SPECIFICATION FOR LOW VOLTAGE SWITCHGEAR AND DISTRIBUTION BOARDS

PL 631

REV. 009

DOCUMENT APPROVAL PROCESS

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01/08/07	008		SABS 10142:2003 Requirements added. Transnet pipeline Logo added.
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2. INTRODUCTION

The objective of this Specification is to establish standards and codes of practice that are required to be adhered to by both Contractor and Client in the design, supply and installation of LV Switchgear and Distribution Boards, on all Transnet Pipelines Sites.

3. SCOPE

3.1 General

This document describes as a minimum, the technical requirements and general responsibilities regarding the safety, design, supply, manufacture, population, type-testing, performance, constructional and routine testing, delivery to site, site erection, site testing and commissioning requirements for 50 Hz LV Distribution Switchgear and Controlgear ASSEMBLIES for voltages up to 660 V. Contractors are required to familiarise themselves with all applicable Standards and Codes of Practice listed herein, and to ensure compliance in the execution of any work in terms of this document. Failure to comply may render the contractor liable for corrections at his own cost.

These Standards and Codes of Practice should be read in conjunction with all other Specifications and drawings as issued for a particular contract. Where discrepancies occur, these must be brought to the attention of Transnet Pipelines in writing before commencement of work. In the event of any conflict between the contents of any documents forming part of a contract (as listed in the Schedule of Contract Documents) and this document, the former shall prevail.

3.2 Application to Work Activities

The Standards and Codes of Practice contained herein apply to all installations involving the safety, design, supply, manufacture, population, type-testing, performance, constructional and routine testing, delivery to site, site erection, site testing and commissioning requirements for 50 Hz LV Distribution Switchgear and Controlgear ASSEMBLIES for voltages up to 660 V, and includes amongst others the following activities:

- Design, supply and installation of LV Distribution Panels for voltages up to 660 V
- Design, supply and installation of Motor Control Centres for voltages up to 660 V

The ASSEMBLIES shall be required for distribution, motor control & /or a combination of these functions, for floor or wall mounting and for indoor or outdoor use as detailed in the project specification. All boards shall be totally enclosed.

4. NORMATIVE REFERENCES

4.1 The following national and international specifications and standards shall be read in conjunction with this Specification.

Where reference is made to a Code, Specification or Standard, the reference shall be taken to mean the latest edition of the Code, Specification or Standard, including addenda, supplements and revisions thereto, in content or numbering.

General:	
API 2003	Protection against ignitions arising out of static, lightning and stray currents
SABS ISO 9000:	Quality management systems
SANS 10086-1	The installation, inspection and maintenance of equipment used in explosive atmospheres
SANS 10089-2 (2007)	The petroleum industry Part 2: Electrical and other installations in the distribution and marketing sector
SANS 10142-1 (2012)	The wiring of premises Part 1: Low-voltage installations
SANS 10198 - 2004	The Selection, Handling and Installation of Electric Power Cables of rating not exceeding 33 KV
SANS 10313	The Protection of structures against lightning.
Equipment :	
SANS 1700	ISO metric black bolts, screws and nuts (hexagon and square)
SANS 1019 - 2014	Standard voltages, currents and insulation levels for electricity supply
SANS 1091 - 2012	National colour standards
SANS 1195	Busbar Systems
SANS 1274- 2014	Coatings applied by the powder-coating process
SANS 1507	Secondary Wiring
SANS 1973-1	Low-voltage switchgear and controlgear ASSEMBLIES Part 1: Type-tested ASSEMBLIES with stated deviations and a rated short-circuit withstand strength above 10 kA
SANS 1973-3	Low-voltage switchgear and controlgear ASSEMBLIES Part 3: Safety of ASSEMBLIES with a rated prospective short-circuit current of up to and including 10 kA
SANS 60269 (2014)	Low-voltage fuses
SANS 60439-1	Low-voltage switchgear and controlgear assemblies
SANS 60529	Degrees of protection provided by enclosures (IP Code)
SANS 60947-1 (2012)	Low-voltage switchgear and controlgear Part 1: General rules
SANS 60947-2 ((2014)	Low-voltage switchgear and controlgear Part 2: Circuit-breakers
SANS 60947-3 (2012)	Low-voltage switchgear and controlgear Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units

SANS 60947-4 (2013)	Low-voltage switchgear and controlgear Part 4 -1;-2;-3: Contactors and motor-starters
SANS 60947-5	Low-voltage switchgear and controlgear Part 5: Control circuit devices and switching elements
SANS 61439	Low-voltage switchgear and controlgear assemblies
SANS 61558	Safety of power transformers, power supplies, reactors and similar products
SANS 61643-1	Low-voltage surge protective devices Part 1: Surge protective devices connected to low-voltage power distribution systems - Requirements and tests
SANS 61643-12	Low-voltage surge protective devices Part 12: Surge protective devices connected to low-voltage power distribution systems - Selection and application principles
SANS 61869-1	Instrument transformers
BS 142	Electrical protection relays
BS 159	Busbars and busbar connections
BS 5486	Low voltage switchgear and controlgear assemblies
BS 1433	Copper for electrical purposes. Rod and bar.
BS 3693	Design of scales and indexes. Part 1.
BS 3938	Current transformers
BS 4794	Control switches. (Switching devices, including contractor relays, for control and auxiliary circuits, for voltages up to and including 1000 V AC and 1200 V DC.) Part 2.20.
BS 5472	Low voltage switchgear and control gear for industrial use. Terminal marking and distinctive numbering. General rules.
DIN43620	Low voltage high rupturing capacity fuses with blade contacts.
NRS 002	Graphical symbols for electrical diagrams
VDE 0660	Regulations for low voltage power fuses (NH fuses) Part 4
Government, local authorities or other statutory bodies' regulations, laws, requirements or customs which are more stringent than those detailed in this specification.	

4.2 The following standard specifications are to be used for reference purposes and need to be noted by Contractors in order to signify familiarity and compliance with the requirements. It is expected of Contractors that they are familiar with the applicable clauses and that these will be adhered to in the execution of any work in terms of this specification. Contractors will be required to confirm that they are able to meet these requirements.

The Occupational Health & Safety (OHS) Act No. 85 of 1993.	
SANS 10108: 2014	The Classification of hazardous locations and the selection of electrical apparatus for use in such locations
SANS 60079	Explosive atmospheres: Part 14: Electrical installations design, selection and erection; Part 17: Electrical installations inspection and maintenance; Part 25: Intrinsically safe electrical systems

API	Manual of Petroleum Measurement Standards Chapters 4 to 12 IP Chapter 10 and Papers 2 and 3
SANS 60529	Degrees of protection provided by enclosures (IP Code)
BS 5490	Classification of degrees of protection provided by enclosures
BS 229	Flameproof enclosures for electrical apparatus
BS 1259	Intrinsically safe electrical apparatus and circuits for use in explosive atmospheres
BS 4683	Electrical apparatus for explosive atmospheres
Safety Regulations for Contractors	
Technical Instruction No. 16 – Contractors Work Permit Procedures.	
VDE Standards	

4.3 Where no specific rules, regulations, codes or requirements are contained in this specification nor covered by the above mentioned codes, the contractor shall, in consultation with Transnet Pipelines, adhere to internationally accepted modern design and engineering practices in the Petroleum Industry.

5. TRANSNET PIPELINES SPECIFICATIONS

5.1 The following Transnet Pipelines standard specifications are to be read in conjunction with this document and require separate statements of compliance, which should be included in the tender documents.

PL727 Specification for Cable, Racking, Trenching & Earthing Reticulation Codes of Practice

PL711 Specification for Equipment Cabinets to house Electronic Equipment Safety Regulations for Contractors

6. ABBREVIATIONS & DEFINITIONS

6.1 For the purpose of understanding these Standards, the following abbreviations apply.

AC	Alternating current
ACB	Air Circuit-breaker
ANSI	American National Standards Institute
BS	British Standard
BSI	British Standard Institution
C&I	Control and Instrumentation

CT	Current Transformer
DC	Direct Current
DCS	Distributed Control System
EDS	Engineering Design System
EMC	Electro magnetic compatibility
FAT	Factory Acceptance Test
fn	Rated frequency
HEM	High Efficiency Motor
HRC	High Rupturing Capacity
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronic Engineers
IP	Ingress Protection
ISO	International Organisation for Standardisation
ISA	Instrument Society of America
LV	Low Voltage
mcb	Miniature Circuit-breaker
MCC	Motor Control Centre
MCCB	Moulded-Case Circuit-breaker
OEM	Original Equipment Manufacturer
OHS Act	Occupational Health and Safety ACT
PE	Protective Conductor
PEN	Combined Protective Earth & Neutral
PTTA	Partially Type-tested ASSEMBLY
RCC	Regulatory Certificate of Compliance
RDF	Rated diversity factor
SAT	Site Acceptance Test

SABS	South African Bureau of Standards
SANS	South African National Standards
SCPD	Short Circuit Protective Device
SPD	Surge Protection Device
TPL	Transnet Pipelines
TTA	Type-tested ASSEMBLY
UPS	Uninterruptible Power Supply
Ue	Rated operational voltage
Uimp	Rated impulse withstand voltage
Un	Rated voltage
VT	Voltage Transformer

6.2 The following Definitions are consistent with the Transnet E5 Agreement and General Conditions of Contract and apply to this specification in its entirety.

CHIEF EXECUTIVE (Transnet Pipelines) means the officer appointed as Chief Executive (Transnet Pipelines) of Transnet Limited or any person lawfully acting in that capacity.

ENGINEER means any officer in the office of the Chief Executive (Transnet Pipelines) deputed by the Chief Executive (Transnet Pipelines) to supervise and take charge of the contract.

PLANT means any machine, excluding a tool, and any vehicle, excluding a passenger vehicle, used on site for the carrying out of the Works.

EQUIPMENT means any device not forming a permanent part of the Works, used on site for the carrying out of the Works, and also any temporary building, which is required for the carrying out of the Works, and which is erected on site.

TOOL means any instrument, powered or otherwise, which is accepted as a hand tool by the industry concerned and which is normally used in a manual operation by an individual labourer, artisan or workman.

MATERIAL means any constructional substance or ingredient that shall form part of the permanent Works and the substances in excavations and earthworks.

DRAWINGS means the drawings referred to in any specifications, schedule of quantities and prices and any alterations of such drawings made or approved in writing by the Engineer and

such other drawings as may from time to time be furnished or approved in writing by the Engineer.

SITE means the land and any other place on, under, over, in or through which the Works are to be executed or carried out and any other land or place made available by Transnet in connection with the Works.

WORKS means the works to be executed in accordance with the Contract.

6.3 General Definitions

In addition to the definitions of SANS 10142-1; SANS 1973-1; SANS 1973-3 and SANS 60439-1, the following apply:

Approval	Written agreement or authorization by Transnet Pipelines. All requests for approval shall be submitted in writing and any proposed deviation from specified requirements shall be fully justified and agreed by Transnet Pipelines.
Barrier	A part providing protection against direct contact from any usual direction of access (minimum IP2X) and against arcs from internal arc faults, if any.
Cable way	A section of the ASSEMBLY that provides a platform for the routing and termination of cables.
Collection Busbars	A type-tested intermediate busbar arrangement between the main busbars to distribute power to especially mcb's which are connected in cascaded circuit arrangements.
Data Sheets	All drawings, tabulations, sketches, and relevant documentation which Transnet Pipelines shall submit with an enquiry, to clearly indicate to a bidder or supplier the technical, electrical and physical requirements of the completed equipment.
Distribution Feeder	A functional unit supplying power to another low voltage ASSEMBLY either through a cable or step-down transformer.

Equalizing Busbars	Busbars to which the incoming or outgoing power electric cables are connected to enable an even distribution of current to the terminals of the protective gear.
Fault-Free Zone	Zone in ASSEMBLY or section of an ASSEMBLY that comprises the conductors (including distribution busbars) between the main bursars and the supply side of functional units, in which, under normal operating conditions, the occurrence of a short-circuit fault is only a remote possibility.
Padlocking facility (Padloackable)	Part of the ASSEMBLY or component that allows one to insert a padlock for locking purposes during maintenance.
Type-Tested ASSEMBLY with stated deviations	An ASSEMBLY System which has been verified by a comprehensive range of tests of worst case scenarios and documented in accordance with an approved Engineering Design System with all type-tests performed in accordance with the requirements of SANS 10142-1, SANS 1973-1 and SANS 60439-1.
Intelligent Electronic Device (IED)	Microprocessor-based device with the protection, control, monitoring and communication functionalities.
Incomer Unit	A functional unit through which electrical energy is fed into the ASSEMBLY.
Modular Design	An ASSEMBLY System which accommodates a variety of section sizes, sub-section sizes, and busbar and cable compartment sizes in such a way that the different combinations has been subjected to all type-tests as prescribed by SANS 1973-1.
Partition	A part of the enclosure of a compartment separating it from other compartments.

Protective Gear	Individual or combinations of circuit-breakers and or switch-disconnectors and or fused switch-disconnectors
Stated Deviations	Deviations from a type-tested ASSEMBLY which is documented in the Engineering Design System and supported by type-test reports.
Withdrawable Unit	A functional unit which can be moved from the connected position to the isolated position and to a test position, if any, whilst remaining mechanically attached to the ASSEMBLY.

8. SITE CONDITIONS

8.1 The equipment shall be designed to operate continuously at its rated capacity, at the specified ambient temperature and site elevation conditions as detailed in the datasheets. Typically these conditions are tabulated below:

Ambient operating temperature	-5 to 40 °C (Daily average +35 °C)
Maximum relative humidity	0 to 95 %
Maximum altitude	0 to 2000 above sea level
Lightning conditions	Severe, max ground flash density 11 flashes per km² per annum
Exposure conditions	Salt laden as well as industrial atmosphere

8.2 **Electrical Conditions.**

8.2.1 The system of supply shall be 3 phase, 4 wire, 50 Hz alternating current with earthed neutral at a nominal voltage of 400/230 Volts.

8.2.2 The voltage may vary within the range of 95% to 105% of the nominal. All equipment installed shall be suitably rated.

8.2.3 The Switchgear Panel, switchgear components, busbar systems and cables shall be adequately rated for prospective fault level ratings. Prospective system fault level requirements shall be obtained from the relevant supply authority, and used to determine switchboard fault levels after making allowances for circuit impedance of associated cables and transformers. It will be the Contractor's responsibility to provide for supply authority requirements when compiling their Offers.

8.2.4 The LV Switchgear and Controlgear ASSEMBLY shall comply with the fundamental safety requirements of Clause 5 of SANS 10142-1.

8.2.5 LV Switchgear and Controlgear ASSEMBLY shall as a minimum be designed, constructed and tested in accordance with the requirements of Clause 6.6 of SANS 10142-1.

8.2.6 All components and electric conductors fitted to the ASSEMBLY shall be certified as safe by means of a valid Regulatory Certificate of Compliance (RCC) in accordance with SANS 10142-1 Table 4.2 or an SABS Mark of approved performance.

8.2.7 ASSEMBLIES shall be fit-for-purpose type-tested low-voltage free-standing metal-enclosed switchgear and controlgear ASSEMBLIES with stated deviations in accordance with the requirements of this Specification, SANS 10142-1, SANS 60439-1, SANS 1973-1 and /or SANS 1973-3. The ASSEMBLIES shall also meet the Transnet Pipelines requirements in terms of safety, operation and maintenance requirements.

8.2.8 ASSEMBLIES shall be constructed only of materials capable of withstanding the mechanical and electrical stresses as well as the effects of humidity which are likely to be encountered in normal service.

8.2.9 The manufacturer shall have conducted full type tests and specified special tests as required at a Third Party Test House accredited by an internationally recognized Accreditation Authority in terms of ISO 17025 in accordance with SANS 60439-1, Table 7 for a reference design and shall be in possession of valid type test report/s not older than 5 years that reflects a reasonable and true outcome of the results. In addition, the type tests shall comply with the latest revisions of the applicable standards. In case a certificate is older than 5 years, proof shall be provided that the design and materials used match that of the type tested ASSEMBLY.

8.2.10 A valid "scope of testing" certificate issued by the Accreditation Authority shall be submitted.

8.2.11 The manufacturer shall be in possession of an Engineering Design System (EDS) as specified in SANS 1973-1, specifically Annex B, in which deviations to meet requirements of this Specification and plant specific requirements (items subject to agreement) as may be detailed in enquiries issued by Transnet Pipelines can be verified and validated.

8.2.12 A type-tested ASSEMBLY with stated deviations would typically be of modular design, extensively type-tested under worst-case conditions of IP Rating, Forms of Separation, a complete range of sizes of sections, sub-sections and busbar compartments. Worst case power losses, highest ratings of protective gear installed, highest possible diversity factors, current ratings, short-time ratings, conditional short-circuit ratings at maximum voltages with type II co-ordinated arrangements, maximum support and busbar

configurations, busbar cross-sectional area, conductors installed in the 'fault-free-zone' etc.

9. DRAWINGS AND INSTRUCTIONS

9.1 The Contractor shall issue to the Engineer, documentation as per specific contract requirements. Where not specified, the Contractor shall provide one set of sepias, 3 copies of drawings and 1 electronic media of "As Built" drawings, in their native format, of equipment which have been installed on site.

9.2 Handbooks, spares lists and maintenance instructions shall be issued to the Engineer in triplicate at the time of handing over the equipment.

9.3 All Documentation issued shall be in full compliance with Transnet Pipelines Specification PL100 Drawing Standard and in particular:

- **PL101** Plant & equipment Tag numbering Standards
- **PL102** Equipment, Instrument & Electrical Symbology Standard
- **PL103** General Drawing Standards

9.4 The requirements of the materials, design, layout, fabrication, assembly and erection of Low Voltage Panels / Motor Control Enclosures shall, where relevant, be in accordance with the following Transnet Pipeline approved drawing Typicals forming part of this Specification: -

- LV Panel GA – External Arrangement
- LV Panel GA – Internal Arrangement
- LV Panel Single Line Diagram Typical
- LV Panel Schematics – DOL Starter
- LV Panel Schematics – Star Delta Starter
- LV Panel Schematics – VSD Starter

9.4.1 General arrangement drawings

General arrangement drawings shall be completely dimensioned, showing:

a) Arrangement of equipment
b) Top, front, and side views and cross-sections of the ASSEMBLY.
c) Position of each functional unit and their compartments.
d) Clearances for opening doors.
e) Locations of busbars and distributions.
f) Details on the required openings for the power cables
g) Incoming and outgoing cable termination positions and details.
h) Cable slot positions.
i) The height of all cable glands above floor level
j) Instrument transformers (i.e. VT's and CT's) physical positions.

k) Terminal block locations.
l) Earthing or bonding connections.
m) Mass of transportable sections of equipment
n) Details and position of the holding down bolts
o) Magnitude and disposition of all loads imposed on foundations

9.4.2 Single line diagram

Single line diagram shall show the following:

a) Configuration of the circuits (i.e. incomers and feeders) on the ASSEMBLY.
b) Electrical connection of VT's and CT's
c) Section or sub-section numbers of the different functional units.
d) Mechanical key interlocking design.

9.4.3 Schematic Drawings

Schematic wiring diagrams shall show the following:

a) All protection and control devices and their contacts, each of which shall be labelled with its correct ANSI device function number (i.e. protection and control scheme).
b) Device terminal numbers, terminal block numbers and terminal numbers.
c) All wiring within each functional unit.
d) All internal interconnections, bus wiring, inter ASSEMBLY wiring and connections to external equipment.
e) All control and protection switches
f) Power supply connections
g) Component schedule for each circuit

9.5 All cable and wire sizes, values of resistance, breaking capacity of switches and ratings of equipment shall be clearly specified on a drawing.

9.6 All Electrical symbols shall comply with NRS 002-2000 Graphical Symbols for Electrical Diagrams.

9.7 Prior to commencement of manufacture, design approval shall be obtained from the Engineer. Design approval shall entail as a minimum, the submission of the following documentation:

a. Single Line Drawings.
b. Circuit diagrams of power, control, alarm and indication circuits.
c. Layout of equipment in or on panels, boards and cubicles.
d. Internal wiring diagrams of panels, boards and cubicles showing cable connections to associated equipment.
e. Internal wiring diagrams of any individual specialized components.
f. Equipment and material lists.
g. Panel Fault Level calculations.

9.8 The Contractor should take note that approval of submitted drawings does not relieve the Contractor of any responsibility for errors in design or obvious errors in drawings supplied to him by the Engineer.

10. STANDARD OF WORK, EQUIPMENT & MATERIALS

10.1 All work, equipment and materials shall conform to the requirements of the latest edition and amendments of SANS 10142-1 Code of Practice for the Wiring of premises and all other specifications detailed herein.

10.2 All equipment and material used shall be of high quality and the work shall be of a high standard of workmanship, carried out by qualified staff under proper supervision by experienced and competent officers.

10.3 If special tools are required for installation and maintenance, one set per site shall be supplied by the manufacturer.

11. CONSTRUCTION OF SWITCHBOARD / DISTRIBUTION PANELS

11.1 **General**

11.1.1 Rated operating voltage: 230/400VAC, 50Hz -5% to +5% of nominal voltage

11.1.2 Control Voltage: 24V DC for ET200 I/O, and all field devices
24V AC for Specialised IT security equipment
230V AC MCC control voltage,
230V AC UPS supply to PLC, PC CPUs.

11.1.3 Type of MCC: Individual fixed cubicles, single sided MCC's with rear access.

11.1.4 Fault level minimum: Design 15kA for 1 second Main Busbars
Actual: Refer to specific requirement.

11.1.5 Manufacturer shall supply SABS test certificates validating the short circuit strength of the Factory Built Assembly according to SANS 60439-1.

11.1.6 MCC to be limited to a peak 400V AC load of 850 Amp unless otherwise specified.

11.1.7 Metal-enclosed Low Voltage (LV) Switchgear and Controlgear ASSEMBLIES shall be designed, manufactured, type-tested, and routine tested in accordance with this Specification, the switchgear schedule accompanying any enquiry document to detail TPL's requirements, and in accordance with the reference documents referred to in Section 3 of this specification.

11.1.8 MCC Construction:

All items shall be made with cold rolled steel.

Frames:	Minimum thickness:	**2.5mm**
Doors:	Minimum thickness:	**2.0mm**
Covers:	Minimum thickness:	**2.0mm**
Gland Plates	Minimum thickness:	**2.0mm**

11.1.9 All doors with cut-outs are to be from 2.0mm thick material, with stiffeners where required.

11.1.10 Unless otherwise specified, all equipment shall be painted and finished using a powder coating process in accordance with SANS 1274- 2014; Table 2 - type 2 (minimum thickness 35 micron).

11.1.11 In general, the following colour standards shall be used, but shall require to be confirmed with the Engineer prior to manufacture:

Non-essential switchboards	Light Orange (Colour B26) – SANS 1091
Essential switchboards	Signal Red (Colour A11) – SANS 1091
Uninterruptible Power UPS Mounting Plates Gland Plates	Purple White Zinc Passivated

11.1.12 LV Switchgear and Controlgear ASSEMBLIES shall be constructed as freestanding, factory built ASSEMBLIES comprising of several sections and subsections with withdrawable and/or fixed functional units.

11.1.13 Unless otherwise specified in the switchgear schedules, ASSEMBLIES shall consist of an enclosure, doors, partitions, main busbars, control busbars, phase and protective earth conductors, functional units and other equipment.

11.1.14 Measures shall be taken to prevent electrolytic corrosion where dissimilar metals are in contact with each other.

11.1.15 All boards, panels and cubicles provided shall be vermin and dust proof with the minimum degree of ingress protection to SANS 60529 being as follows:

i) Inside substation and motor control rooms: IP 42
ii) All other locations: IP 55.

11.1.16 Barriers with an internal degree of protection of at least IP2X shall be provided to prevent accidental contact with live conducting parts of the circuit and to protect the unit from falling objects.

11.1.17 Particular attention shall be given to the ventilation of panels, to eliminate build-up of excessive heat caused by the sun or internal heat generation. All necessary

precautions shall be taken to ensure that the temperature of the air in any portion of the assembly does not rise more than 15°C above ambient air temperature.

11.1.18 All boards shall be so designed to ensure easy access to all control units, wiring etc. Access shall be possible by means of hinged or removable panels, secured to the framework by captive type screws or latches.

11.1.19 For easy access, each cable compartment and each fixed pattern functional unit sub-section shall be provided with individual hinged doors.

11.1.20 All removable covers shall require the use of a tool for their removal. Opening of doors for all mcb groups shall be padlockable.

11.1.21 Doors shall have not less than the following points of hinging:
up to 450mm - 2 hinges,
up to 800mm - 3 hinges
more than 800mm - 4 hinges.

11.1.22 All doors shall be secured by 6mm square key latches as follows:
up to 450 mm - 2 latches,
up to 800 mm – 3 latches and
more than 800 mm – 4 latches
Any other proven design shall be submitted to TPL for approval.

11.1.23 Doors shall have stops to prevent over swing when opening and to avoid interference with adjacent compartments.

11.1.24 Doors of 800mm or longer shall be provided with webs or other methods to prevent wobbling when the door is operated.

11.1.25 Every door shall have a suitable gasket incorporated into the frame to ensure that the arrangement is in accordance with the required degree of protection. Sealing strips and gaskets shall be made of durable, non-hardening rubber, neoprene or other synthetic material, suitably fixed to the door or frame to ensure that the seal does not become dislodged during normal operation.

11.1.26 No circuit breaker toggles shall be permitted to project through the outside of the doors.

11.1.27 Traffolyte Identification labels shall be attached to the front of each door on the panel and will include the equipment Functional and Location Identification tag, descriptor and rating of the equipment located within.
Refer to Section 18 for details on Panel Label Specifications.

11.1.28 Due care shall be taken to ensure that the live side of the MAIN SWITCH is suitably protected so that no live conductors are exposed when the panel door is opened or

the panel cover is removed. Barriers between power terminals shall be robust with high impact strength and made of material that is self-extinguishing or resistant to flame propagation.

11.1.29 All hinges and door handles shall be of the bolted on variety, shall be manufactured from non-ferrous materials or stainless steel, suitably finished and treated against corrosion by an electro-plating process and shall ensure effective electrical bonding to the enclosure is maintained. All hinges are to be of the lift off variety

11.1.30 Where possible the lock and door catch shall comprise of a combination unit. Door latching and delatching operations shall be smooth and quick, whilst ensuring proper compression of the sealing gaskets. Repeated opening and closing of the hinged doors and operations of the door locks and catches shall not cause chipping or scratching of the painted surfaces or any other blemishes to the finished boards. At least the center square key latch shall be padlockable.

11.1.31 Bolts, nuts and washers used throughout the board shall be of stainless steel or brass zinc passivated plated, with the exception of busbar bolts, nuts and lock washers which shall be of stainless high tensile steel or phosphor bronze material. The method of fastening the latches and hinges shall be such that it will not wear loose due to vibration or rough handling of the door.

11.1.32 Lifting lugs shall be provided for equipment lifts heavier than 150 kg.

11.1.33 Removable gland plates shall be provided.

11.1.33.1 These gland plates shall be of adequate thickness or construction for the cables to be terminated without distortion of the gland plate, and shall not be less than 2mm mild steel (zinc passivated).

11.1.33.2 Gland Plates shall not be mounted less than 300mm above ground floor level, alternatively a base frame of suitable depth may be provided.

11.1.33.3 Metal gland plates shall be bonded to the PE conductor by means of a bonding conductor whose cross-section is selected in accordance with SANS 60439-1 Table 3A.

11.1.33.4 The design of the gland plates shall ensure an internal protection of at least IP2X before and after installation of the incoming/outgoing cables

11.2 **CABLE ENTRY/CABLES**

11.2.1 Panels shall be generally of the wall or floor standing cubicle type, suitable for cable entry from the bottom for both power and control cables. Cables shall to be glanded in the rear of the panels in cable compartments (on an individual MCC tier basis) provided. Panels shall be mounted on plinths of height minimum 100mm, sized to accommodate cable bend radius.

11.2.2 Panels shall incorporate rear cable compartments per MCC tier with the exception of the main Incomer tiers.

11.2.3 Cabling running in the rear cable compartments shall be supported at regular intervals. Spacing of these cable supports shall not be larger than the height of the smallest MCC tier.

11.2.4 Conductors passing through holes in compartments shall be protected by means of robust neoprene grommets. Bevelling of steel sheet as a substitute is not acceptable.

11.2.5 Conductors carrying currents in excess of 100 A and passing through metal shall either be all three phases (both poles of DC conductors) or the metal barrier shall be split.

11.2.6 Power circuit cable sizing shall be based on SANS 1973-1 Annex H.

11.2.7 Stripping of insulation shall not result in damage to the conductors, shall result in 90 degrees clean cut and insulation is not damaged.

11.2.8 Power and control terminals are to be mounted in the rear of the panel in vertical orientation.

11.2.9 Correct torque shall be applied when any bolt or screw is tightened.

11.3 **INCOMER PANEL**

11.3.1 The MCC Incomer panel shall be used to house fixed pattern Air Circuit breakers.

11.3.2 Main Incomer cables shall be made off directly onto stub busbars connected to the bottom of the incomer breaker by means of compression lugs.

11.3.3 Panel Incomer front doors shall be earthed and with a minimum of three un-insulated copper braid straps, of not less than 6mm² cross sectional area. The length of these straps shall be kept as short as possible. (<100mm max.). These earth straps shall be connected to the chassis / door with welded studs and without paint between the connection surfaces. (Normally the paint will have to be scraped away).

11.3.4 In an event that more than one core per phase of single or multi-core core cables is terminated in an incomer or feeder compartment, equalising busbars shall be provided to facilitate the connection. The equalising bars shall be adequately rated and braced to withstand the thermal and dynamic stresses under normal, short circuit and internal arc operating conditions and shall have been type tested as part of the assembly for all operating conditions.

11.3.5 Power terminals shall be separated from the control terminals by means of a barrier and shall be fully shrouded to prevent accidental contact.

11.3.6 Access to busbars shall be prevented by sheet steel covers.

11.3.7 Surge Protection Devices shall comply with the requirements of SANS 61643-1 and their selection, connection and application shall be in accordance with SANS 61643-12.

11.3.8 The wiring to the (ZORC) surge protective device shall be kept as short as possible <300mm. The wiring cross section shall be the maximum compatible with the size of the terminal studs and terminal box on the device. A cross section of less than 70mm^2 (earth cabling included) is not acceptable. Earth cabling shall be terminated directly to the Electrical Earth Bar running the entire length of the LV Panel.

11.4 **PANEL COMPARTMENTS**

11.4.1 Panel Compartments shall comprise of Chassis (Bucket Type) with cable connections directly onto vertical dropper busbars. The chassis (Bucket type) shall be interchangeable with other units of the same external dimensions. All cabling used shall be approved before use. All cable connections to the busbar droppers are to be suitably braced.

11.4.2 Control and PLC Interface wiring shall be routed between the front chassis (cubicles) and the rear cable compartment via slots cut in each cubicle backplane. All Control and PLC Interface wiring shall be run in suitably sized PVC Trunking in both the rear Cable compartment and individual Cubicles. Grommets shall be used to protect cabling running through panel cut outs/slots.

11.4.3 All LV Starter cubicles shall have an external operating handle interlocked with the cubicle door in order that the handle can be padlocked in the Off Position. A door lock defeat release shall be provided in order that authorised personnel may bypass the interlock when the operating handle is in the On position, for testing purposes.

11.4.4 All Panel compartment doors shall be earthed with a minimum of two un-insulated copper braid straps, of not less than 6mm^2 cross sectional area. The length of these straps shall be kept to be as short as possible. (<100mm max.). These earth straps shall be connected to the chassis / door with welded studs and without paint between the connection surfaces. (Normally the paint will have to be scraped away)

11.4.5 All Spare Compartments shall be arranged as indicated on approved Panel Layout diagrams, but will not need to be equipped. All accessories for the addition of a Starter unit including hinged doors, vertical busbars shall be provided. Dropper power cut outs shall be covered with steel plates.

11.4.6 Where wiring greater than 10mm^2 is required to be suitably braced, flexible cable (welding type) shall be used.

11.4.7 Where instruments such as ammeters, voltmeters etc. are required, these shall be mounted flush according to instrument type either on a hinged door section or separate compartment to that of the control circuitry (MCB's, fuses etc.)

11.4.8 All instrument wiring shall be contained in a flexible flame retardant sleeving where hinged sections are utilised, and shall be securely clamped to the hinged door and panel to avoid straining the connections on the instruments. All other wiring shall be loomed neatly in suitably sized PVC cable trunking.

11.4.9 Where holes are required in the chassis plates for access to the terminals in the rear, these shall be of adequate size to accommodate the wiring size and quantity for the application. Provision shall be made for additional capacity of 25 %. All panel cut-outs/slots shall be protected by means of suitably sized grommets, to ensure wiring insulation is protected from damage.

11.4.10 Components shall be arranged and mounted in the ASSEMBLY in such a way that maintenance work can be performed in a safe and orderly manner.

11.4.11 Switchgear and control-gear when mounted shall not cause injury during switching.

11.5 **INTERNAL ARC CONFINEMENT**

11.5.1 ASSEMBLIES shall be designed to confine internal arcing faults and to direct arcs and gases arising from these away from the possible operator interface points (i.e. back and front).

11.5.2 Provision shall be made to limit pressure build up and/or re-direct gases resulting from an internal arc fault in any section or sub-section.

11.5.3 Each section of the ASSEMBLY shall be equipped with a pressure activated relief flap that shall direct ionised materials and gases away from the operator interface points.

11.5.4 The two main function of internal arc confinement are to protect the operator in front and also prevent the arc from spreading to any other compartment that might also be energized.

11.6 **BUSBARS**

11.6.1 All boards shall be equipped with a set of 3 x phase, neutral and earth busbars running the entire length of the board within a designated busbar chamber located at the top of the cabinet and continuously rated for the full load of the incoming supply switch. Busbars, risers and droppers shall be air-insulated and shall be fabricated from high-conductivity copper. Aluminium busbars will not be permitted.

11.6.2 Busbars shall be rated for a normal current equal to the incoming circuit rating, designed in accordance with the requirements of SANS 1195/BS 159 and shall comprise

of a standard modular system, tested to SABS standards. Busbars shall be suitably enclosed in a busbar chamber to protect against inadvertent contact with access panels removed.

11.6.3 Busbar Chambers shall be divided into two sections, namely a rear compartment running the full length of the board and used to house both Mains Supply and Emergency Supply busbars, and a front compartment used to house Control Voltage supplies to the respective MCC Tiers. Busbar and Control Voltage chambers shall be suitably enclosed using sheet steel covers/boxing to protect against inadvertent contact. Access to the Busbar Chamber from within the Control Voltage Chambers will be prevented by the use of either sheet steel or transparent PVC covers.

11.6.4 All interconnections between busbars and control units shall be by means of fully insulated, adequately rated conductors firmly bolted to the busbar and secured to the appropriate terminals of the control units using crimped-on terminal lugs. Solid flat conductors shall be used for ratings in excess of 200 Amps.

11.6.5 Termination Points shall be easily accessible, conveniently located near the incoming and outgoing cable entries and with sufficient clearance and space to enable the incoming and outgoing cables to be connected to their corresponding terminals without difficulty or strain.

11.6.6 Terminals of all incoming and outgoing cables shall be firmly connected to terminals provided by means of crimped on terminal lugs or ferrules, unless the terminals are designed to grip the cable without causing the slaying of the conductor strands

11.6.7 The busbar current density shall not exceed 1,3 A/mm^2. Where relaxation of SANS 1973 has been given to permit the drilling of holes, the cross sectional area of the busbars shall be reduced by the area of the holes in determining compliance.

11.6.8 Busbars and supports shall be constructed to withstand the forces to be encountered on occurrence of fault currents up to the full fault levels specified without reference to the type or speed of operation of the protective devices used. Porcelain or glass supports are not permissible.

11.6.9 Joints and Tee-off connections in busbars shall be made by means of high tensile bolts, nuts and approved locking washers. A minimum of two such bolts shall be used per joint or tee. The joint contact areas shall be smooth, very flat and polished or silver plated for dry pointing. The joints shall not be taped in order to facilitate visual inspection and checking of bolt tensions.

11.6.10 Busbars shall be provided with phase colour markers, red, white, blue. Such colour identification may take the form of coloured bands at intervals along the busbar run of not more than 800 mm. The combined width of the colour bands per phase shall not be less than 300mm per 800mm-busbar lengths.

11.6.11 All covers, whether hinged or bolted, giving access to busbars and incoming circuits shall have the international dangerous voltage symbols placed thereon. In the event of the cover being reversible, symbols shall be placed on both sides of the plates.

11.6.12 Busbars and droppers shall be torqued after installation on site.

11.7 **NEUTRAL BARS**

11.7.1 The neutral bar shall be sized and rated in accordance with the provisions contained within SANS 10142-1. In a multiphase circuit the neutral conductor shall be rated to carry the maximum predictable out-of-balance current under normal operating conditions, with a minimum of 50% cross sectional area of the main busbars. The neutral bar shall be mounted on insulators and connected to the earth bar via means of an adequately rated copper connection. The bar shall be marked black at regular intervals so that identification in each panel section is possible.

11.7.2 A minimum of 6 holes per section is to be provided. High tensile phosphor bronze or passivated plated nuts, bolts and lock washers shall be provided through the earth bar at each earthing position, with at least 25% additional holes being provided for future connections, all fitted with nuts and bolts.

11.8 **EARTH BARS / EARTHING**

11.8.1 Earthing and bonding conductors shall be sized and installed in compliance with regulations detailed in the current SANS 10142 Standard Regulations for the Wiring of Premises and in SANS 10313 as applicable. Conductors shall comprise of multi stranded, PVC insulated cable, of gauge not less than 6mm2, cross sectional area.

11.8.2 All cabinet/cubicle doors shall be earthed to the panel earth using a braided copper conductor of not less than 6mm², cross-sectional area.

11.8.3 Each cabinet shall make provision for a suitable 'electrical earth' to be installed within the busbar chamber and comprising of a solid 50 x 5mm min copper bar running the entire length of the cabinet. The bar shall be bolted to the base framework with a minimum clearance of 40mm from the other busbars.

11.8.4 The following equipment shall be earthed directly to the electrical earth bar, via adequately sized PVC insulated copper cabling (green/yellow):

a. Electrical equipment housings/backplanes. (Where earth terminals have been provided, the earth wiring cross section shall be the maximum compatible with the size of the terminals provided. Where earth studs have been provided, the earth wiring cross section shall be in compliance with manufacturer's recommendations. Where not specified, earth cable cross sectional areas shall not be less than 6mm²).

b. Cable overall screens.

c. Electrical Power cable earth cores.
d. Cabinet chassis.
e. Transorbs. (Earth cable cross-sectional area 70-mm² min).

11.8.5 Where required, cabinets shall make provision for a suitable "instrument earth" to be installed at the bottom of the respective cabinet tier and comprising of a solid copper bar (50mm x 5mm). The bar shall be supported on robust insulated spacers, with a minimum clearance of 40mm to the sheet steel panel, and clearly labelled. The instrument or clean earth shall be insulated from the panel at all times.

11.8.6 The following equipment shall be earthed directly to the instrument earth bar, via adequately sized PVC insulated copper cabling (blue):
a. 24 V DC Power supply common rail.
b. Barrier/Isolator earth (Earth cable cross sectional area 70 mm2 min).
c. Cable individual screens

11.8.7 Earth bar specifications shall comply with the following:
a. Size: 50mm x 5mm x full length of MCC.
b. Marking: Yellow/Green (Electrical) and Blue (Instrument) at regular intervals, so that identification from each panel section is possible.

11.8.8 A minimum of 6 holes per section is to be provided. High tensile phosphor bronze or passivated plated nuts, bolts and lock washers shall be provided through the earth bar at each earthing position, with at least 25% additional holes being provided for future connections, all fitted with nuts and bolts.

11.8.9 Sufficient number of holes to be provided on bus sections for all outgoing circuits & 20% spare for double cables.

11.8.10 All panel cubicles to be bonded to each other and to the Main earth bar.

11.8.11 All metal housings must be earthed.

11.9 CONDUCTORS INSTALLED IN THE "FAULT-FREE" ZONE

11.9.1 Cable installed between the main or distribution busbars and the functional units are deemed to be unprotected "active" conductors and shall be installed and braced in such a manner that a short-circuit is unlikely to occur. The smallest conductor that may be installed in the 'fault-free-zone' is 16 mm² for Assemblies >10kA and 10mm² for Assemblies ≤10kA a detailed in SANS 1973-1 and SANS 1973-3 respectively.

11.9.2 Conductors installed in the 'fault-free-zone' shall be braced at intervals not exceeding 300 mm.

11.9.3 Conductors installed within a fault-free zone, where they could come in contact with conducting parts, shall be protected by supplementary insulation (double insulated).

12. CONTROL TRANSFORMERS / CONTROL VOLTAGE DISTRIBUTION

12.1 Provision shall be made in the LV Panel design for the supply and installation of dual 400/230V 1Ph:1Ph Constant Voltage Transformers of suitable rating in a bypass configuration. Dual 400/230V 3Ph:1Ph CVT's may be provided where load balancing across phases is deemed a requirement.
CVT's shall be installed externally to the LV Panel and shall be fed from the Emergency Busbar / Standby Alternator Supply where available.

12.2 Where MV Starter Control & Tripping Voltage distribution is fed off of Normal/ESKOM Supply in the LV Panel, provision shall be made in the LV Panel design for the supply and installation of 400/230V 1Ph:1Ph Constant Voltage Transformers of suitable rating in a bypass configuration. CVT's shall be installed in the MV Starter Control Voltage Feeder Cubicle within the LV Panel.

12.3 Individual 230V~ Control Voltage distribution (other than Auxiliary Motor Starters) shall be fed from suitably rated double pole MCB's located in the Control Voltage Distribution Cubicle.

12.4 Motor Starter Control Voltage Distribution shall be fed from the Control Voltage Incomer directly to the respective Starter cubicles, via knife-edge disconnect terminals (both Live and Neutral) located in the Control Voltage Busbar compartment at the top of the respective MCC tiers. The control voltage disconnect terminals are to be installed in the starter panel sections only.

12.5 Provision shall be made in the LV Panel design to incorporate a 230V/230VAC UPS of adequate rating in a by-pass configuration (unless specifically stated otherwise in Contract Documentation). This UPS feed shall be used to power all Control System Equipment located in associated MV panels, LV panels and PLC Equipment Panels.

13. TERMINAL / WIRING SPECIFICATIONS

13.1 Terminals used for control and power (where required) marshalling shall be of the Klippon Type RSF1 or equivalent and shall be sized for the cross section of the incoming cable but not less than 4mm^2. Where power cabling exceeds 10mm2 (and hence RSF1 terminals cannot be used), Klippon SAKD or equivalent terminals may be utilised.
Terminals used for PLC I/O marshalling shall be of the Klippon Type RSF1 or equivalent and shall be sized for the cross section of the incoming cable but not less than 2.5mm^2.

13.2 Terminal end plates shall be provided on the first and last terminal of a terminal strip.

13.3 End stops shall be provided on the first and last terminal of a terminal strip.

13.4 Terminal barriers shall be fitted between terminals with different voltage levels.

13.5 All termination arrangement not in accordance with IP2X shall be provided with separate covers to act as shroud so that accidental contact is impossible when making off adjacent cables.

13.6 A maximum of 1 wire per termination side will be accepted (Except for I/O panels).

13.7 Wires terminated into terminals shall be properly lugged with the correct size lug used for the specific application - bootlace ferrules shall be used for pressure type terminals, with ring and spade lugs used for post type terminals.

13.8 Terminal arrangement and numbering shall be arranged in accordance with approved termination schedules. Terminals shall be numbered on both sides.

13.9 Terminal Rails shall be mounted with bolts or screws with tapped holes.

13.10 Spacing requirements between terminals and PVC Trunking shall be sized to accommodate core idents, with a minimum of 50mm allocated.

13.11 Internal Panel Wiring specifications:

All control wiring to be 600V Insulation.	
Control wiring:	230V AC ≥ 1.5 mm² min multistrand at 600V max.
Direct ET200 I/O	
PLC I/O wiring – from terminals:	0.5-0.75mm² fine multistrand wires at 300V max.
PLC Power Distribution wiring:	230 AC ≥ 1.5 mm² multistrand at 600V max.
	24 DC ≥1.0 mm² multistrands at 300V max.

13.12 All control wiring to be colour coded as follows:

230V AC Supply	
Live	Brown
Neutral	Black
Earth	Green/Yellow

230V Switchgear Control Circuits	
Live	Brown
Neutral	Black
Control Circuit	Grey

Earth	Green/Yellow

24V AC/DC Distribution:	Red and the symbol "+" or 24V AC
	Black and the symbol "-" or 24V AC

PLC and ET200 I/O Distribution:	
Digital Inputs/Outputs	-Grey
Analogue Inputs/ Outputs	-Violet (+)
	-White (-)
Power Earth / Panel Earth	Green / Yellow

13.13 Conductors of CT and VT circuits shall bear the phase colours. The neutral conductor shall be coloured BLACK.

13.14 Where pre-manufactured plug arrangements are supplied, the manufacturers standard colour may be used.

13.15 Cable Identification Standards: Refer to Transnet Pipelines Specification PL727 Section 8.5.

13.16 Core Ident Standards: Refer to Transnet Pipelines Specification PL727 Section 8.6.

13.17 All AC Input Wiring to D.C. Power Supplies and Transducers shall be twisted.

14. WIRING STANDARDS

14.1 **Power Circuits**

14.1.1 Connections between all switchgear components and busbars shall comprise of modular PVC insulated laminated high conductivity copper bars or where current and fault ratings allow, heavy duty coloured PVC insulated stranded, annealed copper conductors, complete with crimped bolted lugs.

14.1.2 Colours to be used in all instances shall be red, white and blue for phase connections, black for neutral connections and yellow/green for earth connections.

14.1.3 Conductors for power conductors shall bear the face colour along the entire length of the phase to which they are connected or may be used in a common colour provided they are phase colour coded at each end of the conductor and at every connection point.

14.1.4 All cabling and connections will be sized and rated in accordance with the relevant SANS Specifications, and as a minimum will suit the maximum full load current of the

circuit breaker/fuses protecting the circuit. Minimum size of stranded conductors will be 2.5mm².

14.1.5 Unless stipulated elsewhere in Contract Documentation, all field Power cabling, inclusive of phase, neutral and earth connections, shall be terminated directly into adequately rated terminals provided in the rear of the panel cubicles/tiers and from there to the relevant ACB's, MCB's, Fuse Holders, busbars etc. Where cables exceed 70mm², connections shall be made directly onto the relevant ACB, MCB or Fuse Holder. Rating of terminals used shall exceed full load ratings by 50 % minimum.

14.2 **Control Circuits**

14.2.1 Wiring shall be comprise of multistrand, single-core PVC-insulated copper conductors, 660/1000 V grade (minimum), to SANS 1507, sized and derated where required for the currents to be carried. Single-strand conductors shall not be permitted and no conductor shall be less than 1,5mm² cross-sectional area, nor be of less than 7 strands in lay.

14.2.2 All conductors shall be identified by means of a core identification number, in conformity with the approved circuit and connection diagrams. No core ident number shall be used more than once in each panel except where electrically identical. Wires/conductors shall have the same number on either end of the wire and all wires, which are electrically identical, shall have the same wire number.

14.2.3 All circuit diagrams shall clearly identify all wire numbers on all termination/connection points.

14.2.4 Transnet Pipelines have standardised on Crutchley core ident numbering markers for electrical control wiring core identification. Core Idents shall be correctly sized to ensure a snug fit on the conductor.

14.2.5 For details of Transnet Pipelines Core Ident Numbering Standards refer to Transnet Pipelines Specification PL727 Rev 6 Section 8.6.

14.2.6 Common Terminal strips of suitable rating shall be provided at all cable and wiring entry points between Switchgear Cubicles, both front and rear, to accommodate all PVC wiring having a cross-sectional area of up to 70 mm². Allowance shall be made on these terminal strips to accommodate 25 % spare capacity minimum. Where cables exceed 70mm², connections shall be made directly onto the relevant ACB, MCB or Fuse Holder.

14.2.7 Where terminal strips are associated with the same circuit (e.g. wiring running between the front and rear of a cubicle shall be terminated into terminal rails provided), these terminal strips shall be identical in layout and terminal allocation, for ease of maintenance.

14.2.8 Rating of terminals used shall exceed full load ratings of the protection circuit by 50 % minimum. Terminals used shall incorporate spring-loaded clamping arrangements. Transnet Pipelines have standardised on "KLIPPON" type RSF 1 or equivalents.

14.2.9 Wiring for voltmeters shall be arranged in such a way that the ASSEMBLY's Fault-Free Zone integrity will not be impaired, as detailed in section 11.9 of this specification.

14.3 **Cable Glanding**

14.3.1 Unless stated otherwise, all cabling, inclusive of power, control, data and instrument shall be bottom entry. Cable entry shall be via pre-punched gland plates, and shall be glanded within the cabinet to which the associated cable is terminated. Glanding of cables in cabinets different to that in which the cable is terminated shall not be permitted. Spare cable entries shall be plugged using appropriately sized blanking plugs. The use of "push-out" blanking inserts to plug cable entries shall not be permitted.

14.3.2 Cable identification (panels within buildings) shall be as follows:

a) Where Cable Tags are fixed to the cable within Electrical Panels:
Grafoplast Trasp Series 130 Gull-wing transparent PVC sleeves (30mm in length), with printed text black on white background, fastened onto the cable via means of Stainless Steel cable ties. Text height to be 3mm minimum.

b) Where Cable Tags are fixed to the cable outside of Electrical Panels:
Grafoplast Targa Metal TGT System (Carrier Rail length: 58mm for 7 characters, 82mm for 11 characters, 106mm for 15 characters) 316 Stainless Steel Markers, with punched text 6 mm height minimum, fastened onto the cable via means of Stainless Steel cable ties.

14.4 **Screening and EMC Measures**

14.4.1 Connecting of Screen Cables:
Electrical and Instrument Overall Cable Screen wires shall be attached to electrical earth/screen bar at point of entry into panel.

14.4.2 All Screen cables shall be routed to the point of connection and may only be stripped back to enable practical connection of the cores. The cable ends with exposed screen braid shall be covered with a suitably sized insulation sleeving to prevent inadvertent contact. Cable ends shall be protected against ingress of moisture using heat shrink sleeving.

14.4.3 Instrument cable pairs shall remain twisted up to the point of connection.

14.4.4 Screen cable and panel wiring routing:

All cabling and panel wiring shall be routed in PVC trunking mounted against a back plate. Unsupported wire connections of more than 50 mm apart shall not be permitted.

14.5 **Trunking**

14.5.1 Sizing of PVC Trunking and related conductors shall comply with SABS 0142 of 1981 code of Practice Reg. 5.4.1 (f). In addition to the above requirements an additional 25% Spare capacity shall be allowed. The manufacturer shall ensure that all trunking is adequately sized.

14.5.2 Allowance shall be made during LV Cabinet Layout design to ensure that a minimum distance of 50mm is maintained between terminals and PVC Trunking, in order to ensure that conductor core idents are visible at all times.
The manufacturer shall also ensure that a space of not less than 50mm shall be maintained between trunking and any component or object.

14.5.3 Transnet Pipelines has standardised on PVC slotted trunking for use in cable and wiring marshalling
(Non IS circuits – grey in colour, IS circuits – blue in colour).

14.6 **Valve Panel Wiring**

14.6.1 Valve cables shall be glanded in the rear of the Valve Panels in gland plates located at the bottom of the panels above the plinth. Cabling shall be marshaled neatly within slotted trunking provided running up the sides of the panel tiers, the full length of the cabinet. Individual cable cores shall be terminated directly into MCB's provided. Inner PVC sheaths shall be removed before the cable enters the PVC trunking.

14.6.2 Wire ways located within the trunking will permit power cabling to pass from the front of the cabinet to the rear and shall be protected from damage via robust neoprene grommets. Bevelling of steel sheet as a substitute is not acceptable.

14.6.3 A minimum of 500mm excess length of cable shall be provided before the cable is glanded, for future re-termination of the cabling.

14.6.4 PVC Trunking shall be sized to handle 25% spare capacity.

14.6.5 For maintenance purposes, padlocking facilities shall be installed for all switch disconnection devices and provided both on the outside and the inside of the section or sub-section to lock the switch-disconnecting device in the isolated position.

14.7 **LV Distribution/Starter Panel Wiring**

14.7.1 Power and control cabling shall be glanded in the rear of the LV Panels in gland plates located at the bottom of the panels above the plinth. Cabling shall be marshaled neatly within slotted trunking provided running up the sides of the panel tiers, the full length of the cabinet. At the point of termination, the individual cable cores shall be terminated into vertically orientated terminals provided. Inner PVC sheaths shall be removed before the cable enters the PVC trunking.

14.7.2 Note that the cables shall be glanded in such a manner so as to ensure that cables do not cross from the point of glanding to the point of termination. A minimum of 500mm excess length of cable shall be provided before the cable is glanded, for future re-termination of the cabling.

14.7.3 Wire ways will permit control and power wiring to pass from the front of the cabinet to the rear - and shall be protected from damage via robust neoprene grommets. Bevelling of steel sheet as a substitute is not acceptable.

14.8 **ET 200 I/O Panel Wiring**

14.8.1 I/O INTERFACE SIGNALS – CONTROL SYSTEM

The following hard wired I/O signals are to be provided for interface with the PLC Control System:

LV PANEL GENERAL:

(Status: F31 breaker open, no voltage; UPS online, no fault; PLC PSU no alarm)

a. F31 Breaker Closed status CL = 0
b. Loss of supply voltage UV = 0
c. UPS Status - Fault FLT = 0
d. UPS Status - Bypass BYP = 1
e. PLC PSU Status FA = 1

14.8.2 Discrete and analogue signals are to be clearly separated and identified in the Cabinets. Termination rails shall be divided into units on the basis of ET I/O Card Rack and Slot position.

14.8.3 Each conductor/core of a cable shall be fitted with an insulated double crimp lug of the correct size. LeGrand bootlace ferrules shall be used for pressure type terminals, with ring and spade lugs used for post type terminals.

14.8.4 Proprietary type wire strippers and crimping tools must always be used.

14.8.5 Each conductor shall be identified by a Core Identification number, which shall include the number of the terminal into which the core is to be terminated.
For details of Transnet Pipelines Core Ident Numbering Standards refer to Transnet Pipelines Specification PL727 Section 8.6.

14.8.6 All terminals shall be numbered on both sides and consecutively in accordance with design documentation. All terminal rails shall be identified by means of a terminal rail label situated at the top of the termination rail. End stops and end plates shall be used to prevent inadvertent contact with conducting surfaces.

14.8.7 All spare cores shall be terminated and identified as "spare".

14.8.8 Surge Protection:
Transnet Pipelines Pump Stations are situated in areas of high risk in terms of lightning strikes and thus adequate Surge Protection shall be required to be provided by the Contractor. Contractors are to note that responsibility for the provision of adequate surge protection lies with the Contractor and that Transnet Pipelines will not regard damage to equipment resulting from a lightning strike or power surge as unavoidable, except in instances of a "direct strike".

15. EQUIPMENT SPECIFICATIONS

Cognisance shall be taken of manufacturers derating tables for equipment located within enclosures and equipment shall be rated accordingly.

15.1 Fuse Switches

15.1.1 Fuse Switches shall be utilised only under circumstances where single phasing may be tolerated. Where single phasing may not be tolerated, only VCB's and MCB's may be utilised.

15.1.2 Combination fuse switches shall comply with SANS 60947-3 and shall be of the individually metal enclosed, triple pole, quick break, dustproof, and withdrawable type, with neutral link. Fuse switches shall afford minimum protection of IP21 or IEC 61032. Combination fuse switches shall be rated for uninterrupted duty and shall be of utilization category AC-23 as detailed in SANS 60947-3.

15.1.3 Fuse Switches shall have a lever or rotary action with a positive spring controlled opening and closing action for making or breaking the circuit under load conditions. Fuse carrier and base contacts shall be designed to give permanent high contact pressure and shall be designed to facilitate location of blown fuses without removal of the carrier. Fuse carriers and bases shall be of the highest grade phenolic mouldings to BS 771 and shall be non-flammable and non-hygroscopic, with a hard gloss black finish.

15.1.4 Three spare fuses of each rating shall be provided and fixed into a suitable cubicle on the switchboard. The door of this cubicle shall be suitably identified.

15.1.5 Switches shall be interlocked to prevent the opening of the front covers unless the switches are in the "Off" position and the closing of the switches with the covers open.

The switches shall be lockable in the "Off" position. (For details on the Switch Mechanisms, refer to Section 10.3. of this specification).

15.1.6 Switches shall comply with the following provisions:

- Double break contact on each pole
- Arc barriers on each pole
- Silver plated copper contacts
- Neutral link where required
- Mechanically operated ON/OFF indicator
- Auxiliary switch facility
- Full interchange ability of equivalent rated units

15.2 **HRC Fuse Links**

15.2.1 HRC Fuse Links shall be of the high rupturing capacity type, compliant with SANS 60947-3. Fuse links shall incorporate a visual indication device to facilitate location of blown fuses and shall be designed to clip into the fuse carrier contacts without the use of fixing screws.

15.2.2 Breaking capacity of all fuse links shall be not less than Category of duty AC.50 at 415 Volts (SANS 60947-3). The Fusing factor of the fuses shall not exceed 1.5 (SANS 60947-3 Class Q1).

15.2.3 Fuse current ratings shall be indicated on engraved 20 x 12mm white-black-white trifoliate labels in 4mm letters. The labels are to be fitted at the fuse bases and shall not be obscured by wiring.

15.2.4 Fifty- percent spare fuses of each size shall be provided in suitable cubicle on the switchboard. The door of this cubicle shall be suitably identified.

15.3 **Air Circuit Breakers**

15.3.1 Air Circuit Breakers shall be used on the incoming supply side of the distribution board and shall comply with SANS 60947-2. Transnet Pipelines have standardised on withdrawable type Circuit Breakers for all Panels rated >= 400 A, and moulded case Circuit Breakers for Panels rated < 400 Amps.

15.3.2 Circuit Breakers shall have a continuous enclosed current rating as indicated on the relevant drawings, with a minimum fault capacity of 50 kA at 415 Volts for I sec, tested for category p.2, unless otherwise specified. All switchgear supplied shall be rated for Type 2 Co-ordination (SANS/IEC 60947-4-1) i.e. capable of renewed operation after testing at rated conditional short-circuit current.

15.3.3 Air Circuit Breakers shall be of the enclosed, ventilated, independent manual spring, draw out or permanently mounted type rated for 660 Volts and shall be suitably equipped for shunt tripping from a DC Battery supply (either 50 VDC or 110 VDC).

15.3.4 Shunt tripping facilities shall be provided; such that will cause the associated high voltage transformer circuit breaker to trip when the associated air circuit breaker is tripped (to protect against fault conditions) unless otherwise specified.

15.3.5 Adjustable inverse definite minimum time (IDMT) overcurrent release facilities are required in addition to the instantaneous fault trip for the air circuit breakers.

15.3.6 Mechanical interlocks shall be provided to prevent draw out type circuit breakers from being racked in or out when closed.

15.3.7 All circuit breakers shall be provided with mechanical position indicators for both the on and off positions.

15.4 **Moulded Case Circuit Breakers.**

15.4.1 Moulded Case Circuit Breakers (MCCB's) shall be of the fixed pattern, multi-pole, free handle, air-break, non adjustable type, housed in a moulded phenolic or glass polyester case and suitable for panel mounting, and shall comply with SANS 60947-2.

15.4.2 Circuit Breaker contacts shall be made of silver alloy, with arc chutes and blowouts provided.

15.4.3 Incoming terminals of miniature circuit breakers shall be suitable for connection to a common busbar. No looped wiring shall be permitted. Miniature Circuit Breakers shall be utilised for general-purpose applications, controlling of mixed circuits of lighting, heating and actuator motors. Ganged toggles shall not be permitted to be utilised.

15.4.4 Switch operating mechanisms shall be provided for CFS's, moulded case circuit breakers (on Panel Incomers only) and motor protection circuit breakers and shall comply with the following:

- Switch operating mechanisms shall be door mounted and the switches fixed mounted.
- Switch operating mechanisms shall positively engage with the switch shaft with the door fully closed and shall be interlocked with the door so that:

i) It shall not be possible to gain access via a cover or door to any live points unless the switch is in the open position.

ii) It shall not be possible to re-close the door or cover unless the switch is in the open position. Operation of the switch with the door open is permissible.

iii) Clear indication shall be given, both with the access cover/door open/closed, as to whether the switch is in the open or closed position. This indication shall be

via internationally accepted symbols i.e. I (ON) and O (OFF). Colour indication alone will not be acceptable.

iv) Operating handles shall be pad lockable in the "off' position. The mechanisms shall accept not less than two padlocks each having a shackle diameter of 6mm.

15.4.5 Circuit Breakers shall have a continuous current rating, trip rating and rupturing capacity as defined on approved engineering drawings. Operating characteristics (curves) shall be selected to suit the particular application. All breakers shall have a minimum breaking capacity of Class SABS 5 kA. All switchgear supplied shall be rated for Type 2 Co-ordination (SANS/IEC 60947-4-1) i.e. capable of renewed operation after testing at rated conditional short-circuit current.

15.4.6 The full load current rating of the current limiting circuit breakers shall not exceed 100A where current limiting circuit breakers are used to protect 5 kA circuit breakers to SANS 60947-2.

15.5 **Miniature circuit breakers**

15.5.1 Miniature circuit breakers (mcb's) shall comply with the requirements of SANS 556-1 and SANS 60947-2.

15.5.2 Provision shall be made for mcb's applied on multiple or single phase distribution sections or sub-sections to be operated from the front of the ASSEMBLY and this shall only be possible after opening the front door.

15.5.3 With regards to lockable isolating devices, a mechanical hinged pad lockable device shall be installed to disable operation of each of the mcb's individually.

15.5.4 Mcb's shall be of the non-adjustable type.

15.5.5 Where cascading is required, the mcb's shall be certified by the OEM that the mcb's will be protected by the upstream switching device using proven cascading methods.

15.6 **Residual current circuit breakers**

15.6.1 Residual current (earth leakage) circuit-breakers shall comply with SANS 767-1 and SANS 60947-2.

15.7 **Contactors**

15.7.1 Contactors shall be that of triple-pole electro-mechanically operated air-break type, with a held in pattern unless otherwise specified. Contractors shall comply with the requirements of SANS 60947-4-1 and shall withstand the thermal and dynamic effects arising from the magnitude and duration of through fault currents as dictated by the characteristics of the associated protective devices.

15.7.2 Contractors shall be classified as utilisation category AC3 uninterrupted duty for motor starting and as utilisation category AC1 intermittent duty, Class 1, 60% for heater duty. All switchgear supplied shall be rated for Type 2 Co-ordination (SANS/IEC 60947-4-1) i.e. capable of renewed operation after testing at rated conditional short-circuit current.

15.7.3 Contactors shall be fitted with the required auxiliary contacts as indicated on the circuit diagrams. These shall be rated at not less than 10 A and shall be positively driven in both directions.

15.8 **Anti Condensation Heaters**

15.8.1 Anti Condensation Heaters shall be provided when called for in the project specification. A suitably rated circuit breaker shall be provided to control the heaters and protect the circuit.

15.8.2 Anti Condensation Heaters shall be powered from 230V AC. Wiring from the heater elements to terminals shall be of the high temperature, insulation covered variety.

15.9 **Motor Starters**

15.9.1 Motor starters shall comply with SANS 60947-4-1.

15.9.2 Motors starters supplying Ex "d' motors shall comply with SANS 60079-14, clause 11.2.

15.9.3 LV motors (typically operating at 400V) shall be controlled using Transnet Pipelines approved Type 2 coordinated motor starter combinations.

15.9.4 LV motor protective devices shall as a minimum cater for the following:

a. Rated short circuit protection
b. Thermal overload with single phasing protection (motors rated up to 55kW only).
c. Electronic motor protection (motors rated 75kW and above only).

15.9.5 Typical Transnet Pipelines LV motor starting philosophy is as follows:

a. LV motors ≤ 15kW DOL starting
b. LV motors > 15kW –VSD's / Soft Starter

16. INSTRUMENT SPECIFICATIONS

All instruments shall be of a matching, flush pattern of dial dimensions 96mm x 96mm, with calibrated scale lengths of 70 mm minimum.

16.1 **Ammeters**

16.1.1 Combined maximum demand ammeters shall be used on major circuits only, all others being instantaneous current ammeters to suit load conditions.

16.1.2 Combined maximum demand type ammeters shall be of the moving iron type, showing instantaneous current, combined with an ambient corrected, manually reset, thermal maximum indicating ammeter, indicating the mean current reached during any 15 minute period. All three indications shall be given on concentric scales. Window cut-out scales are not acceptable. All maximum demand meters shall be fitted with a current transformer of 1 Amp secondary, unless otherwise specified. All maximum demand meters shall be fitted with a saturation transformer and marked with the appropriate phase colour to which it is connected.

16.1.3 Instantaneous current ammeters shall be of the moving iron type, showing instantaneous current. CT operated ammeters shall be 1 A full scale, calibrated to read actual primary circuit currents. The CT ratio shall be indicated on the face plate. A zero adjustment screw shall be provided. Full load or rated current shall be clearly indicated, preferably with a red line. Unless specified to the contrary, a 100% condensed over scale shall be provided for instantaneous reading instruments.

16.1.4 All ammeters shall incorporate an adjustable red pointer.

16.1.5 The intrinsic error, expressed in terms of the fiducial value on accordance with IEC 60051, shall be class 1,5 for the instantaneous readings and class 2,5 for the mean maxima.

16.2 **Voltmeters**

16.2.1 Voltmeters shall comprise of the moving iron, suppressed zero type, having a full scale deflection of not less than 480 Volts, unless otherwise specified. Voltmeters shall comply with IEC 60051 and BSS 89.

16.2.2 Where specified, a Selector Switch shall be provided enabling phase to phase, phase to neutral and off selection. The switch shall have a positive locating mechanism, and indicator plate included. The indicator plate shall have the positions "R-W", "W-B", "B-R" and "off" engraved on it.

16.3 **Current Transformers**

16.3.1 Current transformers shall be designed, constructed and tested in accordance with the requirements of SANS 61869-1; SANS 61869-2; IEC 60044-1, BS 3938 and BS 3941 respectively. Current transformers shall be on the low-impedance type and shall, where ratio, class and output requirements permit, preferably be of the ring-type bar-primary design.

16.3.2 Secondary windings of current transformers shall be earthed at one point only. Each group of current transformers (i.e. protection, metering, etc.) shall be earthed by means of bolted or insertion clamp, spring loaded terminal to the PE conductor.

16.3.3 Current transformers for ammeters and metering purposes shall be of 1A secondary unless otherwise specified. The rated output shall be selected according to the requirements of the driven circuit but shall not be less than 5 VA.

16.3.4 Current Transformers shall have accuracy's as detailed below, unless stated otherwise:

Indicating Instruments	(ammeters)	Class 5 or 3
KW Hour Meters	(commercial grade)	Class 1 or 0.55.
	(precision)	Class 0.5 or 0.2
Protection Relays		Class 10P5 or 10P10

16.3.5 Instrument transformer rating plates shall be duplicated on the main incomers of an ASSEMBLY. These duplicate plates shall be located on the sidewall of the relay compartment or adjacent to the cable termination (when the protection relay is remote from the ASSEMBLY) and shall identify the phase to which the current transformer is connected

16.4 **Voltage Transformers**

16.4.1 Voltage transformers shall comprise of the single-phase double wound type with an earth screen winding and shall be either air insulated or cast epoxy-resin encapsulated, in accordance with the requirements of SANS 61869-3; BS 3938 and BS 3941. Voltage adjustments over the range 95 – 105% of normal ratio shall be provided by off-circuit tappings.

16.4.2 Voltage Transformers shall be provided with isolating switches on the HV side and with protection on both the HV and LV sides.

16.4.3 Control transformers shall be rated as follows:
(Sealed-in burden of all contactors, relays, timers and lamps fed from the unit) +
(Pickup burden of largest Contactor fed from the unit) + 10%.

The regulation on closing of the largest circuit with all the loads imposed on the transformer shall not exceed 5%.

One side of the transformer secondary winding or the star point shall be connected to earth via a removable bolted link.

16.4.4 Conductors that connect VT's to the busbars shall be protected by suitable fuses installed close to the busbars. The fuses used shall be accessible without the use of tools to open covers.

16.5 **Aux Relays, Pushbuttons, Indicator Lamps**

16.5.1 Auxiliary relays for control purposes shall be of the multiple pole type with the following features:

a. Positive-acting mechanical retaining clips. Contact friction alone, as a retaining method is unacceptable.
b. A keyed member on plug and socket sides to prevent incorrect insertion.
c. Clear and indelible markings on both the relay and base indicating the circuit reference in conformity with the associated circuit and connection diagram.

16.5.2 Pushbutton and selector switches shall comprise of the one-hole fixing, oil tight pattern and shall be keyed to prevent rotation of the assembly in the panel. Contacts shall be adequately rated for the circuit duty but shall not be less than 10 A, 230V AC or 120V DC rating.

16.5.3 Pushbutton operators shall be coloured to indicate their function as follows:

Green	To indicate action e.g. “start”, “forward”, “reverse”, “up”, “down”, “close” or to close a circuit.
Red	To stop a function e.g. “stop”, “open”, * or to open a circuit.
Black	Test functions only

In addition the operator shall carry an internationally acceptable symbol indicating its function and shall have mounted immediately above it a clear legend of its function or action.

16.5.4 Indicating lamps shall be continuously rated for a voltage of 10% in excess of the rated voltage. The LED indicator and lens assembly shall be replaceable from the exterior of the panel and shall be possible to execute this operation without the use of any special tools.

16.5.5 Indicating lamp tools shall follow the following standard:

Red	Circuit off i.e. open*, motor stopped, etc.
Green	Circuit in operation, i.e. closed*, motor running, etc.
Amber	Alarm condition, trip indication.

Indicating lamps shall render good visibility under conditions of an ambient illumination level of 400 Lux.

17. INSTALLATION

17.1 General

17.1.1 All Assemblies, including Motor Control Centres shall comply with the requirements of SANS 60439-1 Low-voltage Switchgear and Controlgear Assemblies.

17.1.2 The internal separation of circuits shall be either Form 3b or Form 4 to SANS 60439-1 (refer paragraph 7.7) All internal separation of circuits shall have an enclosure rating of IP4X or better to SABS 1222.

17.1.3 Small power Distribution Boards shall have an internal degree of separation of form 2B as detailed in SANS 60439-1.

17.1.4 All Assemblies inclusive of motor control centres but excluding Valve Distribution panels, shall in addition to the specified cubicles, make provision for at least 10 % spare unequipped cubicles complete with busbars, partitioning into compartments etc for future extensions.

17.1.5 Valve Distribution Assemblies shall be sized to cater for the following requirements:

- Provision for an additional 25 % spare valve MCB's, of which 10% shall be installed and labelled as spare.

17.1.6 The maximum height of all MCC boards shall be 2 200 mm unless otherwise approved by the Engineer. No equipment other than busbars and/or inter panel control wiring shall be installed higher than 1 800 mm above finished floor height, neither shall any equipment, other than cable glands and inter panel control wiring be installed lower than 300mm above finished floor level.
Where a base frame is utilised for cabling purposes, cables may be glanded at the panel base.

18. LABELLING

18.1 **Internal Labels:**

18.1.1 All components shall be labelled according to the schematic diagram, with their complete "-" Component Identification designation, in accordance with the Transnet Pipelines Label Designation Standard attached to this Specification (Ref: 631-001_LVLabelSpec, 711-001_PLCLabelSpec).

18.1.2 Where possible, labels are to be attached on the panel next to the device, but where this is not practical, then, and only then, may the label be placed directly onto the device.

18.1.3 Labels shall comprise of the Traffolyte engraved type, and fixed to the board by means of stainless steel screws or epoxy glue.

18.1.4 Finish shall comprise of black letters against a white background, except in the case of cautionary labels where letters shall appear white on a red background.

18.1.5 Labels shall be affixed in such a way that they are easily legible and not obstructed by the wiring or by other components.

18.1.6 All lettering shall be in upper-case letters except where standard abbreviations of units are used, e.g. kWh, kVA, etc.

18.2 **Internal Labels: Terminal Rails**

18.2.1 All Terminal Rails shall be labelled with their complete "-" Component Identification designation, in accordance with the Transnet Pipelines Label Designation Standard attached to this Specification. (Ref: 631-001_LVLabelSpec, 711-001_PLCLabelSpec).

18.2.2 Note that two types of Terminal Rail Labels have been defined as follows:

a. Field Marshalling – label identifies the Cable ID terminated into the terminals
b. PLC I/O Marshalling – label identifies the PLC ID:Rack No:Slot No of the associated I/O Card

18.2.3 Labels are to be attached to Terminal Rail Label Holders located at the top of the terminal rail.

18.3 **Internal Labels: Equipment**

18.3.1 Each device shall be labelled with its complete Functional Identification designation, in accordance with the Transnet Pipelines Label Designation Standard attached to this Specification. (Ref: 631-001_LVLabelSpec, 711-001_PLCLabelSpec). The labels shall be readable/visible after the wiring has been done. Where possible, labels are to be attached on the panel above the device.

18.3.2 MCB's shall be clearly labelled as to their functionality (what equipment is supplied) and supply voltage by means of a laminated legend plate located on the inside door panel of the cubicle housing the respective MCB's. In addition, all MCB's shall be individually labelled with the respective MCB No's on the front top of the breaker so as to enable rapid visual identification.

18.3.3 MCB's feeding valve actuators shall be individually labelled with the respective Valve Ops Code Identifiers on the front top of the breakers so as to enable rapid visual identification.

Refer to Section 18 for details on Label Specifications.

18.4 **External Labels**

18.4.1 Labels shall be provided in compliance with the OSH Act and SANS 10142-1, and as required to facilitate the operation of the equipment with no prior working knowledge of the Equipment.

18.4.2 Labels shall comprise of the Traffolyte engraved type, and fixed to the board by means of stainless steels screws. Finish shall comprise of black letters against a white background, except in the case of cautionary labels where letters shall appear white on a red background.

18.4.3 All lettering shall be in upper-case letters except where standard abbreviations of units are used, e.g. kWh, kVA, etc.

18.5 **External Labels: Equipment Designation**

18.5.1 Each Panel/Cubicle door shall be labelled with its complete "=/+" Identification designation, in accordance with the Transnet Pipelines Label Designation Standard attached to this Specification. (Ref: 631-001_LVLabelSpec, 711-001_PLCLabelSpec). Labels are to be attached on the panel door top right corner where possible.

18.5.2 RATING PLATE

Each ASSEMBLY shall have a RATING plate in accordance with SANS 1973-1 stating at least the following:

- Name of the ASSEMBLY
- Plant coding
- Manufacturer
- Manufacturer's address and contact telephone number
- Standard to which it was manufactured and type-tested
- Main Busbar current rating
- Rated operating voltage
- Control voltage
- Rated impulse withstand voltage
- IP rating
- Short-circuit rating in kA and duration in seconds
- Form of separation of respective sections

18.5.3 INCOMER CUBICLES

- Incomer Equipment Designation (by Function "=" and Location "+")
- Manufacturers name or Trademark
- Rated Voltage and Current
- Short Circuit Rating and Duration I_{SC}
- Rated Insulation Voltage
- IP rating
- Type of Earthing System
- Indication of where the board is fed from

18.5.4 EQUIPMENT CUBICLES

- Equipment Designation (by Function "=" and Location "+")
- Equipment Description
- Equipment Rating

18.5.5 SMALL POWER & DISTRIBUTION CUBICLES (Fault Level < 10kA)

- DB Board Designation (by Function "=" and Location "+")
- Rated Voltage and Current
- Short Circuit Rating and Duration I_{SC}
- Indication of where the board is fed from

18.6 **EXTERNAL LABELS: WARNING**

18.6.1 The following warning & equipment labels shall be supplied as a minimum on applicable cubicle doors:

18.6.2 INCOMER CUBICLES

- Incomer Equipment Designation (e.g. F31), as well as indication of function "MAIN SWITCH". Black text on white background.
- Danger Notice giving instructions that the switch disconnector be switched off in the event of inadvertent contact or leakage.
- Where series-connected (cascaded) systems have been installed, the warning notice as detailed in SANS 10142-1:2012 Section 6.7.4 (d) shall be installed. White Text on red background.

18.6.3 EQUIPMENT CUBICLES

- Where cubicles are fed from two or more different sources, a warning label shall be installed identifying the sources
  E.g. Feed from Generator ("Emergency Supply"), UPS ("UPS Supply") or both ("Emergency & UPS Supply") White text on red background

18.6.4 All identification shall comply with As Built drawings and single line diagrams, in accordance with the Transnet Pipelines Label Designation Standard attached to this Specification. (Ref: 631-001_LVLabelSpec, 711-001_PLCLabelSpec).

18.7 **External Labels: Small Power & Distribution**

18.7.1 All Plug Sockets, Light Switches etc. shall be labelled with their complete Functional Designation, in accordance with the Transnet Pipelines Label Designation Standard attached to this Specification. (Ref: 631-001_LVLabelSpec). Labels are to be attached on the equipment front cover top right corner where possible.
In this regard, designators shall identify the MCB from which the equipment is fed
e.g. = 38 DB01.Q10.

19. FACTORY ACCEPTANCE TEST PROCEDURES

19.1 Unless otherwise specified, work and acceptance tests shall be conducted on all equipment at the place of manufacture. Contractors shall be responsible for the compilation of an Acceptance Test Schedule to be used for acceptance testing of the system. The test schedule shall be comprehensive and must cover all aspects of the system to be tested and will be subject to the approval of Transnet Pipelines, prior to commencement of Pre-acceptance Testing.

19.2 The successful Tenderer will be responsible for providing all test equipment and facilities required for the period of the acceptance tests such as the Engineer may deem necessary, and to produce a report of the tests concerned.

19.3 Transnet Pipelines reserves the right to add or delete any item or test from the test result of hardware failure, re-scheduling of the test will be at the discretion of the Engineer. Transnet Pipelines reserves the right to repeat or incorporate any additional test into the test schedule.

19.4 Inspection by the TPL representative shall be performed at the following pre-defined stages of manufacture:

a. Prior to commencement of wiring
b. Prior to Functional Testing

19.5 The following tests shall be required to be performed as part of a Factory Acceptance Test Procedure:

a. A physical check of all equipment shall be made against drawings and shall include a check for tightness of connections, correct core idents etc.
b. A terminal to terminal routing check of all panel wiring shall be made against drawings and the drawings red-lined accordingly
c. Trip element ratings of all supply and distribution breakers shall be made
d. Earth leakage tripping shall be made on all circuits
e. Effectiveness of earthing system shall be checked
f. Powering up of panel shall be conducted and equipment run for a period of three hours. During this time a check for abnormal operating conditions shall be made eg. temperature and current.
g. Simulation of all discrete and analog signals from the respective field terminals into the respective PLC I/O modules

19.6 The supplier shall provide proof that specific components installed in the ASSEMBLY complies with relevant specification as tested by an authorized testing authority.

19.7 The following Continuity/Insulation Tests in accordance with SANS 60439-1 shall be performed by manufacturer. NB: All electronic components will require to be isolated before commencement of these insulation tests.

a. Insulation tests
b. Torque tests of all bolted Busbar connectors
c. Point to point wiring checks. (wire buzzer checks)

20. APPENDIX 1

PREFERRED EQUIPMENT LIST			
ITEM	**DESCRIPTION**	**MANUFACTURER**	**TYPE NUMBER**
1	Incoming Circuit Breakers >400A Draw Out	Schneider Electric	Masterpact
2	Incoming Circuit Breakers <400A Fixed Pattern	Siemens; Schneider	3VF; Masterpact
3	Distribution Circuit Breakers	Siemens; Schneider	3VF/3RV
4	Miniature Circuit Breakers	Siemens; Schneider	5SX2
5	Motor Protection Circuit Breakers	Siemens; ABB	3VU/3RV
6	Contactors	Siemens	3TF/3RT
7	Overloads	Siemens	3UA5/3RU1
8	Push Buttons	Siemens	3SB1
9	PLC Interface Relays	Siemens	3TX7
10	Change Over Switches	Krauss & Naimer	
11	Terminals	Klippon	SAK/RSF1
12	Fuses and Bases	Siemens	3NW3
13	Over Voltage Protection	Strike Technologies; Dehn	ZORC
14			
15			
16			
17			
18			
19			
20			