.6 All removable plates shall be secured by means of bolts and nuts. All bolts, nuts, washers fixing

equipment etc. shall be stainless steel. Nuts shall be either welded in position or secured by means of a mechanical fixing device. Self-tapping screws will not be considered.

- 7.1.7 High-voltage and low-voltage equipment shall be housed in separate compartments.
- 7.1.8 The busbars shall be contained in a separate compartment. Air insulated equipment shall be easily accessible.
  - 7.1.8.1 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.
  - 7.1.8.2 Entry through barriers between cubicles shall be via purpose designed bushings.
- 7.1.9 Each switchgear panel shall be a self-contained unit with a minimum degree of protection of IP4X for indoor installations based on IEC 60529.
- 7.1.10 The pollution level (IEC 186) shall be taken as "Medium" (creepage distance of 20mm/kV) for all equipment installed indoors or inside enclosures.
- 7.1.11 The panels shall be built to withstand internal faults and shall be based on IEC 62271-200. In the event of an internal arc fault, a person standing at the front, rear or alongside the panel shall not be burnt or electrocuted.
  - 7.1.11.1 A means of pressure relief shall be provided and the tenderer shall describe in full the method used.
  - 7.1.11.2 Vent outlets, if used, shall be suitably designed to prevent accidental inward opening.
- 7.1.12 The rated insulation levels shall be in accordance with, the recommendation of IEC PUBLICATION 298 Appendix EE test 2.
- 7.1.13 Fault-make integral earthing shall be provided to earth the circuit on the cable side of all switching devices.
- 7.1.14 Where separate earthing switches are used, they shall be so interlocked as to prevent operation when the main circuit is closed.
- 7.1.15 Fault-make integral earthing on the busbar side shall be provided for each busbar section. The busbar-earthing device shall be interlocked to prevent the earthing of an energized busbar. The earth switch can be located in the bus section / bus riser, or dedicated busbar earthing cubicle. If required the busbar earth switch can be located in the same cubicle as the busbar VT.
- 7.1.16 Where separate earthing switches are provided the switching devices shall be capable of earthing either the cable or busbar side.
  - 7.1.16.1 The earthing switching device will be tested at the routine testing of the switchgear as specified in this specification.
- 7.1.17 Integral earthing shall be capable of being padlocked in the earthed position.

- 7.1.18 An earthing bus shall be provided for the entire length of the board and shall provide connection points at each panel section. The cross sectional area of the earthing conductor shall be such that the current density shall not exceed 200A/mm<sup>2</sup> under the specified earth fault conditions. Provision will be made for solder-less connectors for 70mm<sup>2</sup> copper cables.
- 7.1.19 All compartment doors giving direct access to high voltage equipment shall be mechanically and electrically interlocked so that the door cannot be opened whilst the equipment is alive.
- 7.1.20 Each switching device panel shall be fitted with "close" and "open" controls. Where "close" and "open" pushbuttons protrude to the outside of panel they shall be of the shrouded type.
- 7.1.21 Means shall be provided for easy inspection and maintenance of the switchgear and control gear.
- 7.1.22 Applied insulation shall be in intimate contact with conductors and conductor joints to obviate voids.
- 7.1.23 Anti-condensation 230 Volt heaters shall be provided for each individual compartment and the bus bar chamber of each switch-gear. A switch shall be provided to control the heaters.
  - 7.1.23.1 A thermostatically controlled switch, adjustable between 10°deg.C and 40°deg. C, shall be provided in the supply circuit to the heaters. An over-riding switch shall be provided for the thermostat.
  - 7.1.23.2 The wiring from the heater elements to terminals shall be high temperature insulation covered. A suitable compression type gland shall be fitted for an incoming 230V supply.
- 7.2 The successful tenderer shall supply all material required to assemble the switchgear on site.
- 7.3 Two copies of all type and routine test certificates shall be supplied in accordance with NRS 003 for all equipment in the panels as applicable.

## **8. WITHDRAWABLE SWITCHGEAR AND CONTROLGEAR**

- 8.1 Suitable indication shall be provided to mechanically indicate the position of the switching device, i.e. racked-in, racked-out (isolated), earthed, on/off. The indication shall be readily visible from the front of each panel.
- 8.2 Each switching device shall be mounted on a transporting truck device and fitted with wheels.
- 8.3 Connection and disconnection of the switching device shall be by means of suitable contacts mounted on robust insulators.
- 8.4 In addition to interlocks recommended in IEC PUBLICATION 62271-200 the following shall be provided.
  - 8.4.1 Separate shutters shall be provided to cover the "Busbar" and "Circuit" high-voltage sockets. These shutters shall automatically cover the sockets with a positive action when the switching device is withdrawn. The shutters shall be equipped with a fail-safe device to prevent their manual opening when the circuit breaker is removed from the compartment and the door is open.

In addition to the above;



- 8.4.1.1 Facilities shall be provided for independently padlocking each shutter in the closed position.
  - 8.4.1.2 Busbar shutters shall be red (colour D29 in CKS 279) and shall be clearly marked "Busbars". The "Circuit" shutters shall be yellow (colour D26 in CKS 279) and shall be marked "cable".
  - 8.4.1.3 Provision shall be made for testing the operation of the switching device when fully withdrawn from the panels.
- 8.5 Non-withdrawable switchgear shall only be offered if called for in Appendix 1 A of this specification.
  - 8.6 LSC type in accordance with IEC62271-200 shall apply. LSC2B shall apply for withdrawable switchgear and LSC2A shall apply for non withdrawable switchgear, as called for in Appendix 1.
  - 8.7 Partitioning shall be in accordance with IEC 62271-200. For withdrawable switchgear PM shall apply, for non withdrawable switchgear PI shall apply.
  - 8.8 All operations shall be from the front of the switchgear from behind closed doors. No part of any operation / racking / shutter actuation shall be allowed with the door open or partially open.
  - 8.9 The internal arc capability of the switchgear shall be in accordance with IEC62271-200 Appendix 1, and rated at AFLR, for the short circuit current for a duration of 1 second.
  - 8.10 The switchgear shall be fitted with an arc vent duct that will contain the internal arc and safely vent the arc within the switch room or vent to the exterior of the switch room. The manufacturer should access each installation and make recommendations based as to the most suitable option for the switchgear installation. The manufacturers recommendations should be supported by a calculation that will calculate the pressure rise in the room, consider the room volume, and design fault level.

## **9. SWITCHING DEVICES**

### **9.1 General requirements**

- 9.1.1 All switching devices shall be ganged triple pole.
- 9.1.2 The method of securing the moving contact to the armature shall feature a safety device in addition to the normal securing mechanism.
- 9.1.3 A thermal overload device in addition to the low voltage circuit protection shall protect all motors used for spring charging or other applications.
- 9.1.4 Tripping shall be by means of trip coils
- 9.1.5 Electrically held tripping mechanisms shall not trip due to transients or voltage dips to zero for 10 cycles or 70% of the rated voltage. This is not applicable when tripping occurs due to protective system operation.
- 9.1.6 Tripping mechanisms operating on power failures shall restore the switching device to the condition



prior to the power failure.

- 9.1.7 If a direct means of indicating contact wear and the necessity for replacement is not provided, a concise description of how this can be determined shall be provided on a label permanently fixed to the switching device or switch panel.
- 9.1.8 Two spares normally open and two spare normally closed auxiliary contacts shall be provided on each switching device. The spare contacts shall be wired to a terminal strip in the panel. For withdrawable switchgear and control gear auxiliary plugs and sockets shall be used.

## 9.2 Circuit -Breakers

- 9.2.1 The insulation and arc-quenching medium will be vacuum.
- 9.2.2 Circuit breakers shall be designed manufactured and tested in accordance with IEC PUBLICATION 62271-100. The 50Hz electrical ratings of the circuit breaker shall be in accordance (or better) than the data listed in the manufacturer's data sheet.
- 9.2.3 The circuit breaker shall be of the vertical or horizontal isolating, draw out type. Where trolleys are required to remove circuit breakers, VT's or Contactors from the panel, at least two trolleys of each size / type per substation will be provided as standard operating equipment to facilitate swapping of similar equipment.
- 9.2.4 The control mechanism of the circuit breaker shall of the spring assisted trip free type with anti-pumping circuitry. The circuit breaker shall be equipped with mechanical tripping and closing in addition to electrical trip and close.
- 9.2.5 The first pole to clear factor shall be 1,5.
- 9.2.6 The making time shall not be greater than one second.
- 9.2.7 Rated insulation level for circuit breakers shall be in accordance with IEC 62271-100 and will be listed in the data sheet.
- 9.2.8 Interlocking shall be provided to prevent connecting the circuit breaker to or disconnecting it from the bus stabs unless the circuit breaker is open.
- 9.2.9 Barrier shutters shall be provided which effectively close the bus stab disconnect openings when the circuit breaker is withdrawn. These shutters will be pad lockable and clearly marked to indicate the primary circuit, i.e. Busbar, Cable, Left Busbar or Right Busbar. Facilities shall be provided for independently padlocking each shutter in the closed position.
- 9.2.10 All compartment doors giving direct access to high voltage equipment shall be mechanically interlocked so that the door cannot be opened whilst the equipment is live.
- 9.2.11 Suitable indication shall be provided to mechanically indicate the position of the switching device, i.e. racked-in, racked-out (isolated), earthed, on/off.  
The indication shall be readily visible from the front of each panel.
- 9.2.12 Circuit breakers shall have the following class rating, in accordance with IEC 62271-200

Extended Electrical life rating of E2  
Extended mechanical life of rating M2  
Very low re-strike probability or rating C2

9.2.13 Circuit breakers shall have stored energy mechanisms. Where spring assisted stored energy mechanisms are provided these shall be charged by means of a motor. For magnetic actuated circuit breakers the stored energy device shall be charged via an electronic controller. In both cases the circuit breaker may not be able to be closed until there is sufficient energy in the stored energy mechanism to enable the breaker from being opened immediately. The circuit breaker closing and opening mechanisms must not consume more than 750 W of power peak during opening or closing operations.

9.2.14 It shall be possible to mechanically trip the circuit breaker with the CB door closed.

### **9.3 Switch Disconnectors (Isolators) and Earthing Switches**

9.3.1 All disconnectors and earthing switches shall be designed, manufactured and tested in accordance with the recommendation of IEC PUBLICATION 62271-102.

9.3.2 Integral type circuit test facilities shall be provided on all switch-disconnectors.

9.3.3 Earth switches shall be rated for the same fault ratings as the circuit breaker and busbars.

9.3.4 The busbar earthing shall be interlocked to prevent earthing of an energised busbar.

9.3.5 The integral earthing shall be capable of being padlocked in the earthed position.

9.3.6 Both the cable circuits as well as busbars shall be provided with fault-make rated earthing switch, unless otherwise approved. Each busbar section shall be provided with its own earthing switch.

9.3.7 The type of operation shall be independent manual.

9.3.8 The operating mechanism shall be positioned on the front of the panel and be lockable in all switching states. Reliable mechanical indication of these states shall be visible from the front of the panel.

9.3.9 Earth switches shall be equipped with mechanical and electrical interlocking to prevent:

- Closing a cable earth switch unless the circuit breaker is open and disconnected from the bus stubs.
- Reconnection of the circuit breaker to the bus stubs if the earth switch is closed
- Closing the circuit breaker

9.3.10 A notice bearing the following inscription shall be provided adjacent to the operating mechanism:  
"DO NOT OPERATE UNDER LOAD"

## **10. BUSBARS**

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

10.2 The busbars shall be air Insulated and contained in an isolated compartment or gas-filled type.

- 10.3 Busbars shall be made from electrical grade high conductivity hard drawn copper, capable of carrying the continuous rated current as specified in the detail specification, without exceeding the maximum temperature rise specified in the relevant Standard.
- 10.4 The busbars shall be mechanical braced for the asymmetrical ampere rating and duration of the circuit breaker having the highest interrupting rating. 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. Entry through barriers between cubicles shall be via purpose-designed bushings.
- 10.5 All joints and tees in busbars shall be made with high tensile stainless steel bolts, nuts and washers, securely tightened with a torque wrench to the manufacturers specified torque settings. These settings shall aim to minimise contact resistance and avoid distortion and / or hardening of the copper due to overstressing.
- 10.6 Insulated bushings shall comply with SABS 1035.

## **11. BUSHINGS**

- 11.1 All bushings shall be designed, manufactured and tested in accordance with SABS 1035.

## **12. CABLE BOXES, GLANDS AND TERMINATIONS**

- 12.1 All cable end boxes shall be suitable to terminate (sizes up to a maximum of 1000mm<sup>2</sup> wire armoured cable) and clamp all cable types.
- 12.2 Cable armouring shall be insulated from the board with insulating material which shall withstand 4 kV or greater for one minute when tested in accordance with IEC PUBLICATION 60071.
- 12.2.1 Insulated gland plates with substantial links or straps connected to the earth terminal shall be provided for bonding the cable sheath and armouring to the earth conductor of the boards.
- 12.3 Cables shall terminate in air-insulated compartments.
- 12.4 Adequate space shall be allowed from the cable terminations to facilitate connecting onto the boards.

## **13. INSULATING MEDIUM**

- 13.1 The insulation medium will be vacuum or SF<sub>6</sub>, refer to Annexure 1

## **14. HIGH-VOLTAGE FUSES**

- 14.1 All fuses shall be designed, manufactured and tested in accordance with the recommendation of IEC PUBLICATION 60282.
- 14.2 Integral three pole earthing facilities to earth both sides of the switching device shall be provided

unless otherwise approved.

- 14.3 All fuses shall be of the air insulated, cartridge, striker pin type.
- 14.4 Parallel connection fuse cartridges shall not be used unless no single fuse cartridge of the same characteristic is available.
- 14.5 Integral type circuit test facilities must be provided.

## 15. CURRENT TRANSFORMERS

- 15.1 Current transformers shall comply with the requirements of SABS IEC 60044/1 shall be tested in accordance with the following procedure:
  - Each unit must be pre-stressed at 1,04x line voltage and the peak discharge measured at 1,1x the phase voltage.
  - The discharge level shall not exceed 50 pC for a wound primary and 10 pC for a bar primary.
  - A representative from Transnet Projects shall witness this test, unless routine test certificates, issued by a recognised independent testing authority, are submitted
- 15.2 Short circuit ratings and voltage classes shall match the ratings of the associated circuit breaker and the current transformers shall also be rated to ensure the correct operation of the equipment constituting the burden.
- 15.3 Current transformers shall be of accuracy class 3 for measuring purposes be of accuracy class 0,2 for metering purposes and be connected to the cable side and be fitted with a 10 amp test winding. Testing windings shall be fitted on the higher current ratio of multi-ratio transformers.
- 15.4 All current transformers will have a permanent thermal current carrying rating of a minimum of 120% of the maximum specified ratio.
- 15.5 The limits of temperature rise of the windings of the current transformers at the full load continuous primary current rating of the switchgear panel shall comply with SABS IEC 60044.
- 15.6 Ring type current transformers shall have separate insulation between live conductors of the main circuit and inner surface of the current transformers. This insulation shall be capable of withstanding the high voltage test as specified. A rigid system of mounting shall be used to ensure that concentricity is maintained.
- 15.7 All current transformers shall be naturally air-cooled. Their secondary terminal connections shall be safely and readily accessible with the circuit isolated. The current transformers in a switchgear panel shall be readily accessible with only the circuit-side isolated for removal/replacement without extensive dismantling of primary circuits.
- 15.8 The secondary rating of the transformer shall be either 1 or 5 amp as required by the protection or metering equipment.
- 15.9 All terminals of the current transformers shall be terminated individually into terminals in the LV compartment to facilitate changing of ratio's or the star point. The current transformer neutral earthing point will be taken through an earthing link located in the LV compartment.

- 15.10 Each current transformer shall be connected to test block with shorting strips located on the LV compartment door.
- 15.11 Unless specified, each current transformer shall be equipped with a test winding, terminated in the LV compartment, on terminals equipped with test plugs to allow for easy testing. Test winding terminals shall be clearly marked
- 15.12 Each current transformer rating (VA, ALF, V<sub>kp</sub> etc) shall be decided and calculated by the manufacturer to meet the protection requirements. Manufacturers shall provide proof of the calculations.

## 16. VOLTAGE TRANSFORMERS

- 16.1 All voltage transformers shall be designed, manufactured and tested in accordance with SABS IEC 60044/2.
- 16.2 Dry type cast epoxy resin insulated voltage transformers of the withdrawable type shall be provided for protection and metering purposes. When isolated the plug connections on the switchboard shall be fully shrouded by means of automatic shutters with padlocking facilities.
- 16.3 Where directional protection elements are required, voltage transformers shall be of a single phase or five limb construction, star/ star/ residual open delta connected, with primary neutral earthed and secondary neutral earthed via an earthing link in the LV compartment. Ratios shall be:

$$\frac{V_L}{\sqrt{3}} : \frac{110}{\sqrt{3}} : \frac{110}{3}$$

A suitable anti Ferroresonance device shall be fitted to the open delta winding to prevent any Ferro resonance voltages that may occur.

- 16.4 The voltage transformers shall be successfully tested in accordance with the following procedure:
- Each unit shall be pre-stressed at 1,04 x line voltage and then the peak discharge measured at 1,1 x the phase voltage. This discharge level shall be less than or equal to 100 pC. A representative from Transnet Projects shall witness this test, unless routine test certificates, issued by a recognised independent testing authority are submitted.
- 16.5 Voltage transformers secondary shall have the following minimum accuracy classes :
- |        |                            |
|--------|----------------------------|
| 16.5.1 | Indicating instruments - 3 |
| 16.5.2 | Protective systems - 6P    |
| 16.5.3 | Metering - 0,2             |
- 16.6 The primary of the voltage transformer shall be connected to the busbar side through high-voltage fuse-links.
- 16.7 Voltage transformers shall be fitted with three pole moulded case circuit breakers for protection of the secondary winding. The MCB's shall be mounted in the LV compartment of the panel
- 16.8 Phase or neutral earthing of the secondary winding through a removable link shall be provided. No fuses or miniature circuit breakers shall be fitted in this connection to earth.

- 16.9 The burden shall be suitable for the connected load but shall be not less than 25 VA per phase.
- 16.10 Where voltage transformers are fitted these shall be inside the arc proof enclosure. If voltage transformers are fitted outside the arc proof enclosure these shall be fully screened type. The arc capability of the switchgear must not be de-rated due to fitting of voltage transformers. Suitable documentary proof shall be provided for the design to prove compliance to the internal arc capability of the switchgear.
- 16.11 Busbar VT's shall be rackable type from behind a closed door. Busbar VT's can be situated in the cable riser cubicle, and if necessary a dedicated VT cubicle shall be supplied. Cable VT's shall only be accessible once the cable circuit is de-energised and a cable earth applied.

## 17. INDICATING LIGHTS AND INSTRUMENTS

- 17.1 All indicating instruments shall be designed, manufactured and tested in accordance with IEC 60051.
- 17.2 All indicating instruments shall have the following features:
- 17.2.1 be flush-mounted and dustproof.
  - 17.2.2 be of minimum accuracy class 2,5.
  - 17.2.3 have a scale length of not less than 85 mm.
  - 17.2.4 be provided with zero adjustment from the front without requiring dismantling of the indicating instrument.
  - 17.2.5 be marked with the ratios of the associated current and/ or voltage transformers.
- 17.3 Ammeter full-scale shall be the first standard value above the normal primary current rating of the associated current transformers.
- 17.4 Voltmeter full-scale deflection shall indicate nominal voltage at approximately 75% of the scale length and shall be marked with a red line.
- 17.5 Maximum demand ammeters shall be of the 15 minute thermal type and shall be integrated with the indicating ammeters.
- 17.6 All panels will be equipped with cluster LED type lights on the panel door indicating:
- Circuit Breaker Open
  - Circuit Breaker Closed
- 17.7 All earth switch position statuses will be clearly indicated with LED type semaphores or on the protection relay LCD graphical display.
- 17.8 All alarms and trip conditions will be clearly indicated via either programmed LED's on the protection relay or an alarm annunciator.
- 17.9 A capacitive integrated voltage indicator for permanent monitoring of all three line voltages for "cable live", and "busbar live" indication shall be provided on each panel.
- 17.10 The voltage indicators shall comply with IEC 61243-5, consisting of flashing LED diodes deriving its power

directly from the primary system via capacitive coupling electrodes. Test points shall provide for phasing and phase rotation checks.

## **18. ENERGY METERS**

18.1 Energy meters shall be designed, manufactured and tested in accordance with BS 37.

## **19. PROTECTIVE SYSTEMS AND RELAYS**

19.1 Protective relays shall be designed, manufactured and tested in accordance with IEC Publication 60125.

19.2 Protective relays shall have been type tested to verify performance and safety. Proof of these tests in the form of type test certificates shall be included in tender documents.

19.3 Standing load calculations for the all the protection schemes as supplied shall be calculated and submitted with the tender to allow for Battery charger sizing.

19.4 Unless otherwise stated in Appendix 1, each relay shall:

19.4.1 Have an error class index of 10.

19.4.2 Have an operating time class index of 60.

19.4.3 Have a rated number of contact operations with electrical duty class index N3.

19.4.4 Have a mechanical stability class index S2.

19.5 Each Relay shall:

- have at least t over current elements
- be rated in conjunction with its associated current transformer(s), to withstand the over current in the secondary winding of the current transformer/s under fault conditions
- be continuously rated for any current setting
- be clearly marked with the current ratio of the current transformer associated there-with
- have contacts rated to make and carry the current of their associated circuits. The trip coil current shall be interrupted by auxiliary contacts on the circuit breaker.
- have manual reset and flag indications for the protection function that operated
- have an additional set of normally open and normally closed contacts, or auxiliary relays, for remote indication of the relay operation. The contacts shall be capable of handling 50 W in the range of 24 to 110 V DC, and shall be wired to a terminal strip at the back of the panel.

19.6 Microprocessor based digital protection relays with the following features

- A graphical display depicting the status of the devices connected to the protection relay
- A delay closing function as part of the CB control
- Clearly labelled LED indication
- Web server functionality
- Local Remote selection
- Disturbance and event recordings
- Time synchronization

- IEC 61850 communications for both MMS and Goose messaging

19.6.2 Digital relays shall incorporate PT100 RTD inputs where required.

19.6.3 Where microprocessor based relays are supplied, communication cables and software will be supplied to configure the protection relays.

**19.7 Over-current and Earth Fault Relays**

19.7.1 The relays shall have the time/current characteristics as specified below

- IEC Normal inverse.
- IEC Very inverse.
- IEC Extremely inverse.
- IEC Definite Time

19.7.2 The relays shall have current settings adjustable either infinitely or in not less than equal steps in the following ranges:

Overcurrent Low Set	10% to 500%
Overcurrent High Set	10% to 4000%
Overcurrent Instantaneous	100% to 4000%
<hr/>	
Earth Fault Low Set	10% to 500%
Earth Fault High Set	10% to 4000%
Earth Fault Instantaneous	100% to 4000%
<hr/>	

***Where 100% corresponds to the secondary rating of the current transformer specified.***

19.7.5 Sensitive earth fault relays shall have at least a current setting of 2% - 3% and an operating time adjustable from 2 - 10 seconds.

**19.8 Differential Pilot Wire Feeder Protection**

19.8.1 Only to be used where a communication medium (pilot wires or fibre optic) exists or can be installed between the ends of the cable

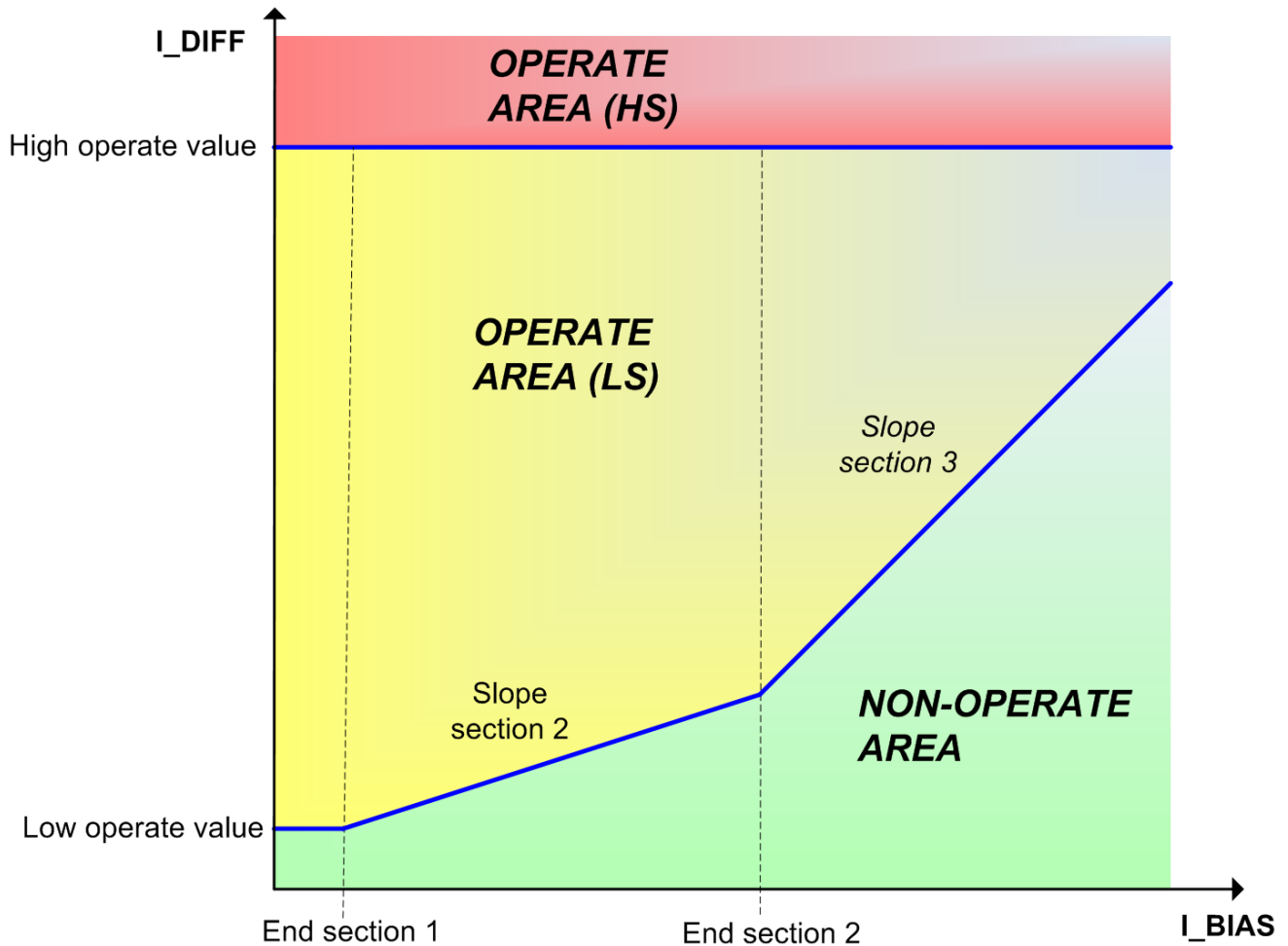


Figure 1

19.8.2 Relays incorporated in this system shall have a setting range of between

- I diff restrained 10% to 500%
- I diff un restrained 10% to 500%
- CT compensation 20% to 500%

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

19.8.3 It shall be the responsibility of the tenderer to ensure that the current transformers and relays supplied will match exactly the equipment installed at the other end of the cable to be protected and that the whole protective system will be stable on through-faults but will operate satisfactorily on feeder faults.

**19.9 Arc Protection and Busbar Blocking Scheme.**

19.9.1 A combination of Arc Protection and a Busbar blocking scheme shall be used to detect tbusbar fault under the following 3 conditions:

- Earth faults
- Phase to Phase faults.
- Three Phase faults.

19.9.2 The switchgear protection “Zones” must be split over two sections

**19.10 Arc protection**

19.10.1 The individual zone relays shall trip all the switching devices in their respective zones to isolate the fault from all sources of supply.

19.10.3 The reaction time of the busbar protection system shall be such as to limit the duration of an internal arc fault to the withstand capability of the board.

19.10.4 Each relay shall:

19.10.4.1 Have its current setting adjustable in not less than seven equal steps  
 Overcurrent 50% to 600%

---

Earth Fault 5% to 50%

where 100% corresponds to the secondary rating of the current transformer specified.

19.10.4.2 tripping the Incomers and sections directly and loading Input on the feeder breakers to clear to zone

**19.11 Transformer Protection - (3 phase, 2 winding power transformers)**

19.11.1 Over-current and Earth Fault Protection relays shall consist of the following elements:

The relays shall have the time/current characteristics as specified below

- IEC Normal inverse.
- IEC Very inverse.
- IEC Extremely inverse.
- IEC Definite Time

19.7.2 The relays shall have current settings adjustable either infinitely or in not less than equal steps in the following ranges:

Overcurrent Low Set	10% to 500%
Overcurrent High Set	10% to 4000%
Overcurrent Instantaneous	100% to 4000%

---

Earth Fault Low Set	10% to 500%
Earth Fault High Set	10% to 4000%
Earth Fault Instantaneous	100% to 4000%

---

**Where 100% corresponds to the secondary rating of the current transformer specified.**

19.11.2 Relays provided for Restricted Earth Fault Protection of Star Windings shall be of the Low impedance instantaneous type and shall be tuned to 50 Hz.

19.11.2.1 Stability on through faults shall be maintained up to the fault rating of the switchgear.

19.11.2.2 Sensitivity shall be equal to the rated current of the current transformer.

19.11.2.3 The current transformer, to be installed in the neutral connection of the power transformer, shall be supplied and installed.

19.11.2.4 The insulation of the neutral current transformer shall be equal to the rated voltage of the switchgear.

19.11.2.5 The tenderer shall advise the maximum load burden.

19.11.2.6 The current transformer for the neutral connection of the power transformer shall be installed by the Tenderer, who shall be responsible for the correct operation of the complete protective system.

19.11.3 Biased Differential Protection relays shall have a high speed characteristic and be biased to provide stability during through faults. They shall not be operated by normal magnetising inrush currents.

19.8.2 Relays incorporated in this system shall have a setting range of between

- I diff restrained 10% to 500%
- I diff un restrained 10% to 500%
- CT compensation 20% to 500%
- Vector group Compensation
- Harmonic restraint

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

19.11.4 Over temperature, Gas Detection and Overpressure Protection shall be provided unless otherwise stated in Appendix 1. All circuit breakers controlling transformers shall be provided with the following instantaneous trip auxiliary relays:

- One relay for over-temperature protection.
- One relay for Bucholz or over-pressure protection.

19.11.5 The circuit-breaker panel shall be provided with an instantaneous type relay for protection against

Tank-earth faults.

## **19.12 Electrical Inter-Trip**

19.12.1 When electrical inter-tripping between two circuit-breakers is specified in Appendix 1 and/or on the relevant drawings, tripping of the driving unit shall close a set of contacts, to instantaneously energise the trip circuit of the follower unit.

19.12.2 All circuit breakers, controlling transformers shall be provided with the equipment specified above for driving units.

## **20. CLOSING AND TRIPPING SUPPLIES**

20.1 A battery and battery-charging unit when specified in Appendix 1 shall be supplied, with the switchboard. The battery shall be capable of providing 8 hours standby time in the event of loss of supply. The battery shall be charged via a constant voltage charger that is supplied from a 220VAC supply. The charger shall be sufficiently rated to deliver the average 24hr standing load as well as the battery charging current for a discharged battery. The charger and battery shall have a 20% overcapacity to cater for aging and unforeseen loads. The manufacturer shall provide a preliminary calculation with the tender that shall be finalised on design approval.

## **21. TEST TERMINAL BLOCKS**

21.1 Readily accessible, suitably enclosed test terminal blocks (equal or similar approved to MMLG/MMLB type) shall be provided on the front panel of each switch unit for the purpose of testing all protective systems.

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

21.3 The test blocks shall be wired to the protective relays and associated current transformers.

## **22. CONTROL SWITCHES**

22.1 All control switches shall be designed manufactured and tested in accordance with the recommendation of IEC PUBLICATION 337.

22.2 Rotary pistol grip type switches shall be used on electrically operated switching devices.

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

## **23. MINIATURE CIRCUIT-BREAKERS**

23.1 Miniature circuit breakers shall be designed, manufactured and tested in accordance with SANS 156 and shall be mounted in the relay compartment and be readily accessible.



## 24. LOW VOLTAGE WIRING

- 24.1 Internal LV wiring shall be multi-strand copper conductor with PVC insulation having a minimum insulation rating of 600V/1000V to SANS 1411. When subjected to movement, the wiring shall be fully flexible with a minimum of 40 strands (2.5mm<sup>2</sup>).
- 24.2 Wiring shall be enclosed in a metal conduit when in the high voltage compartments.
- 24.3 Insulated crimp terminal lugs shall be used to terminate all wires. Lugs shall be correctly crimped to the lug manufacturers' specification.
- 24.4 All wiring from heaters to terminals shall be heat resistant.
- 24.5 Wiring shall be suitably strapped and enclosed in flexible conduit when looping from panels to doors and shall be continuous without joints.
- 24.6 Current transformer star points on secondary windings shall be earthed in the immediate vicinity of the transformer as well as onto the main circuit earth.
- 24.7 Terminal blocks or strips shall have a minimum of 10% spare terminals for future additions and be of the box type incorporating a pressure pad between the conductor and clamping screws.
- 27.8 LV wiring shall be colour coded and the ends of every wire shall be numbered as per NWS 1958 and in accordance with the approved schematic diagrams. Wiring shall also be neatly done and suitably strapped or housed in wire channels. Ferrule numbers shall be oil and moisture resistant.
- 24.9 Unless otherwise specified, the following guideline will be followed:
- DC Circuits (Indication and control) 1.5mm<sup>2</sup> Grey
  - DC Circuit (Spring rewind motor) 2.5mm<sup>2</sup> Grey
  - AC Circuits (VT) 1.5mm<sup>2</sup> Colour coded
  - AC Circuits (1A CT) 4mm<sup>2</sup> Colour coded
  - AC Circuits (5A CT) 4mm<sup>2</sup> Colour coded
  - AC Circuits (Panel Heaters) 2.5mm<sup>2</sup> Black
  - AC Circuit (Cable Live Indicators) 1.5mm<sup>2</sup> Colour coded
  - DC Buswiring (Supply) 4mm<sup>2</sup> Grey
  - AC Buswiring (Supply) 4mm<sup>2</sup> Black
  - DC Buswiring (Signalling) 1mm<sup>2</sup> Screened

## 25. REMOTE CONTROL

- 25.1 All electrically operated switching devices shall be equipped with circuits for remote operation and indication.
- 25.2 The circuits shall include the following :
- TWO set of N/O and N/C auxiliary contacts to indicate the "open" or "closed" states of the switching device.
  - Relays for remote closing and opening shall require a maximum of 50 watts at 110 Volts DC.

25.3 All remote circuits shall be wired to a terminal strip at the back of the panel.  
Selectors switch on the front of the panel to select between "local" and "remote" operation.

25.4 An additional socket shall be allowed for at the front of the panel for remote operation via a handheld pendant type remote control unit (chicken switch).

## 26. ARC DUCTING

26.1 The switchgear should be fitted with arc ducting to safely vent the gases away from the operator, to the outside of the building.

26.2 The arc ducting can be vented into the sides of the switchgear or two the rear of the switchgear. The manufacturer must determine the most suitable venting arrangement for his switchgear from the substation drawings.

26.3 If arc ducting cannot be vented to the exterior of the building then the arc ducting can vent into the switch-room through an absorber.

26.4 The design of the switchgear arc ducting system must be supported by type test certificates.

26.5 If the arc ducting is fitted with an absorber then the pressure rise within the switch-room must be determined by means of a calculation.

26.6 The maximum height of the arc ducting should be 2600 mm from the floor to the top of the switchgear including the arc ducting.

## 27. NAMEPLATES AND LABELS

27.1 Labelling shall be done according to NRS 003. Graphic symbols for wiring diagrams shall comply with NRS 002.

27.2 Each switchgear and control gear panel shall be fitted with a nameplate in a conspicuous position indicating:

Maker's name:	Maker's type number
Maker's serial number:	Client contract number
Service voltage:	Number of phases
Continuous rating:	Rating kA seconds

27.3 Identical nameplates as that on all current and voltage transformers shall be mounted in a conspicuous position inside the relay compartment. The phase colour with which each current/voltage transformer is associated shall appear beneath each nameplate.

27.4 Interchangeable, engraved labels, showing panel designation (circuit breaker number and circuit name), shall be fitted to the front and the rear of the fixed part of each cubicle and associated withdrawable equipment for easy identification.



- 27.5 Only screws with nuts or rivets shall be utilized to fix label. Self-tapping screws or similar will not be used.
- 27.6 All equipment shall be clearly designated in position in accordance with the wiring and schematic drawings.
- 27.7 Voltmeter labels shall state whether busbar or cable voltage is indicated.
- 27.8 All labels shall be made of composite sandwich type plastic material with black lettering on white background. Letters must be of sufficient size to be clearly legible. All nameplates and labels shall be in English.
- 27.9 Danger Notices: White lettering on red background. Letters must be of sufficient size to be clearly legible.

## **28. PAINTING**

- 28.1 All surfaces of the distribution board shall be light orange to SANS 1091 colour No. B26.
- 28.2 All surfaces shall be cleaned according to the appropriate method described in SANS 064 for the particular surface to be cleaned, the contamination to be removed and the primer to be applied.
- 28.3 Blast cleaning of components shall be in accordance with clause 4.3 of SANS 064 to a degree of cleanliness of at least Sa2 for inland exposure components and Sa 1/2 for coastal exposure components. See Table 1 of SANS 064 for the appropriate profile.
- 28.4 Sheet metal that cannot be blast cleaned shall be cleaned by pickling according to clause 4.6 of SANS 064.
- 28.5 Components that will be powder coated shall be cleaned and prepared by the surface conversion process according to clause 5 of SANS 064 to a medium-weight classification of table 2 of that specification.
- 28.6 Oil and accumulated dirt on steel components where no rusting is present shall be removed according to clause 3 of SANS 064.
- 28.7 The powder-coating process shall be in accordance with SANS 1274 type 4: Corrosion-resistant coatings for interior use and using the thermosetting type high gloss coating.
- 28.8 All specified coatings shall be applied according to the relevant specification and the manufacturer's instructions shall be followed.
- 28.9 Coatings shall not be applied under conditions that may be detrimental to the effectiveness of the coating or the appearance of the painted surface.
- 28.10 When examined visually the finished products shall have a uniform appearance as far as gloss is concerned and shall show no sign of damage. Damaged areas shall be repaired coat for coat to obtain the desired finish.

## **29. TESTS**

- 29.1 All prescribed tests as referred to in the standard specifications may be called for at the discretion of Transnet Projects
- 29.2 Transnet Projects also reserves the right to carry out any check tests on the equipment.
- 29.3 Notwithstanding the successful completion of tests, the tenderer will still be responsible for the efficient operation of the equipment.
- 29.4 The tenderer shall bear all costs for any tests that will be required.

## **30. INSPECTION**

- 30.1 The successful tenderer shall advise Transnet Projects at least four (4) weeks in advance of panel testing to enable Transnet Projects to witness the testing at the manufacturer's premises once Switchboards are 100% ready before shipment.
- 30.2 All transport cost to enable Transnet Projects personnel to attend such test must be included in the tenderers price (Max. 2 persons)
- 30.3 In the event of major faults ie; wiring discrepancies, VCB'S failed to trip; busbar earthing device not demonstrated on the day, The successful tenderer shall again arrange for a retest at the tenderer cost.

## **31. TOOLS AND APPLIANCES**

- 31.1 One set of any special tools and appliances required for normal operation and maintenance shall be supplied with each board.

## **32. SPARES**

- 32.1 The tenderer shall state whether their local representatives hold a complete range of spares in stock as and when required.
- 32.2 The tenderer shall submit a separate quote for recommended spares for maintenance purposes of supply a detailed description of each item including manufacturer's catalogue number.
- 32.3 A complete spare parts list, including parts location diagrams or drawing and prices, which the manufacturer recommends for the first two years' operation, shall be submitted with the tender.
- 32.4 A separate list detailing items likely to be used in a 10-year period shall also be submitted with the tender.



**33. PACKING**

- 33.1 The equipment shall be packed in such a manner that it will be protected during handling and transport by road, rail or sea as applicable. The movements of instruments, meters and relays shall be protected against vibration damage during transit.
- 33.2 When sea transport is involved, a dehydrating agent shall be provided where necessary.

**34. GUARANTEE**

- 34.1 The tenderer shall guarantee the equipment supplied by him in terms of this specification for a period of one year after successful completion of hot commissioning of the plant. The tenderer shall state his compliance herewith.
- 34.2 This guarantee shall cover all materials, parts, workmanship, performance and efficiency (normal wear and tear excluded). The guarantee shall include all equipment supplied.
- 34.3 If any part/equipment fails during the 12-month guarantee period, the supplied shall immediately replace such part/equipment free of charge.

**WITNESSES**

- 1. ....  
.....  
**TENDERER**
- 2. ....  
.....  
**DATE**

**Transnet Projects**

**ANNEXURE 1**  
**SCHEDULE OF REQUIREMENTS**

<b>BERTH 102 SUBSTATION (11KV)</b>						
Item	Description					
	<b>Panel No</b>	<b>E26 &amp; E33</b>	<b>E29, E31</b>	<b>E30</b>	<b>E27, E28 and E32,</b>	
	<b>Panel Designation</b>	E26 Incomer 1 E33 Incomer 2	E29 – Transformer 03, E31 – Transformer 04	E30- Bussection E30a Busbar ES & VT 1, E30b Busriser & VT 2	E27, E28, E32– Feeders.	
1.1	<b>General</b>					
	Type of panel	New	Yes	New	New	
	Number of switching devices	Two	Two	Three	Three	
	Neutral Earthing: Unearthed: _____ Solidly Earthed: _____ Reactance Earthed: _____ Resonant Earthed: _____	Solidly Earthed				

Item	Description						
	Panel No	E26 & E33	E29, E31	E30	E27, E28 and E32,		
	Arrangement drawing reference of the switchboard with details of each panel and its components and accessories	To be submitted by tender					
	Cable trench layout to be agreed with the supplier Yes/No	No Existing Building					
1.2	<b>Ratings of switchgear panels</b>						
	Rated voltage Kv	11 kV					
	Rated frequency 50 Hz	50 Hz					
	Busbars Rated normal current (amps) Type of Material: Copper..... Insulation	1250A  Copper Air Insulated	1250A  Copper Air Insulated	1250A  Copper Air Insulated	1250A  Copper Air Insulated		
	Rated insulation level KV	95kV					
	Max. Three phase and earth fault current kA / 3 seconds	31.5					
	IAC Rating	AFLR					
	Max Internal arc Fault rating kA / 1 second	31.5					
	Rated normal current for Circuits A	1250A	630A	1250A	630A		

Item	Description				
	Panel No	E26 & E33	E29, E31	E30	E27, E28 and E32,
	Anticondensation Heaters: Yes/No	Yes. In cable and CB compartment.			
	Switchboard Colour	Grey, RAL7035			
1.3	<b>Environnemental conditions</b>				
	a) altitude m	0 to 1800m			
	b) max. daily temperature °C	+45			
	c) min. daily temperature °C	-5			
	d) average daily temperature °C	+35			
	e) humidity %	96			
	f) exposure conditions	Salt laden and industrial atmosphere			
	g) Lightning Conditions	Severe: 11flashes/ km <sup>2</sup> /annum			
1.4	<b>Circuit-breakers</b>				
	Circuit-breaker type required (Withdrawable)	Vacuum			
	Closing mechanism if other than a stored energy type	Stored Energy, spring or Capacitor			
	Rating according to IEC 62271-100	E2, M2, C2			
	Closing Supply: Rated Voltage: _____ Peak Power: _____	110 Volts, Battery Peak Power 750W			
	Tripping Supply: Rated Voltage: _____ Peak Power: _____	110 Volts, Battery Peak Power 750W			

Item	Description						
	Panel No	E26 & E33	E29, E31	E30	E27, E28 and E32,		
	Stored Energy Mechanism Type: Motor/Capacitor Voltage :_____	110 Volts, Battery Peak Power:_____					
	Number of spare auxiliary contacts required on circuit-breakers						
	- “Normally open ” contacts	5	5	5	5		
	- “Normally Closed” contacts	5	5	5	5		
1.5	<b>Safety earthing</b>						
	Are earthing facilities required on main circuits? Yes/No	Yes	Yes		Yes		
	Are earthing facilities on busbars required? Yes/No			Yes one per busbar section 1 x ES in Bus Section or Bus Riser (RHS) 1 x ES in BB VT / ES Cubicle (LHS)			
	Are these facilities to be rated for fault making? Yes/No	Yes	Yes	Yes	Yes		

Item	Description					
	Panel No	E26 & E33	E29, E31	E30	E27, E28 and E32,	
	Interlock BB E/S with all incoming and Feeders CB, racking.			Yes via Fortress Type Key Interlock		
1.6	<b>Cable terminations</b>					
	Type and size of cable	TBA	TBA		35mm <sup>2</sup> , 3-core XLPE	
	Cable termination compartments					
	Type of cable boxes required	Air Insulated.	Air Insulated.		Air Insulated.	
	Type of filling required: XLPE Air insulated Cables.	Termination kits to be provided.	Termination kits to be provided.		Termination kits to be provided.	
	Are gland plates required? Yes/No	Yes	Yes		Yes	
1.7	<b>Current transformers (CTs)</b>					
	Current transformer specification applicable	Yes	Yes	Yes	Yes	
	a) Class type: Protection:	1	1	1	1	
	- quantity	3	3	3	3	
	Class X	400-10/1 0.03 A RCT < 2.8Ohm	Nil	Nil	Nil	
	- ratios	800/1	100/1	800/1	100/1	
		5P20 7.5VA RCT < 6.8 Ohm	5P20 2,5VA RCT < 0.9Ohm	5P20 7.5VA RCT < 6.8 Ohm	5P20 2,5VA RCT < 0.9Ohm	
	c) Metering CTs					

Item	Description					
	<b>Panel No</b>	<b>E26 &amp; E33</b>	<b>E29, E31</b>	<b>E30</b>	<b>E27, E28 and E32,</b>	
	Where required?	Incomer				
	Class type:	1	1		1	
	- quantity	3	3		3	
	- ratio	800/1	100/1		100/1	
	- accuracy %	Cl 0.5 - 7.5VA	Cl 0.5 - 7.5VA		Cl 0.5 - 7.5VA	
	Test Blocks Yes/No	Yes RXTP type On LV Door				
1.8	<b>Voltage transformers (VTs)</b>					
	Panel to which VTs are to be fitted			Busbar riser / BB VT Panel.		
	VT requirements					
	Connected to			Busbar		
	Quantity			3 x Single Phase		
	a) Class type / VA: Indicating Instruments / Meters			Class 0.5 / 50VA		
	b) Class type / VA: Protection			6P / 150VA		
	- quantity			1 per busbar section		
	- ratios			11000v3/110v3/110/3 Volts		
	VT Protection device			Loading resistor or VT guard.		
	Connection of VT primary to: Busbar side/circuit side			Busbar Side, Withdrawable		

Item	Description					
	Panel No	E26 & E33	E29, E31	E30	E27, E28 and E32,	
	Are HV fuse-links required? Yes/No			Yes		
1.9	<b>Live circuit indication</b>					
	According to IEC 61243-5	Yes	Yes		Yes	
	Is live circuit indication required Yes/No	Yes	Yes		Yes	
	If Yes, on which panels?	Incomer	Transformer		Feeders	
1.10	<b>Control, protection and alarm circuitry</b>					
	Drawing number, if applicable, for all panels	To be submitted by Manufacturer				
	Are control wires to be terminated with crimped lugs? Yes/No	Yes				
	Colour of auxiliary wires, if not grey	As per specification.				
	Requirements for alarm circuits					
	Protection of d.c. circuits Fuses/MCCBs	MCB's				

Item	Description						
	Panel No	E26 & E33	E29, E31	E30	E27, E28 and E32,		
	Are Ammeter required? Yes/No	Yes via IED					
	Are Voltmeters required? Yes/No	Yes via IED					
C.11	<b>Battery, battery charger and d.c. supplies</b>						
	Are a battery and battery charger to be supplied? Yes/No	Yes					
	If Yes, details of the battery V A.h capacity suitable for 8hour standby	110 Volt (gel type, maintenance free batteries) Manufacturer to calculate the Ah capacity required					
	Auxiliary supply	Yes 380/220V Local AC DB existing					

Item	Description					
	Panel No	E26 & E33	E29, E31	E30	E27, E28 and E32,	
1.12	<b>Protection Relays Overcurrent and Earth Fault Relays:</b>					
	Overcurrent:	Yes	Yes	Yes	Yes	
	Number of elements	Three	Three	Three	Three	
	IDMT Inverse	Yes	Yes	Yes	Yes	
	IDMT Extremely Inverse	Yes	Yes	Yes	Yes	
	High Set Instantaneous Instantaneous	Yes	Yes	Yes	Yes	
	Definite Time	Yes	Yes	Yes	Yes	
	Earth Fault:					
	Number of elements	Three	Three	Three	Three	
	IDMT Inverse	Yes	Yes	Yes	Yes	
	IDMT Extremely Inverse	One	One	One	One	
	High Set Instantaneous Instantaneous					
	Definite Time	Yes	Yes	Yes	Yes	
	Autoreclosing	No	No	No	No	
	Cable Differential Protection	Yes	No	No	No	
	Power Factor Protection	No	No	No	No	
	Busbar Blocking	Yes	Yes	Yes	Yes	
	Details of indication functions required					
	Current Indication	Yes in IED	Yes in IED	Yes in IED	Yes in IED	
	Voltage Indication	Yes in IED	Yes in IED	Yes in IED	Yes in IED	

Item	Description					
	Panel No	E26 & E33	E29, E31	E30	E27, E28 and E32,	
	Energy Metering	Yes in IED	Yes in IED	NA	Yes in IED	
	Specify	P, Q, Pf	P, Q, Pf	NA	P, Q, Pf	
	Binary Inputs	12 Inputs	16 Inputs	16 Inputs	12 Inputs	
	Binary Outputs	6 Normal + 4 Power Outputs	6 Normal + 4 Power Outputs	6 Normal + 4 Power Outputs	6 Normal + 4 Power Outputs	
	Communications	Ethernet RJ45				
	Communications Protocol	IEC 61850				
	Type of IED	Similar to ABB REF615 HBFEAEAGNB A1BNA1XD	Similar to ABB REF615 HBFEAEAGNBA1BNA1 XD	Similar to ABB REF615 HBFEAEAGNBA1BNA1 XD	Similar to ABB REF615 HBFEAEAGNBA1BNA1XD	
	Differential Protection	Solkor	No	No	No	
	Pilot wire Modem required Yes/No	No	No	No	No	
	Arc Protection	REA 101	REA107	REA107	REA107	
	Arc Protection system	Non Selective Tripping				
1.13	<b>Electrical Intertrip</b>	Remote Cable Differential Signal	Yes via IED, Rcd from LV ACB	No	No	
	Driving unit: Breaker No. Follower unit: Breaker No	Cable Differential Trip Signal	Main LV ACB	NA	NA	

Item	Description					
	<b>Panel No</b>	<b>E26 &amp; E33</b>	<b>E29, E31</b>	<b>E30</b>	<b>E27, E28 and E32,</b>	
	Where are VT fuses or links located?			On VT		
1.14	<b>Remote Switching</b>	Remote Wired Control Panel and SCADA	Remote Wired Control Panel and SCADA	Remote Wired Control Panel and SCADA	Remote Wired Control Panel and SCADA	
1.15	<b>Tests</b>					
	Routine test and type test of metering CTs required	Yes according to IEC 60044-1				
	Routine test and type test of protection CTs required	Yes according to IEC 60044-1				
	Routine Test and Type test of VTs required			Yes according to IEC 60044-2		
	Number of copies of routine test certificates required	Three				
1.16	<b>Marking/labeling/documentation</b>					
	Are main circuit labels to be engraved? Yes/No	Yes				
	Documentation to be provided with the offer.	General Arrangement and details of equipment offered				



Technical Specification  
Specification No. TPD: 007-MVSWITCHSPEC

Item	Description					
	Panel No	E26 & E33	E29, E31	E30	E27, E28 and E32,	
	Quantity of Operational and Maintenance manuals required:	Three copies				
1.17	<b>Accessories</b>					
	Supply of cabinet required Switchgear Operating Tools Wall Mounted tool cabinet CB service trolley	Yes Yes If Required				
	Number of as-built drawings and O and M manuals required.	Three				
	<b>Spares</b>					
	Period required for routine maintenance spares	1 year				
	Minimum availability of spares from date of supply	10 years				
	<b>Delivery</b>					
	Delivery period EXW in Weeks					
	Delivery period installation in weeks					
	Delivery period for commissioning in weeks					

**Tenderer:** .....  
**Date:** .....

**Witness 1:** .....  
**Witness 2:** .....

**ANNEXURE 2**  
**TECHNICAL DATA SHEET**  
**To be completed by the Tenderer**

<b>BERTH 102 SUBSTATION (11KV)</b>						
Item	Description					
	<b>Panel No.</b>					
1.1	<b>General</b>					
	Details of provisions for lifting/slinging					
	Type of transporting device if not an integral device					
1.2	<b>Circuit-breakers</b>					
	Circuit-breaker type offered					
	Rating of the closing device					
	a) rated control voltage	V				
	b) rated current	A				
	c) rated power	kW				
	d) time lag fuses or MCCBs?					

Item	Description					
	<b>Panel No.</b>					
	e) alternative methods of tripping if any					
	Number of spare auxiliary contacts offered on circuit-breakers					
1.3	<b>Safety Earthing</b>					
	Details of earthing facilities offered					
	Details of earthing busbars in bus-section and/or bus-coupler panels					
1.4	<b>Cable termination compartments</b>					
	Type of compartment offered					
1.5	<b>Current transformers (CTs)</b>					
	Current transformer specification offered					
	Type of CT offered					
	Are separate CTs used for indications?					

Item	Description					
	<b>Panel No.</b>					
	Is approval for connection of protection or indicating instruments to metering CTs required? Yes/No					
1.6	<b>Voltage transformers (VTs)</b>					
	Type of VTs offered					
1.7	<b>Live circuit indication</b>					
	Type of indication offered					
	Voltage divider bushing details					
	- manufacturer					
	- type					
	- dielectric					
	- rating					
1.8	<b>Battery, Battery Charger and dc supplies</b>					
	Type of battery offered					
	Type of battery charger offered					
	Battery load					
	Peak current from all switchgear A					
	Standby current A					

Item	Description					
	<b>Panel No.</b>					
1.9	<b>Protection relays and instruments</b>					
	Details of protection equipment offered					
1.10	<b>Terminals for auxiliary circuits</b>					
	Type of test block offered					
1.11	<b>Painting/Coating</b>					
	Paint/coating system offered					
1.12	<b>Tests</b>					
	Summary of type test certificates available					
	Test authority for type certificates					
	Are any test certificates overseas products?					
	If Yes, is the South African product identical?					

Item	Description					
	<b>Panel No.</b>					
	How many units installed in South Africa?					
1.13	<b>Accessories</b>					
	Details of the accessories supplied					
1.14	<b>Spares</b>					
	Is a complete range of spares held in stock by the local representative? Yes/No					

**Tenderer:**.....

**Date:** .....

**Witness 1:** .....

**Witness 2:** .....

**ANNEXURE No.3**  
**ELECTRICAL DRAWINGS**

This appendix lists the Transnet Port Terminals Drawings, which shall be read in conjunction with this specification:

DRG No.	Description
	Main Switching Layout
2233497-2-000-E-LA-0001-02	Berth 102 Substation Proposed Equipment Layout
2233497-2-000-E-LA-0001-04	Berth 102 Substation Proposed MV Single Line Diagram

**SIGNATURE OF TENDERER**

\_\_\_\_\_

**DATE**

\_\_\_\_\_

**ANNEXURE 4**  
**TEST REQUIREMENTS**

**1. TYPE TESTS**

- 1.1 Type testing shall be carried out in accordance with the Recommendations, Standards, or Specifications referred to in this specification.
- 1.1.1 Type test certificates shall be submitted with tender documents.

**2. ROUTINE TESTS**

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

**3. FUNCTIONAL TESTS**

- 3.1 A functional test of the complete board including all protective relays by primary injection shall be carried out by the manufacturer.
- 3.2 The breaker opening times shall be indicated in these tests.

**4. GENERAL**

- 4.1 Four copies of all approved routine test certificates shall be supplied, at a date not later than the delivery date of the switchgear or control gear.
- 4.2 All routine testing shall be witnessed and inspection carried out by the Engineer (Electrical) or his duly appointed representative.

**SIGNATURE OF TENDERER** \_\_\_\_\_

**DATE** \_\_\_\_\_

