

TRANSNET SOC LTD

TENDER NO.: iCLM PE 746/TPT

(e-Tender Reference No.: TPT/2025/05/0026/96950/RFP - ICLM PE 746/TPT)

**DESCRIPTION OF THE SERVICES: PROVISION TO REFURBISHMENT OF SUBSTATION 1A AND 1B AT NGQURA CONTAINER TERMINAL FOR TRANSNET SOC LTD (REG NO:1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS (HEREINAFTER REFERRED AS "TPT") FOR NGQURA CONTAINER TERMINAL AS A
ONCE OFF**

ADDENDUM NO. 01

DATED 20 June 2025

The following information is hereby furnished for your further attention in respect of the above-mentioned service/tender.

1. T1.1 Tender Notice and Invitation to Tender

- The closing date of the tender/RFP is extended from 27 June 2025 @ 14h00 pm until **04 July 2025 @ 14h00 pm.**

2. C3 - SCOPE OF WORK

8.1 Drawings issued by Employer were omitted on the initial RFP and now have been attached.1.

Table 7: Drawings

Drawing number	Revision	Title
	0A	Port Switching Layout
	0A TD	Substation 1A MV Single Line Diagram and Floor Plans
	0A TD	Substation 1B MV Single Line Diagram and Floor Plans

3. Bidders requested for The Etap Software Specification as indicated on Scope of Work Bullet number 7.5.b

- The Drawings attached Refer to **Annexure P**

4. Bidders requested Request for a Revised BOQ to include the Etap Software & Network Study Refer to Revised BOQ attached.

• **C2.1.2 Pricing Schedule**

F MEDIUM VOLTAGE CABLE TERMINATION			
ITEM NO.	ITEM DESCRIPTION	QUANTITY	UNIT
15.	Power system Protection		
15.2	ETAP software as per annexure P	Each	1

Note:

An amended C2.1.2 Bill of Quantities is provided for completion by the bidder/tenderer (Annexure C).

• **Additional Information and Revised Drawings**

• **With regards to T2.2-04: Evaluation Schedule - Previous Experience**

Tenderers to note that completion certificates or handover certificates shall be signed and stamped by the bidder's previous client. Sufficient information as per the tender returnable shall be provided in the handover or completion certificate. In a case where the handover or completion certificate does not show the required information to award the points, the bidder shall submit an accompanying reference letter from the previous client and the reference letter shall provide all the required details. The reference letter shall also be signed and stamped by the bidder's previous client. A reference letter without a completion or handover certificate will not be considered. A clear project name, number, and/or tender number of the previous experience work shall be provided for verification purposes. Bidders to note that Transnet may request, from the bidder's previous client, additional substantiating information or proof of the previous experience. Bidders shall provide traceable references. In a case where Transnet attempts to contact the reference client for verification of the provided previous experience, and there is no response for a period of five working days, the reference experience provided will not be considered.

• **T2.2-05: Evaluation Schedule – Method Statement**

Tenderers to note that the statement that reads, "The method statement should not be longer than 10 pages", in the returnable will not apply. Bidders can provide as much details as possible to qualify the method statement/s. Bidders to also note that the any requirement relating to changing of the transformer oil should be omitted, changing of the transformer oil is not part of the SoW.

• **T2.2-03: Evaluation Schedule: Management & CV's of Key**

Tenderers to note that the copies of qualification for the key persons must be certified and the validity period for the certification is three months from the date of the tender issue.

- **Attachments: (Refer Annexure B)**

- a. ETAP Specification
- b. High Level Commissioning Plan
- c. DB Specification
- d. Earthing and Lightning Protection Specification
- e. Single Line Drawings x 3
- f. Substations (1A and 1B) building Drawings x 4. Showing floor plans with EL&P and Elevations.
- g. C2 pricing data addendum to replace the RFP pricing data.

- **Important note regarding the Mechanical HVAC Scope:**

- a. Bidders shall omit from the scope of works the design, supply, installation of a new HVAC positive pressurized HVAC system in both the transformer rooms of Substation 001A and Substation 001B.
- The contractor shall further allow in in the pricing of the design of HVAC systems for the LV room, MV room for the control of the humidity inside the substation rooms by including the necessary plant/equipment as part of the HVAC system to control the humidity in the optimum desired band/range for substations as per the relevant applicable codes and standards and in line with best industry practice and sound engineering principles

ADDITIONAL RETURNABLE:

ANNEXURE D- T2.2-02 – CIDB Returnable attached.

COMPILER:

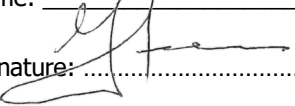
Name: Sinenhlahla Mtshali

Signature: 

Date: 20/06/2025

APPROVER:

Name: Mbulelo Mfecane

Signature: 

Date: 20/06/2025

TRANSNET SOC LTD

Dear Sirs/ Madam

TENDER NO.: iCLM PE 746/TPT
(e-Tender Reference No: TPT/2025/05/0026/96950/RFP - ICLM PE 746/TPT)

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ONCE OFF**

Receipt of **Addendum No. 01 dated 20 June 2025** is hereby acknowledged.

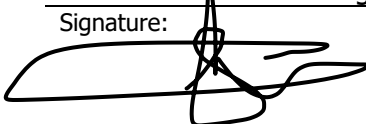
Kind regards

TENDERER NAME
DATE:

NOTE: This acknowledgement must be signed and returned via email on or before closing date of tender via email to Snenhlanhla.mtshali@transnet.net

Transnet Port Terminals High Level Commissioning Plan Electrical Equipment

Document No:

Prepared by: Name: Samukelo Magcaba Date: May 2018
Signature:  Date

Reviewed by: Name: _____ Date: _____
Signature: _____ Date

Approved by: Name: Samukelo Magcaba Date: September 2022
Signature:  Date

00	May 2018	Issued for Review
Rev	Date	Revision Details

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1. INTRODUCTION

The purpose of the High Level Commissioning Plan is to outline the procedures associated with commissioning various types of electrical and mechanical systems and equipment. A detailed commissioning plan as where deemed appropriate at the discretion of the responsible engineer, shall be prepared as required for the various systems. International best practice norms and standards shall be followed in terms of inspection, testing for safety, setting and configuring, and rendering the installed equipment fully functional to its intended purpose.

2. STATUTORY REQUIREMENTS

All aspects of the commissioning process shall adhere to any and all relevant requirements of the following legislation, as appropriate:

- Occupational Health and Safety Act 85 of 1993
- National Environmental Management Act 107 of 1998
- South African National Standards and Codes of Practice
- All local, provincial or S.A. Government laws in force at the time.

3. GOVERNING CODES, STANDARDS AND SPECIFICATIONS

The commissioning process for all electrical and mechanical equipment shall adhere to any specific and relevant requirements contained in the following national and international standards. Where different standards call for different testing and commissioning procedures for the same equipment, the most stringent alternative shall apply.

Note: Where reference is made to a code, standard or specification, the reference shall be taken to mean the latest edition of the code, standard or specification, including latest Addenda, supplements and revisions thereto.

The commission process in general, shall be in accordance with the recommendations of:

- ♦ The International Electrotechnical Commission (IEC), and
- ♦ The Institute of Electrical and Electronic Engineers (IEEE)
- ♦ International Standards and Codes – ISO, DIN, BS, ASME, ASCE, ANSI, ASTM, EU

4. SCOPE

This plan covers site electrical pre-operational tests and commissioning tests required for electrical apparatus, wire, cables and other miscellaneous equipment and material as called for in the specifications and must be read in conjunction with the other specifications.

5. GENERAL INFORMATION

- 5.1. Pre-operational tests and acceptance certificates as herein specified are defined as those tests and inspections required by the ENGINEER prior to equipment being energized to

determine that the apparatus involved may be safely energized.

- 5.2. Calibrating tests, checks on limit switch settings, interlocking, PLC functioning etc. are so called cold commissioning or dry tests.
- 5.3. Hot commissioning tests are the tests as specified by the Engineer such as burn in tests for electronic equipment and continuous cycle tests etc. when the equipment is handling the product it was designed for.
- 5.4. Final acceptance will not only depend on equipment dependability, as determined by the subject tests, but will depend on complete operational tests on all equipment to show that the equipment will perform the functions for which it was designed.
- 5.5. These specifications intend that the workmanship methods, inspections and materials used in erection and installation of the subject equipment shall conform with accepted engineering practices, the specifications as prepared by the Engineer, Manufacturer's instructions and the relevant Standards as referred to in all the attached specifications.
- 5.6. **Thermographic images shall be taken, as directed by the Engineer, of all equipment put into service, as part of the commissioning documentation. These images shall be time and date stamped.**
- 5.7. The Contractor shall bear the costs of all tests required.

6. RESPONSIBILITY

- 6.1. The testing shall be performed by and under the immediate supervision of the Contractor and witnessed by the Engineer and/or his duly authorised representative. This representative may be an Independent Commissioning Engineer appointed by the contractor with the Engineer's approval.
- 6.2. The Contractor shall adjust, set, co-ordinate, calibrate and test all systems and equipment furnished and/or installed by him.
- 6.3. The Contractor shall determine, and the Engineer shall approve the individuals in whom final responsibility and authority rests for carrying out these tests and inspection procedures on particular equipment. The method to be followed in obtaining clearances on electrical equipment shall also be established and such method rigidly adhered to.
- 6.4. All testing shall be scheduled by the Contractor and cleared through the Engineer. No testing of any kind shall be done or scheduled without this clearance.
- 6.5. The Contractor shall notify in person or by letter all the interested parties at least 24 hours prior to tests, establishing the time the test is to be performed.
- 6.6. The interested parties to be informed will be determined in conjunction with the Engineer.
- 6.7. The parties notified shall be responsible for having their representatives present at the designated time. Absence of any one representative will not prohibit the test from proceeding on schedule, unless such representative is essential in doing the tests.
- 6.8. Each of the notified interested parties and the testers employed shall be individually responsible for the safety of all members of their organization during such time as the tests

are performed.

- 6.9. The Contractor will coordinate all testing to ensure that all trades are prepared and that the conditions are safe.
- 6.10. Detailed testing method and equipment shall be approved by the Engineer.
- 6.11. On some tests, particularly the final inspections of important equipment, the manufacturer's Engineer or representative shall be present and perform same. The request for a manufacturer's representative shall be made sufficiently in advance to the date the test is scheduled so that satisfactory arrangements for the representative's services can be made. Frequently, the manufacturer's responsibility applies to both electrical and mechanical equipment. Where such joint responsibility exists, the request for a manufacturer's representative shall be arranged to satisfy both electrical and mechanical requirements simultaneously.
- 6.12. Manufacturer's instructions shall be carefully read for any special conditions that may be required for testing.
- 6.13. Following established procedures, equipment will be energized after certification on the relevant form by the personnel performing the tests, that equipment is ready for energizing and with the concurrence of the Engineer.

7. TESTING EQUIPMENT

- 7.1. All testing equipment for tests which are to be performed shall be furnished by the Contractor.
- 7.2. Testing equipment required to prove guarantee values shall be calibrated immediately prior to the relevant tests to be performed. The error curves shall be submitted with the report.

8. TESTING RECORDS

- 8.1. Test results shall be entered in test forms provided by the Contractor or, if such forms are not available, in test forms approved by the Engineer.
- 8.2. Authorized, qualified representatives of the parties interested (see paragraph 3.0 shall be present to approve a test when made. One (1) copy of the rough draft-test report shall be given to each authorized representative at the time the test is made.
- 8.3. Formal test reports approved by the Engineer shall be supplied and prepared by the party performing the test within 48 hours, signed by the authorized representatives, and furnished to the Engineer for distribution.

9. SAFETY PRECAUTIONS

- 9.1. The Contractor shall exercise extreme care in performing the tests specified so as not to jeopardize the safety of personnel and to prevent equipment damage during any tests. All exposed live parts subject to testing shall be guarded by personnel, barricades, or other practical means to ensure against personnel being injured by coming in contact or close proximity to exposed parts.
- 9.2. All equipment, exposed live parts, etc., shall be completely discharged by grounding or other accepted methods so as to eliminate the possibility of injury to personnel from electrical shock after the tests have been completed.

10. PROVISIONAL ACCEPTANCE

- 10.1. The Engineer's Provisional Acceptance of any electrical installation shall be based upon the completion of tests and checks prescribed in clauses 8 through 13, submission of test data (where required), satisfactory materials and workmanship, and demonstration of satisfactory start-up.

11. EARTH CONTINUITY AND RESISTANCE TESTS

11.1. General:

- 11.1.1. All earthing and bonding cables must be checked for continuity and earth resistance.

11.2. Test procedure:

- 11.2.1. Measuring the cable and connection resistance simultaneously with a resistance bridge or accurate multi-meter.

11.3. Acceptance:

- 11.3.1. The resistance of the earthing and bonding cables and connections must be less than stated in SABS 0142/latest.
- 11.3.2. Complete and accurate records of all resistance readings of all earthing conductors of motors, transformers, power cables etc. must be made.

The records shall include the following:

- 11.3.2.1. Complete identification of the cable and connection points including its approximate length;
- 11.3.2.2. Resistance reading;
- 11.3.2.3. The approximate average cable temperature.
- 11.3.3. No electrical systems will be energized until the master copy of its test record is approved by the Engineer.

12. MEDIUM VOLTAGE CABLES

12.1. General:

- 12.1.1. The Contractor shall give all medium voltage cables a Very Low Frequency (VLF) Hi Pot test in compliance with the cable manufacturers specifications, after all splices and potheads or cable terminations have been made.
- 12.1.2. The Contractor shall then perform a Dissipation Factor (Tan-Delta) test on the cable as per the cable manufacturer's specifications.
- 12.1.3. The medium voltage cables shall be given a complete dielectric absorption test before and after the VLF and Tan-Delta test. The cable test shall be performed prior to connections to the electrical equipment at either end.
- 12.1.4. DC Hi Pot Testing is strictly prohibited on any MV cables or systems owned and operated by Transnet.
- 12.1.5. The Contractor shall supply all instruments for testing.



12.2. Test Procedures:

- 12.2.1. Medium voltage stress cone type terminations or potheads shall remain intact but testing shall not include any bus work beyond the pothead or stress termination.
- 12.2.2. Cable continuity and phase identification shall be checked.
- 12.2.3. In setting up the test set special safety precautions should be taken regarding grounding of the test equipment. The test set, its voltmeter and the cable shield should be grounded at the same ground.
- 12.2.4. All 4 core cables shall be tested between one conductor and ground with the other conductors and the metallic shield, metallic sheath or armour grounded to the same ground. Each conductor to be tested in this manner.
- 12.2.5. All single conductor cables shall also be tested between one conductor and ground with the other conductor in the same conduit grounded.
- 12.2.6. Each cable is to be given a full dielectric absorption test as herein specified with a suitable motor driven or electronic megger. The readings taken shall be recorded in the test record.
- 12.2.7. The dielectrical absorption megger test shall be applied for a long enough duration to fully charge the cable. Megger readings shall be taken every fifteen (15) seconds during the first three (3) minutes and at one (1) minute intervals thereafter. The test shall continue until three (3) equal readings one (1) minute apart are obtained. The cable may then be considered to be fully charged.
- 12.2.8. All cables should have approximately the same megohm reading. In the event that a cable shows an appreciably lower resistance value than the others in the same conduit or cable run, this condition shall be discussed with the Engineer prior to the application of the high potential test.
- 12.2.9. After an acceptable megger test, the Contractor shall give the cables a VLF high potential test in accordance with the requirements of IEEE 400.2-2013. After completion of the test, the contractor shall ensure that there is no residual charge contained in the cables. Any cable that does not perform as per manufacturer's specifications shall be rejected.

12.2.10. Cables shall then be subjected to the Tan-Delta testing.

12.2.11. The successful high potential test shall be immediately followed by another megger test as heretofore specified.

12.3. Acceptance:

12.3.1. The cable must withstand the specified high voltage without an appreciable increase in leakage current.

12.3.2. Final acceptance will also depend on satisfactory results of the two megger tests. The results of the final megger test should reasonably parallel those of the first megger test and should show no evidence of differing performance prior to the VLF Hi-Pot and Tan-Delta Testing.

12.3.3. Complete and accurate records of all megger and accompanying VLF and Tan-Delta tests shall be made. The records shall include the following:-

12.3.3.1. Complete identification of the cable including its approximate length;

12.3.3.2. Megger readings vs time data;

12.3.3.3. VLF and Tan-Delta test results with date and time of test.

12.3.3.4. The approximate average cable temperature taken by Thermographic Imager, with images recorded along the entire length of cable.

12.3.4. No cable shall be energized until the master copy of its test record is approved by the Engineer.

13. LOW VOLTAGE POWER CABLES

13.1. General:

13.1.1. All wires and cables shall be tested for continuity. Except for 60 volt services and below, all wires and cables shall be given a megger test.

13.1.2. All cable connections must pass visual inspections for workmanship and conformance with standard practice.

13.2. Test Procedure:

13.2.1. Continuity shall be checked by means of a DC test device using a beeper.

- 13.2.2. Bus tie cables shall be meggered before connections to buses are made.
- 13.2.3. Each 400 volt service cable from substations shall be meggered with the cable connected to the switch gear with the corresponding breaker racked in and open. Connections at the other end of each of these cables shall be as follows:-
 - 13.2.3.1. Cables to individual motors shall be disconnected from the motor for initial tests, and followed by cables connected to motors as per specification for rotating equipment;
 - 13.2.3.2. Cables to control centres shall be connected to the control centre main breaker with breaker in the open position.
- 13.2.4. Minimum megger readings shall be 1 Me 6 ohm.
- 13.2.5. The megger test must be held until the reading reaches a constant value. For 400 volt cables the cable megger test shall be held until three (3) equal readings, each one (1) minute apart, are obtained.
- 13.2.6. A 1000 volt motor-driven or electronic megger with a value of at least twice that of the RMS voltage shall be used on all service conductors.
- 13.3. Acceptance:
 - 13.3.1. Minimum megger requirements must be met.
 - 13.3.2. Any cable having a megger reading 50% lower than average, even though meeting minimum requirements, shall await further instructions from the Engineer as to drying or other treatment to be given the cable prior to acceptance.
 - 13.3.3. Complete and accurate records of all tests and inspections shall be made.

14. MEDIUM VOLTAGE SWITCH GEAR AND CIRCUIT BREAKERS

- 14.1. General:
 - 14.1.1. All switch gear shall be given operational tests. This shall include mechanical operation, as well as operation by control circuits, relays and tripping devices. All breakers and busbars shall be given a megger test.

14.2. Test Procedures:

- 14.2.1. Megger tests on the medium voltage bus shall be applied between each phase separately and ground with other phases tied to ground. All breakers shall be racked-out.
- 14.2.2. In addition each breaker shall be given a megger test in the racked-out and closed position. Megger tests shall be applied between each phase to ground and to each other phase.
- 14.2.3. A suitable motor driven or electronic megger shall be used. Each test shall be held until a constant reading is obtained. Minimum test values shall be as specified in specifications.
- 14.2.4. All test readings shall be recorded.
- 14.2.5. All circuit breakers shall be operated through at least three (3) open-close-open cycles in both the rack-in and test positions by manual operation and by control circuits from each control point. All indication lights, annunciators, alarms and targets shall be observed to determine correct operation and breaker mechanism shall be observed for correct alignment, freedom of binding and good contact. All breakers shall be checked for ease of rack-in and rack-out and checked to determine that the breaker cannot be moved out of operation position while the breaker is closed.
- 14.2.6. The interchangeability of the circuit breakers shall be demonstrated.
- 14.2.7. PT and CT data shall be recorded and PT and CT circuits shall be checked with a multi-tester.
- 14.2.8. Protective relays shall be adjusted and calibrated with an injection type test arrangement (multi-amp or equal). Results shall be recorded and the co-ordination of the protective relaying shall be proved.
- 14.2.9. After initial energization, switch gear shall be checked for correct phase sequence.

14.3. Acceptance:

- 14.3.1. Minimum megger requirements must be met;
- 14.3.2. Proper mechanical and electrical operation of switch gear must be assured;
- 14.3.3. Correct protective relaying operation must be proven;
- 14.3.4. Complete and accurate records of all tests and inspections shall be made.

15. POWER TRANSFORMERS

15.1. General:

- 15.1.1. Before testing, all transformers shall be inspected for cleanliness, damage, moisture (blue coloured silica gel), oil leaks and phase identification. Each transformer winding shall be given megger tests.
- 15.1.2. Oil filled transformers shall have the oil checked for dielectric strength.
- 15.1.3. Accessories and auxiliary circuits to switchgear and alarm panels shall be checked.

15.2. Test Procedures:

- 15.2.1. Transformer windings shall be meggered with cables disconnected. (The cables have to be disconnected anyhow for cable high potential tests). See clause 9.0.
- 15.2.2. The 400 volt connection to the switchgear does not have to be opened, but the secondary isolator shall be racked out.
- 15.2.3. The transformer neutral has to be disconnected from ground.
- 15.2.4. When meggering the primary side, the secondary winding has to be grounded and vice versa.
- 15.2.5. The minimum values of the specified megger tests shall be as specified in the standard specification.
- 15.2.6. All 2500 V megger tests shall be held at least five (5) minutes and until three (3) consecutive equal readings one (1) minute apart are obtained. Readings shall be taken every thirty (30) seconds during the first two (2) minutes and every minute thereafter. 1000 V Megger readings must be held until the reading reaches a constant value and until three (3) consecutive equal readings one (1) minute apart are obtained.
- 15.2.7. The oil samples for the dielectric strength test shall be taken from the bottom of the transformer tank and tested in accordance with SABS Specifications.
- 15.2.8. Oil temperature indicator, level gauge and pressure relief devices must be manually actuated to check operation of auxiliary circuits.
- 15.2.9. To check the Bucholz relay, air shall be injected at the test connection.

15.3. Acceptance:

- 15.3.1. Minimum megger requirements must be met.
- 15.3.2. Oil dielectric strength shall be above the minimum specified by the manufacturer.
- 15.3.3. Auxiliary circuits shall be fully operational.

16. LOW VOLTAGE SWITCH GEAR

16.1. General:

- 16.1.1. The 400 volt switch gear bus shall be given a phase-to phase and phase-to-ground megger test.
- 16.1.2. All switch gear, relays and control devices shall be given complete operational tests to show that the equipment performs all design functions and meets design and equipment procurement specifications.

16.2. Test Procedures:

- 16.2.1. With transformer secondary breaker and load breakers open, all current transformers shorted, all potential transformer fuses removed and all 400 volt feeder breaker load terminals grounded, the 400 volt bus shall be given a phase-to-phase and phase-to-ground megger test.
- 16.2.2. Megger tests on the 400 volt bus shall be applied between each phase and ground with phases not under test also grounded.
- 16.2.3. All circuit breakers shall be operated through at least three (3) open-close-open cycles in both the rack-in and test position by manual operation and by control circuits from each control point (draw out breakers only). All indicating lights, annunciators, and breaker mechanisms shall be observed for correct alignment, freedom of binding and good contact. Draw out breakers shall be checked for ease of rack-in and rack-out and checked to determine that the breaker cannot be moved out of operating position while the breaker is closed.
- 16.2.4. PT and CT data shall be recorded and PT and CT circuits shall be checked with a multi-tester.
- 16.2.5. Protective relays shall be adjusted and calibrated with an injection type test arrangement (multi-amp or equal). Results shall be recorded and the co-ordination of the protective relaying shall be proved.

16.2.6. After initial energization, switch gear shall be checked for correct phase sequence.

16.3. Acceptance:

16.3.1. Minimum megger requirements must be met.

16.3.2. Proper mechanical and electrical operation of switch gear must be assured.

16.3.3. Correct protective relaying operation must be proven.

16.3.4. Complete and accurate records of all tests and inspections shall be made.

17. COLD COMMISSIONING

17.1. The programmable logic control system shall only be tested once the LV switchboard and other control panels have been tested in the manual mode and been provisionally accepted by the Engineer.

17.2. The control system shall firstly be tested DRY, i.e. all motor fuses shall be removed or circuit breakers shall be in the OPEN positions.

17.3. All plant/external inputs to the PLC shall be individually checked in the field or motor control centre by operating the required field limit switch, relays etc. and checked on the programmer monitor if the status indication of the correct input reference alters.

17.4. All plant/external outputs shall be checked individually by forcing the PLC output coil by means of the programming unit and checking the field, motor control or mimic display panel if the correct relay, indication lamp or contactor has operated.

17.5. A signed test record showing all input/ output references and reference to which field, motor control centre or mimic panel device was initiated or was operated shall be made and handed to the Engineer before the second part of the DRY test commences.

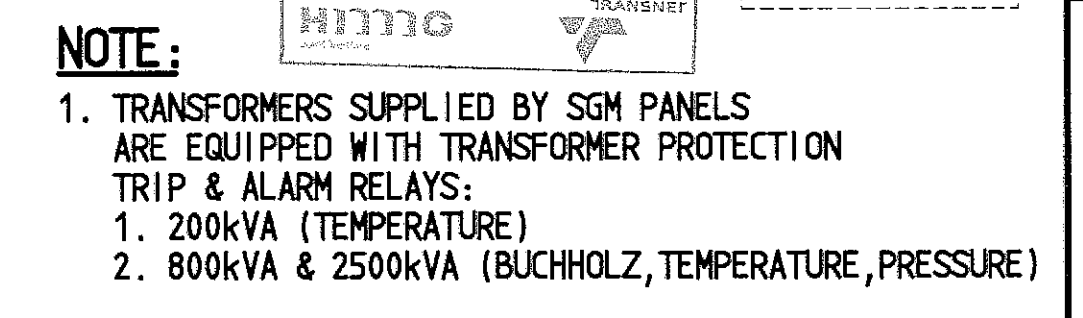
17.6. The second part of the DRY test shall be by carrying out drive selections, route start ups and route stops for all possible drives as listed. All inputs which cannot be present because of the absence of any plant movement shall be simulated by a plant input simulator to be provided by the Contractor.

17.7. Upon completion of the tests, a signed test record showing all route selections, starts and stops simulated for every route and a list of all simulated inputs/outputs used shall be made and handed to the Engineer.

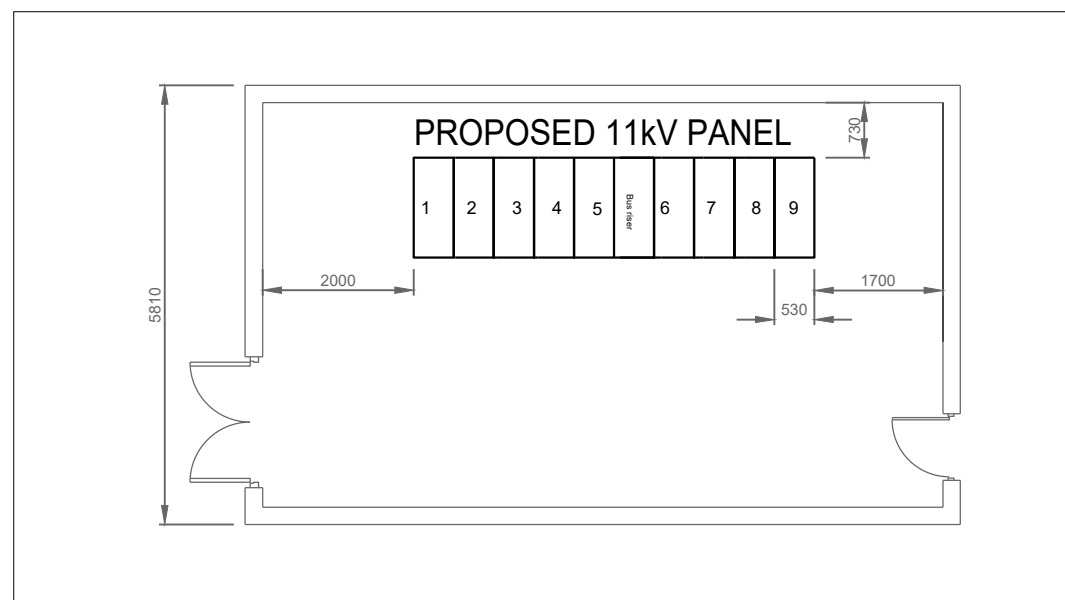
17.8. The Contractor shall then call upon the Engineer to witness a repetition of all previous DRY tests.

18. HOT COMMISSIONING

- 18.1. Commissioning of the whole installation shall not commence until all work which is essential for safe operation has been completed.
- 18.2. First, the electrical equipment and circuitry shall be checked and tested in each Motor Control Board and shall be rendered "healthy" and fully operational before any other part of the installation is commissioned.
- 18.3. The settings of all protective, instrument and timing devices are to be correctly based on the manufacturer's characteristic curves.
- 18.4. The operation of all equipment and motors shall be tested on the "manual" sequence first prior to attempting "automatic" sequence control.
- 18.5. Commissioning shall follow the electrical testing procedures necessary prior to start-up of the equipment.
- 18.6. The start-up of each system or plant shall be done in the presence of the authorized representatives of the machine suppliers, the mechanical contractors, the electrical suppliers of the boards, the Electrical Contractor and the Engineer, unless otherwise arranged by the Engineer.
- 18.7. During hot commissioning the temperature rise of all motors will be calculated using the resistance method.
- 18.8. For a period determined elsewhere in this document, after completion of the foregoing operations, the Electrical Contractor shall arrange for a competent representative to remain on site to test-run the installation to the satisfaction of the Engineer.

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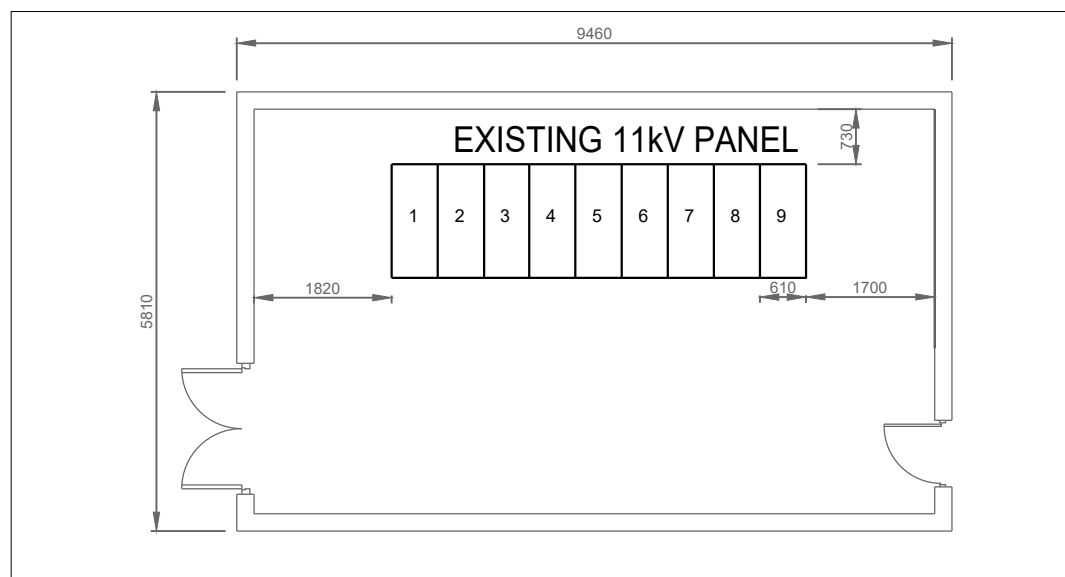
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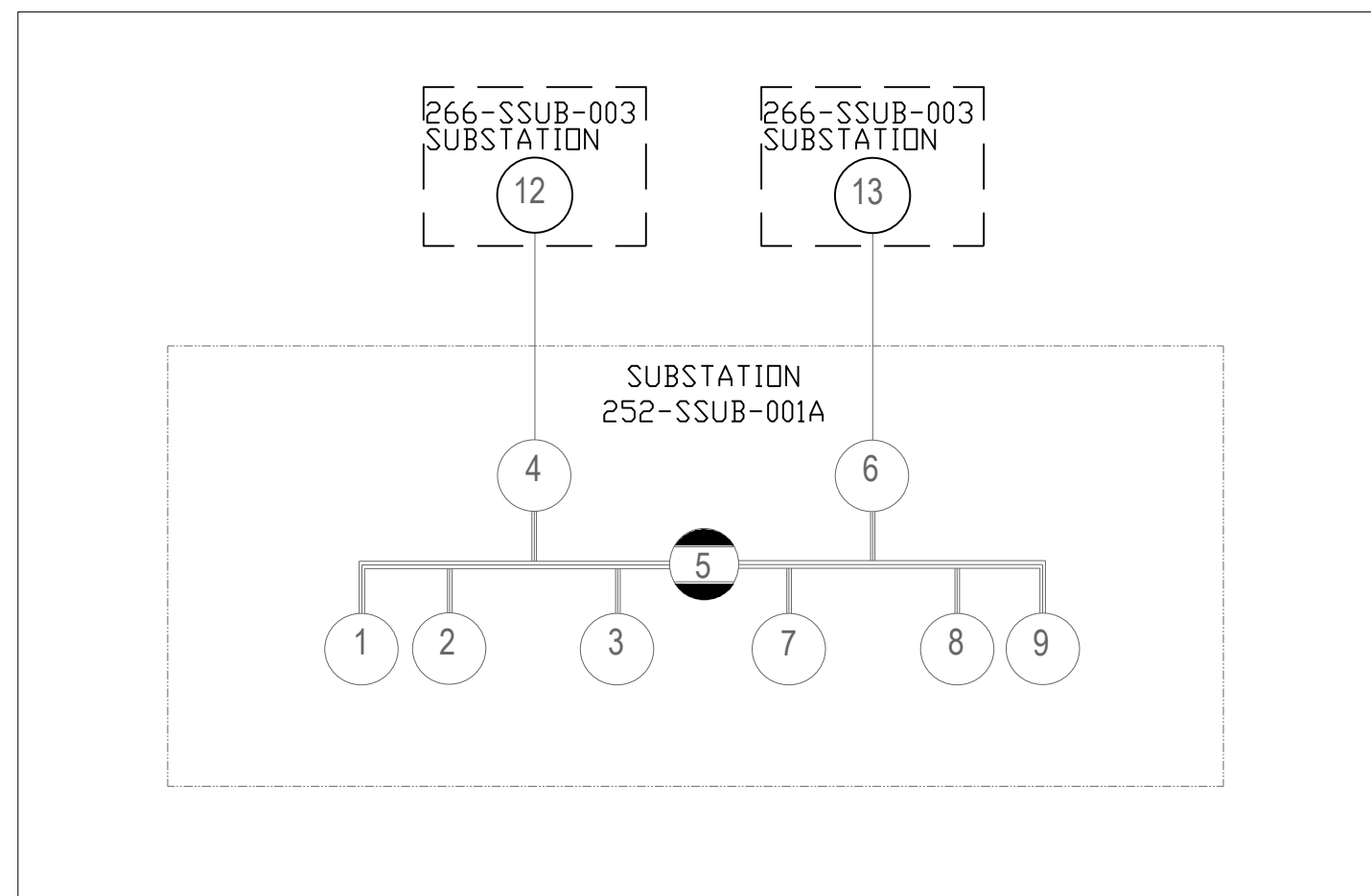
252-SSUB-001A SUBSTATION PROPOSED MV FLOOR PLAN

B



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252-SSUB-001A SUBSTATION EXISTING MV FLOOR PLAN



252-SSUB-001A SUBSTATION LINE DIAGRAM

NOTES:

1. TRANSFORMER CAPACITY SHOWN IN
kVA UNLESS OTHERWISE INDICATED



- ## 2. DEVICE NORMALLY OPEN POSITION



3. DEVICE MAY BE OPERATED WITHOUT REFERENCE TO "CONTROL" BUT WORK PERMITS MUST BE THROUGH CONTROL



NOTES

1. DO NOT SCALE DRAWING - ONLY DIMENSIONS SHOWN TO BE USED.
2. THE CONTRACTOR SHALL VERIFY ALL CONDITIONS, DIMENSIONS AND LEVELS ON THE SITE AND NOTIFY THE NEC SUPERVISOR OF ANY VARIATIONS BEFORE CONSTRUCTION.

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Transnet Port Terminals

TRANSNET LTD
202 SMITH STREET
DURBAN
P.O. BOX 36136, DURBAN

**NGQURA CONTAINER TERMINAL**

TPT SUBSTATION
UPGRADE
252-SSUB-001A SUBSTATION
MV SINGLE LINE DIAGRAM AND FLOOR PLANS

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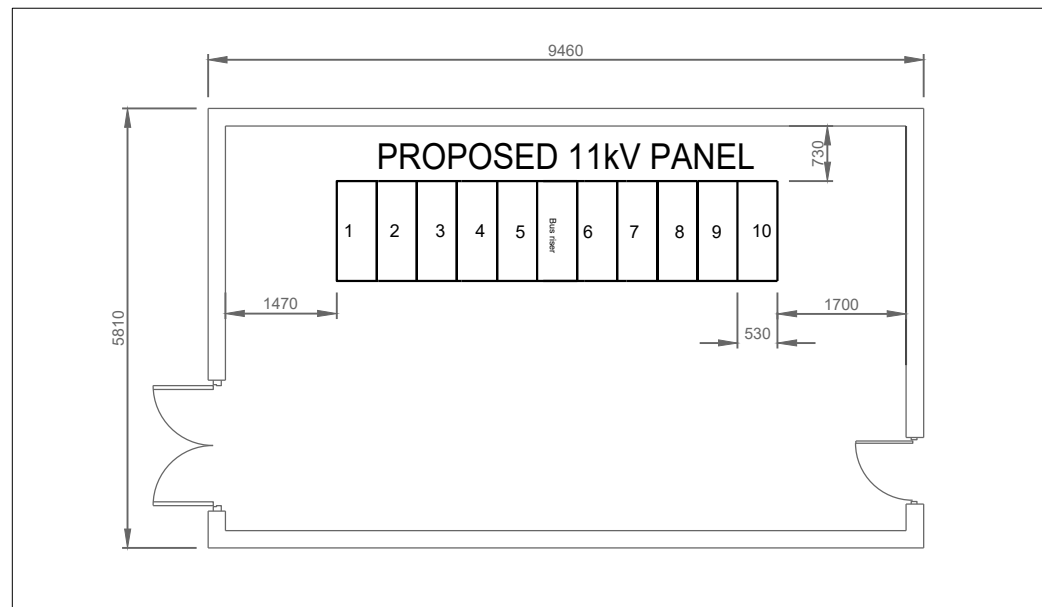
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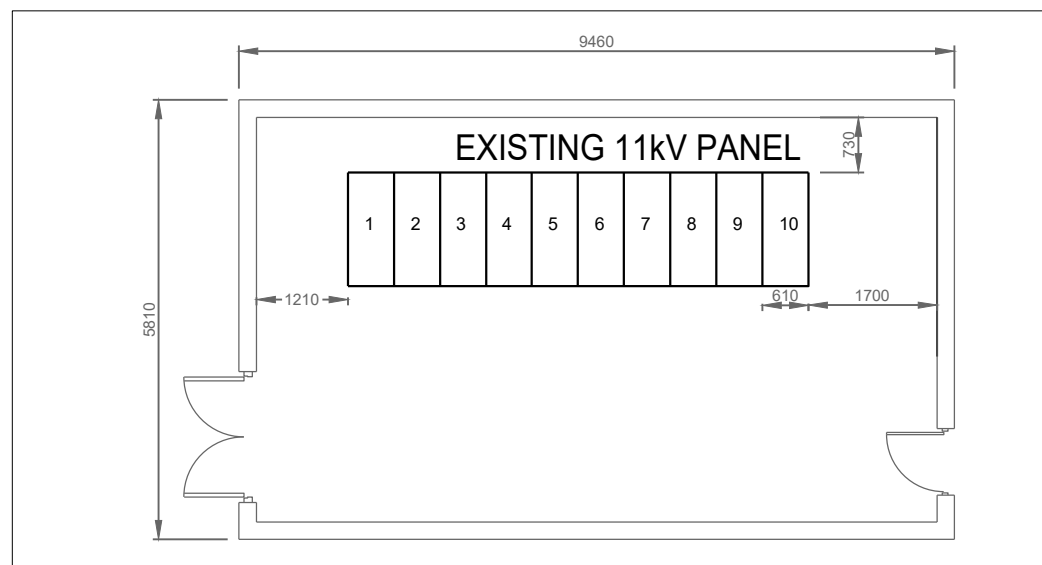
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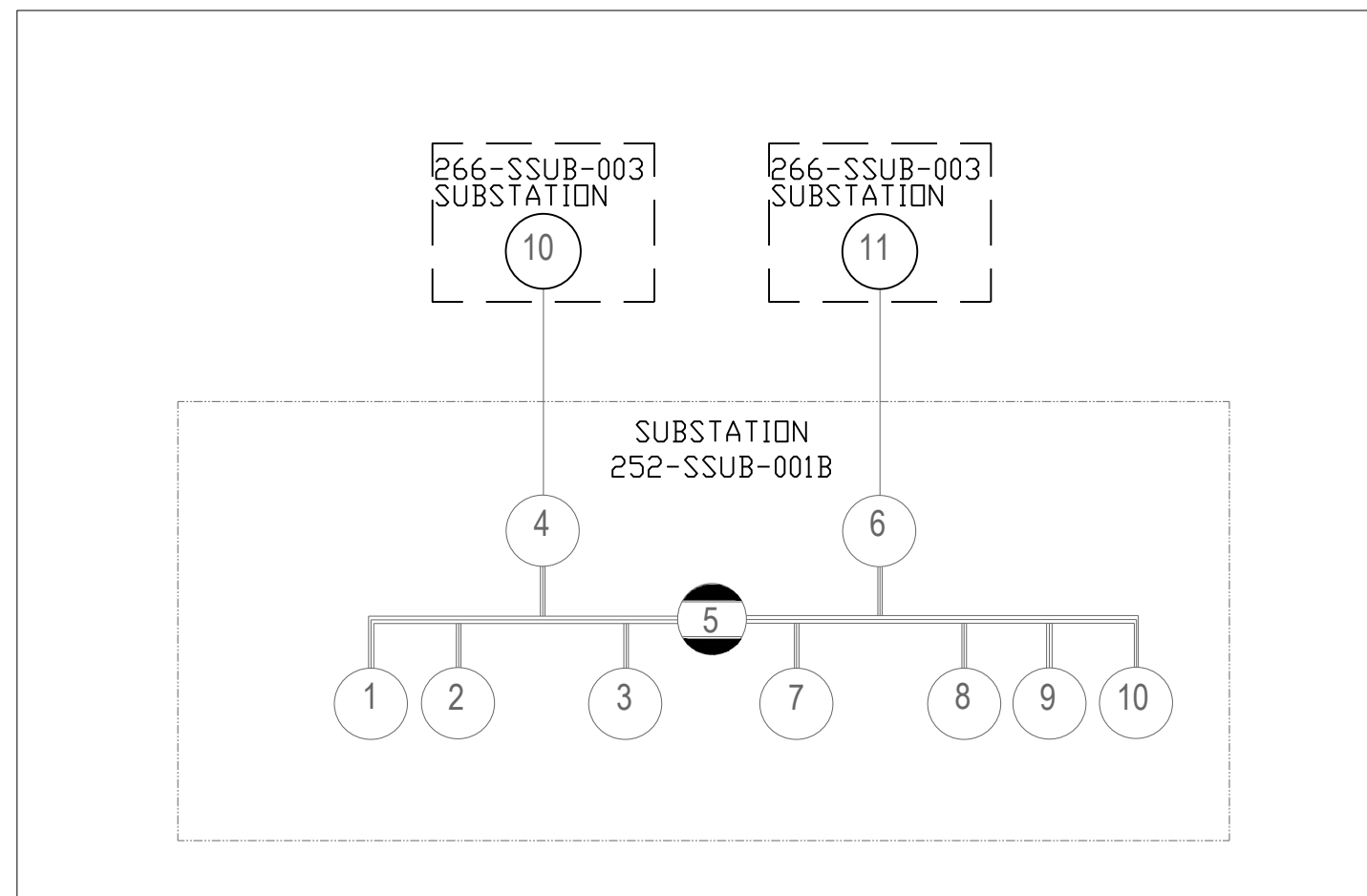
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252-SSUB-001B SUBSTATION PROPOSED MV FLOOR PLAN



SCALE 1:100

252-SSUB-001B SUBSTATION EXISTING MV FLOOR PLAN



252-SSUB-001A SUBSTATION LINE DIAGRAM

NOTES:

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kVA UNLESS OTHERWISE INDICATED



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DRAWING NO.	REFERENCE
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Transnet Port Terminals

TRANSNET LTD
202 SMITH STREET
DURBAN
P.O. BOX 36136, DURBAN



NGQURA CONTAINER TERMINAL

TPT SUBSTATION
UPGRADE
252-SSUB-001B SUBSTATION
MV SINGLE LINE DIAGRAM AND FLOOR PLANS

PROJECT NUMBER					OD	FBS		DIS	TYPE	DRAWING NO.	SHEET	REV	I
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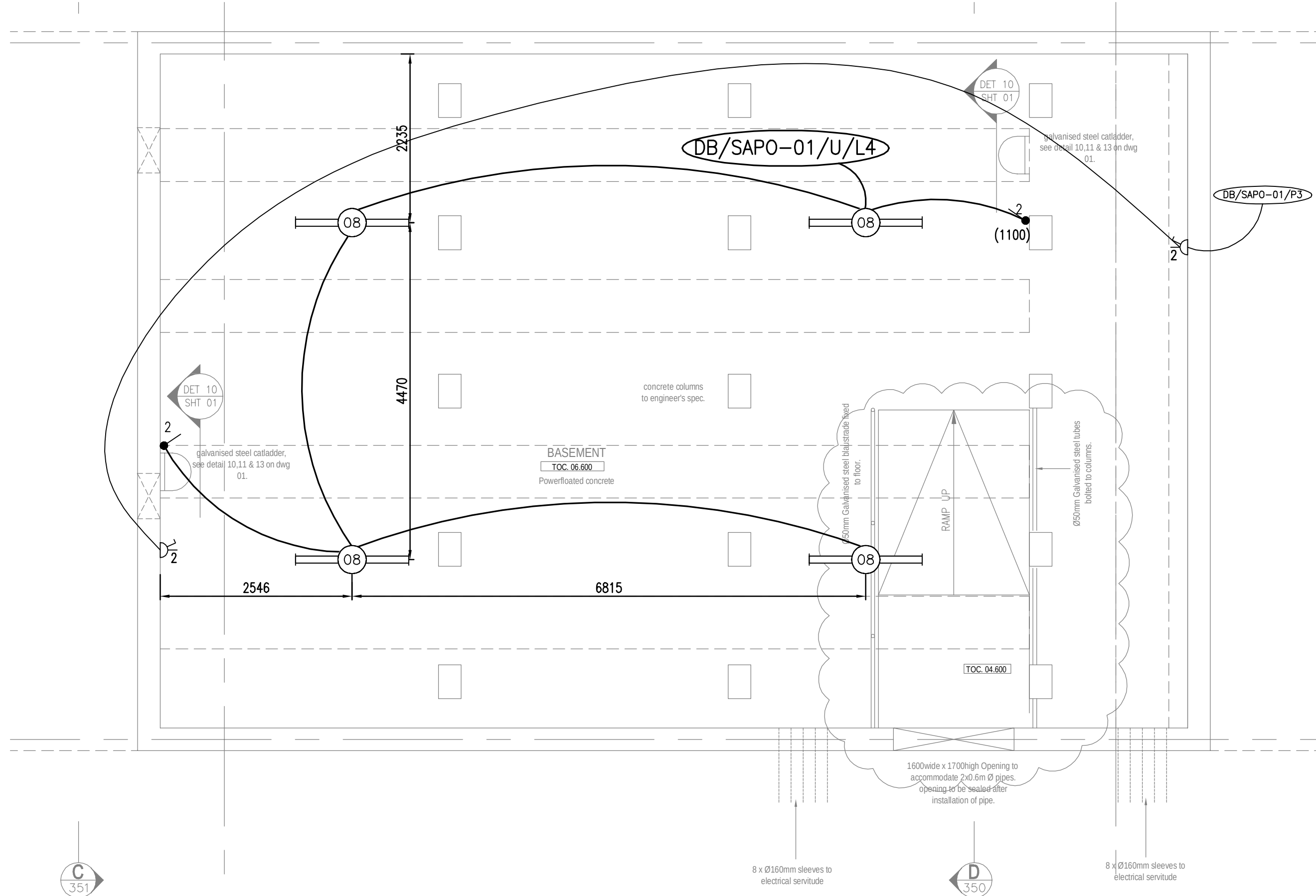
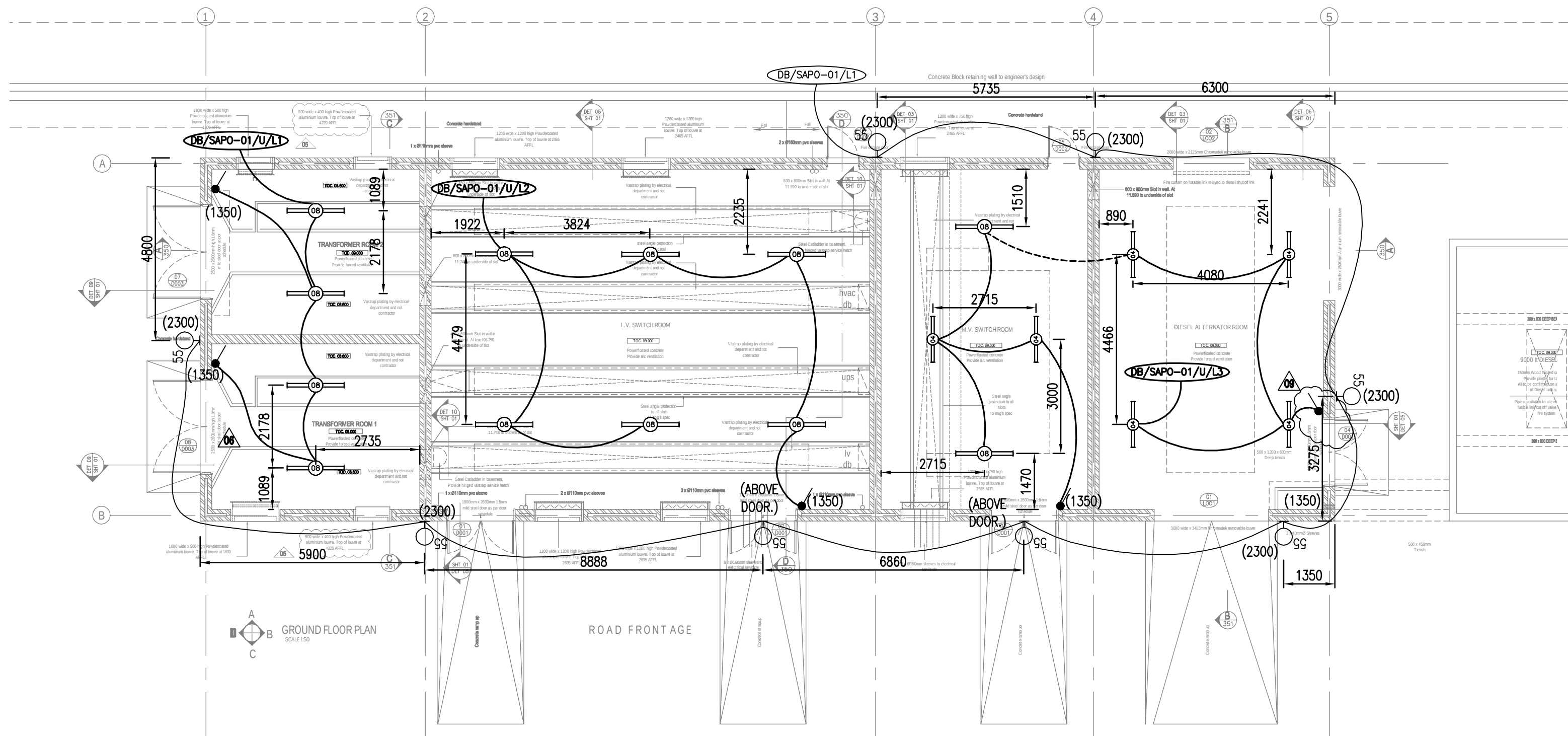
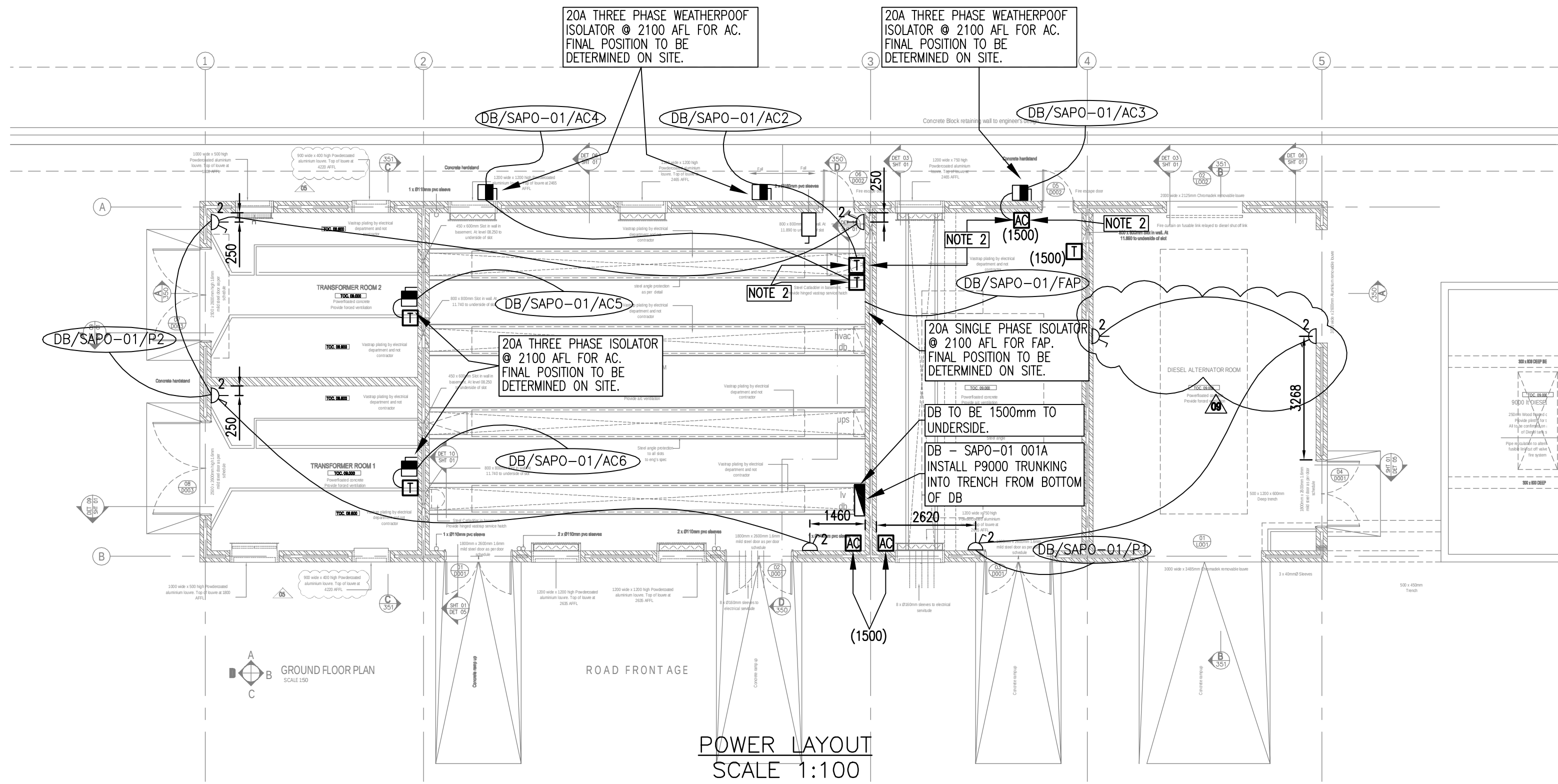
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BASEMENT FLOOR PLAN
SCALE 1:50

BASEMENT LIGHTING LAYOUT
SCALE 1:50

LEGEND:

- DOUBLE 16AMP SWITCHED SOCKET OUTLET - LEGRAND OR SIMILAR APPROVED.
- SINGLE PHASE ISOLATOR
- THREE PHASE ISOLATOR
- ELECTRICAL DB
- TEMPERATURE SENSOR @ 1350 AFFL.
- AIR CONDITIONING CONTROLLER

NOTES

- ALL SSO'S TO BE 300mm A.F.F.L.
- 20mmØ CONDUIT TO AC UNIT

LEGEND:

- 2 X 35W CHANNEL FLUORESCENT WITH PRISMATIC DIFFUSER, ECG, 1500mm LONG
- 2 x PL9W COMPACT FLUORESCENT SURFACE BULKHEAD, UNILUX - WEATHERPROOF-WALL MOUNTED
- 2 X 28W CHANNEL FLUORESCENT WITH PRISMATIC DIFFUSER, ECG, 1200mm LONG
- SINGLE LEVER LIGHT SWITCH



OPTION .A.

E214-6013



PORT OF NGQURA - PORT INFRASTRUCTURE
PORT BUILDINGS
SAPO-001A 11KV SUBSTATION
SMALL POWER & LIGHTING LAYOUT

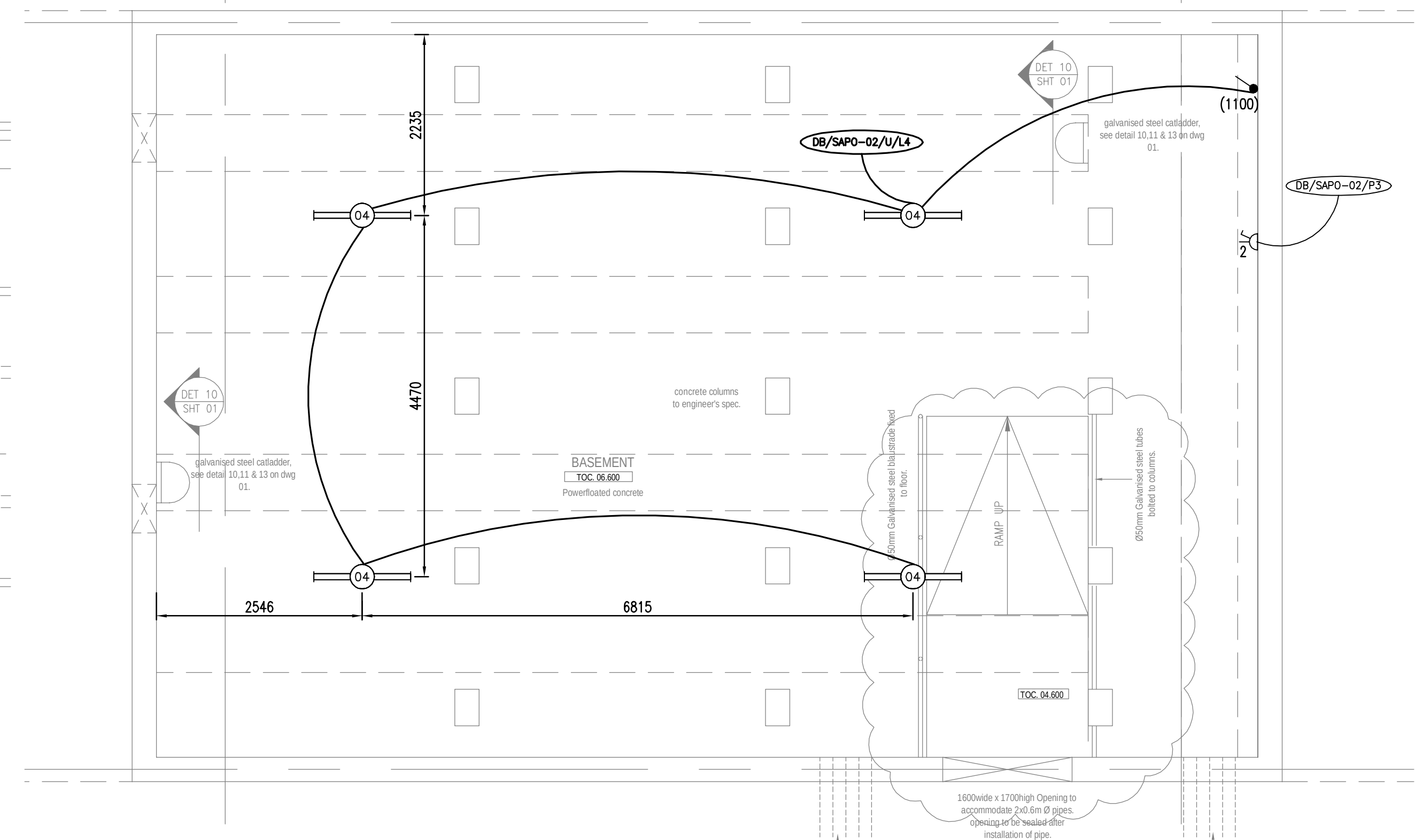
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PROJECT MGR.				ENG. MANAGER			
DIVISION				AREA MANAGER			
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						GINO MAZZUCHETTI	09/02/03
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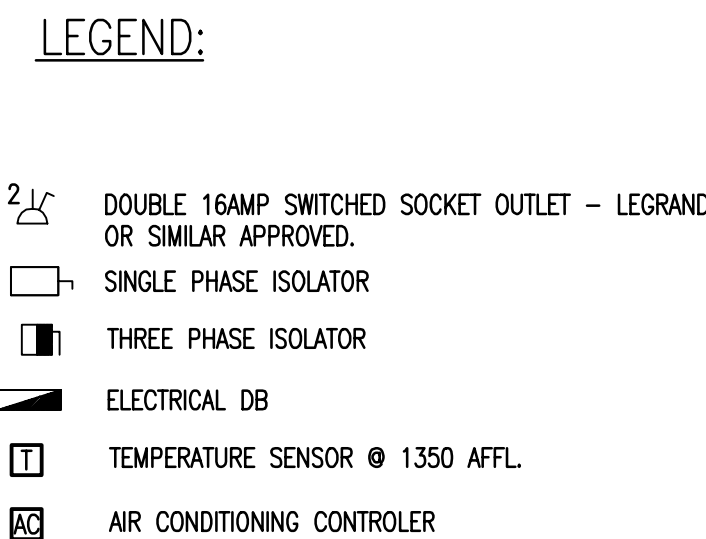
PACKAGE NO: C025

DRAWING NO. REFERENCE
REFERENCE DRAWINGS



BASEMENT FLOOR PLAN
SCALE 1:50

BASEMENT LIGHTING LAYOUT
SCALE 1:50



NOTES

1. ALL SSO'S TO BE 300mm A.F.F.L
2. 20mmØ CONDUIT TO AC UNIT

LEGEND:

- | | |
|---|---|
|  | 2 X 35W CHANNEL FLUORESCENT WITH
PRISMATIC DIFFUSER, ECG, 1500mm LONG |
|  | 2 X 19W COMPACT FLUORESCENT SURFACE
BULKHEAD, UNILUX - WEATHERPROOF - WALL MOUNTED |
|  | 2 X 28W CHANNEL FLUORESCENT WITH
PRISMATIC DIFFUSER, ECG, 1200mm LONG |
|  | SINGLE LEVER LIGHT SWITCH |

MASTER
2010-02-17
HITROG
Gold Version
TRANSNET

OPTION .A.

E214-6015



PORT OF NGQURA – PORT INFRASTRUCTURE
PORT BUILDINGS SAPO-001B 11KV SUBSTATION SMALL POWER & LIGHTING LAYOUT

PACKAGE NO: C025

07	AS BUILT INFORMATION ADDED FOR RECORD.	S.B	S.X.R	<i>SA</i>	28.01.10
06	FOR CONTRACTORS' FINAL MARK UP.	S.B	S.X.R	G.M	08.10.09
05	NORMAL CIRCUITS CHANGED TO UPS	S.B	S.X.R	G.M	06.01.09
04	EMERGENCY LIGHTS REPLACED BY UPS	O.M.M	S.X.R	G.M	28.08.00
03	DIMENSIONS ADDED AND DB HEIGHT SHOWN	O.M.M	S.X.R	G.M	10.07.00
02	MOUNTING HEIGHTS SHOWN AND AC CIRCUITS CHANGED.	S.B	S.X.R	G.M	20.06.00
01	REVISED AS PER ARCHITECTURAL DRAWINGS	O.M.M	S.X.R	S.X.R	11.04.00
00	ISSUED FOR CONSTRUCTION	O.M.M	S.X.R	S.X.R	23.01.00
NO.	DESCRIPTION	BY	CHK'D	APP'D	DATE
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PROJECT MGR.						ENG. MANAGER			
DIVISION					AREA MANAGER				
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TRANSNET
 TRANSNET PROJECTS

PORT OF NGQURA – PORT INFRASTRUCTURE

PORT BUILDINGS

SAPO-001B 11KV SUBSTATION

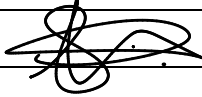
SMALL POWER & LIGHTING LAYOUT

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SPECIFICATION FOR LOW VOLTAGE DISTRIBUTION BOARDS

This specification covers Transnet's requirements for low voltage distribution boards

REVISIONS		
REV	DATE	APPROVED
0	September 2022	

INDEX

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1	SCOPE
2	REFERENCES
3	SERVICE CONDITIONS
4	DRAWINGS AND INSTRUCTION MANUALS
5	STANDARD OF WORK, EQUIPMENT & MATERIALS
6	DISTRIBUTION BOARDS
7	ARC DETECTION SYSTEM
8	FUSE SWITCHES
9	FUSE LINKS
10.	AIR CIRCUIT BREAKERS (ACB)
11.	MOULDED CASE CIRCUIT BREAKERS
12.	MINIATURE CIRCUIT BREAKERS
13.	CONTACTORS
14.	LIGHTNING AND SURGE PROTECTION
15.	ANTI-CONDENSATION HEATERS
16.	INDICATING INSTRUMENTS
17.	CURRENT TRANSFORMERS
18.	MECHANICAL CABLE GLANDS
19.	LIGHT SENSITIVE CONTROL UNIT
20.	EARTHING
21.	CABLING AND WIRING
22.	LABELS
23.	PAINTING
24.	ADDITIONS AND MODIFICATIONS TO EXISTING DISTRIBUTION BOARDS
25.	INSPECTION
26.	TESTS
27.	GUARANTEE
28.	SPARES

1. SCOPE

1.1. This specification covers Transnet's requirements regarding the design, supply, manufacture, population, works testing, delivery to site, site erection, site testing and commissioning of low voltage Distribution Switchboards consisting of fuse switches incorporating high rupturing capacity cartridge fuse links, air circuit breakers, moulded case circuit breakers and auxiliary equipment. The tenderer is 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.

2. REFERENCES

2.1. The following publications (latest edition) are referred to herein:-

2.1.1. SOUTH AFRICAN BUREAU OF STANDARDS

Codes of Practice

SANS064	The preparation of steel surfaces for coating
SANS10111	Engineering Drawings.
SANS10142	Wiring of premises Part 1: Low voltage installations
SANS10313	Protection against lightning - Physical damage to structures and life hazard

Specifications

SANS60947	Low-voltage switchgear and control gear
SANS156	Moulded-case circuit breakers
SANS60269	Low-voltage fuses
SANS1091	National colour standards for paint
SANS1195	Busbars
SANS1274	Coating applied by the powder coating process
SANS1973-1	Low-voltage switchgear and control gear assemblies Part 1: Type-tested assemblies with stated deviations and a rated short-circuit withstand strength above 10 kA
SANS1973-3	Low-voltage switchgear and control gear assemblies Part 3: Safety of assemblies with a rated prospective short-circuit current of up to and including 10 kA
SANS60529	Degrees of protection provided by enclosures (IP Code)
SANS1507	Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V)
SABS ISO 9000	Quality management systems -- Fundamentals and vocabulary
SANS1019	Standard voltages, currents and insulation levels for electricity supply
SANS170	Fasteners

International Electrotechnical Commission

BS 3938	Current Transformers
IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems.
IEC 60051	Direct acting indicating analogue electrical measuring instruments and their accessories

3. SERVICE CONDITIONS

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

3.1.1 Ambient/Environment Conditions:

- 3.1.1.1 Ambient temperature- 5°C to +40°C (daily average +35 °C).
- 3.1.1.2 Relative humidity- As high as 95%
- 3.1.1.3 Lightning conditions- Severe, with a maximum lightning ground flash density of eleven (11) flashes per km² per annum.
- 3.1.1.4 Atmosphere- Salt laden and corrosive industrial atmosphere

3.1.2 Electrical Conditions:

- 3.1.2.1 The system of supply shall be three phase, 4 wire, 50 Hz alternating current with solidly earthed neutral at a nominal voltage of 400 / 231 Volts.
- 3.1.2.2 The voltage may vary within the range of 95% to 105% of the nominal and all equipment installed shall be suitably rated.
- 3.1.2.3 All equipment shall be adequately rated for prospective fault level ratings.

4 DRAWINGS AND INSTRUCTION MANUALS

- 4.1 All drawings shall be in accordance with SANS 10111 – Engineering Drawings.
- 4.2 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.
 - 4.2.1 THREE (3) sets of detailed drawings and instruction manuals, with illustrations where necessary and 2 sets of prints of the "As Built" General Arrangement drawings and the schematic and wiring diagrams to facilitate erection and adjustment of the switchgear.
 - 4.2.2 A full set of electronic media including all information requested above.
 - 4.2.3 These instruction manuals and drawings shall be supplied as soon as possible after placing of the order, but before delivery of the equipment.

5. STANDARD OF WORK, EQUIPMENT & MATERIALS

- 5.1. The distribution board shall conform to the requirements of the latest edition and amendments of SANS 10142-1 Code of Practice for the Wiring of Premises Part 1: Low voltage installations and any additional requirements thereto, described in this specification.
- 5.2. 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.
- 5.3. If any special tools are required for the maintenance of the switchboard, the tenderer shall supply three (3) sets at delivery of the switchboard to site.

6. DISTRIBUTION BOARDS

6.1. The distribution board shall comply with SANS 60439-1

6.1.1. The form of separation will be specified in the project specific documentation.

6.2. The degree of protection shall be to IEC Publication 144/EN60529 and shall conform to the following:

- Inside Substations and MCC Rooms: IP42
- Other Locations: IP65

6.3. The distribution board shall consist of either a framework of substantial steel sections covered with heavy gauge steel plates or of folded sheet steel sections, forming a robust construction.

6.4. 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

6.5. Every board shall be fitted with 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.

6.6. 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

6.7. Lifting lugs shall be provided for floor standing enclosures and as needed for wall mounted enclosures.

6.8. The board shall have a separate latches hinged or removable front cover secured to the board by means of suitable captive type screws or bolts. When the cover is removed/ opened, easy access to that compartments components and wiring shall be possible.

6.8.1. The control units shall be mounted flush with the front cover so that only the operating handles protrude.

6.8.2. Large removable panels shall be supplied with handles for easy handling.

6.8.3. No possibility should exist for panels to come into contact with live parts.

6.9. 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.

6.10. The board shall be equipped with a set of 3 phase and neutral copper busbars. The 3 phase busbars shall be continuously rated for the full load of the incoming supply switch. The neutral shall be 100% of the phase busbars. Earth bar shall be rated to fault current and touch voltage.



- 6.11. All busbars shall be designed, manufactured, marked and tested in accordance with SANS1195.
- 6.12. Busbar rating shall be 2A/mm^2 up to 630A and 1.6A/mm^2 thereafter.
- 6.13. Busbar temperature shall not exceed a 40°C temperature rise.
- 6.14. The busbars shall be adequately braced and supported. The busbars shall be covered with a sufficient number of layers of high quality insulating tape or heat shrinkable sleeving and finished in standard colours.
- 6.15. Where busbar joints and terminations have not been covered, a kit shall be provided for covering during installation.
- 6.16. Alternatively, busbars shall be suitable enclosed in a busbar chamber or behind a protective barrier for protection against inadvertent contact with "live" busbars with access panels removed.
- 6.17. Inter-connectors between the 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 if the rating exceeds 400 A or if the fault current exceeds 25kA rating. No conductor of less than 16mm^2 shall be used between busbars and control units. All conductors shall be suitably rated for the fault level.
- 6.18. The other terminals of the incoming and outgoing panel units shall be connected by means of conductors conforming to clause 6.17, i.e. they shall be robust, insulated, easily accessible terminals, of adequate size, conveniently located in the distribution board near the incoming and outgoing cable entries but with sufficient clearance and space to enable the incoming and outgoing cables to be connected to their corresponding terminals without difficulty or strain.
- 6.19. All the outgoing connections of MCCB'S greater than 400A 3 phase shall be done by means of copper bus bars, securely clamped using approved busbar clamping insulators, fixed to a robust metal section of adequate size, conveniently located in the rear of the distribution board to enable the incoming cables to be terminated in the back of the distribution board cubical behind each respective MCCB. This is to allow for the easy termination of the larger incoming cables, with sufficient clearance and space to enable the outgoing cables to be connected to their corresponding busbar terminals without difficulty or strain to the MCCB's. Each MCCB up to 250A shall be fitted with extended terminal complete with phase barriers as supplied by circuit breaker supplier.
- 6.20. Outgoing cable tails that connect to the busbars in clause 6.19 shall have securing places to enable the cable to be secured with nylon type cable fasteners in an approved manner.
- 6.21. The busbars that protrude into the back compartment of the distribution board shall be covered with a perspex type barrier and shall have danger signs on each section.
- 6.22. Removable gland plates shall be provided. 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). Gland Plates shall not be mounted less than 300mm above ground floor level, alternatively a base frame of suitable depth may be provided.
- 6.23. Distribution board cases shall be of such dimensions that adequate space is available for manoeuvring and connecting the incoming and outgoing cables.

- 6.24. All cable entries shall be from the bottom of the distribution board unless stated otherwise.
- 6.25. Glands shall not be less than 300mm above floor level. Unless otherwise stated.
- 6.26. The terminals of all incoming and outgoing cables shall be firmly connected to the terminals on the lugs or ferrules, unless they are of a type that will grip the cable without splaying the strands of the conductor.
- 6.27. A substantial earthing terminal shall be firmly attached to the metal work of the distribution board and connected to an earth bar of cross sectional area not less than 50% of the phase bars, running the full length of the distribution board to which all earthing conductors of the incoming and outgoing circuits shall be firmly connected.
- 6.28. A removable link shall be provided in the Neutral busbar to ensure that the neutral busbar can be split in two sections for testing purposes. The link shall be secured in position with a bolt and nut arrangement.
- 6.29. The distribution board manufacturer shall allow for at least 30% capacity for the installation of additional switchgear in the distribution boards.
- 6.30. Each distribution board shall be fitted with the following labels as needed in suitable positions:
- Live busbars
 - Flash signs
 - Main label (always required)
 - Voltage rating
 - Current rating
 - Fault level and time
 - IP rating
 - Job number
 - Reference number
 - Date of manufacture
 - Form of separation
 - Fed from
 - Each feeder/starter to be labelled
- 6.31. Each distribution board shall be supplied with a test certificate. This certificate shall include all items as indicated in annexure 1 of SANS 1973–1 and annexure E of SANS 1973–3.

7. ARC DETECTION SYSTEM

- 7.1. All switchgears shall be equipped with an efficient and reliable arc detection system designed according to IEC 61508 with a safety level meeting at least SIL 2.
- 7.2. The system shall consist of one or more arc monitoring units and light detectors.

7.2.1. Arc detection system:

Arc detection system shall not be activated by interfering influences such as portable lamps, electro-magnetic fields, vibration or touching. In case of an arc occurring in the switchgear it shall be possible to identify where and when the arc has occurred. This information should be accessible without opening the switchgear door and stored even if power is lost to the system. The HMI shall not affect the IP degree of the cabinet.

7.2.2. Arc monitoring unit and light detector:

The arc detection system shall use light as the main condition for tripping. Detectors shall cover each bus-bar section, respective circuit breaker and in any other areas where the designer of the switch gear considers or finds it as a potential risk for an arc. The detectors shall be made of optical fibre in order to avoid EMC disturbances. Without any extra calibration from the user the system shall not react for a light intensity lower than 3000 lux in order to avoid nuisance tripping. The light intensity shall also be constant regardless the length of the detector.

7.3. The trip signal shall be sent within less than 2 ms to the circuit breaker in an event of an arc

7.4. The arc monitoring unit shall provide at least three high speed solid state tripping outputs to the circuit breaker.

7.5. It shall be possible to configure the detectors to trip different breakers depending on which detector detects the arc.

7.6. The system shall have the possibility to mount up to 30 detectors in the space of the main unit in order to avoid space issues if the system would be extended.

8. FUSE SWITCHES

8.1. Fuse switches shall comply with SANS 152 and SANS 60947 – 3.

8.2. Fuse switches shall be enclosed, triple pole, quick break and dustproof.

8.3. Fuse switch handle shall have an IP rating of IP65 and the handle shall be defeatable to override the door interlock.

8.4. Fuse switches shall be of the double break type and the fuses shall be completely isolated when the switches are in the "OFF" position.

8.5. Fuse switch and handle shall have a test position. It will be possible to have an auxiliary for only indication test position.

8.6. The 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.

8.7. 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 nonhygroscopic, with a hard gloss black finish.

8.8. It shall be possible to install the fuse switch in any position without derating.

9. FUSE LINKS

9.1. HRC Fuse Links shall be of the high rupturing capacity type, compliant with SANS IEC 60269 –

1:2006. 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.

9.2. Breaking capacity of all fuse links shall be not less than Category of duty AC.50 at 415 Volts (SANS IEC 60269 - 1:2006). The Fusing factor of the fuses shall not exceed 1.5 (SANS IEC 60269 Class Q1).

9.3. 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.

9.4. 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.

10. AIR CIRCUIT BREAKERS (ACB) SHALL CONFORM TO THE FOLLOWING CHARACTERISTICS.

10.1. Functional characteristics:

10.1.1. Air circuit breakers for use on the incoming supply side of the distribution board shall comply with SANS 60947.

10.1.2. The circuit breakers shall have a continuous enclosed current rating as indicated on the relevant drawings with a minimum Icu (ultimate breaking capacity) of 42kA at 415 volts. The circuit breakers shall be tested for category P.2, unless specified otherwise.

10.1.3. The circuit breakers shall have an Ics (service capacity) rating equal to the Icu (ultimate breaking capacity) rating.

10.1.4. The circuit breakers shall have an Icw (withstand current) of 1 sec and 3 sec. The 1 sec Icw rating shall be equal to the Icu rating.

10.1.5. The air circuit breakers shall be of the enclosed, ventilated, independent manual spring, draw-out type with a rated service voltage of 690 volts and a rated insulation voltage of 1000 volts and be equipped for shunt tripping from a 115 V DC battery supply. The shunt tripping facility shall be wired so that the ACB shall trip when it's associated high voltage transformer circuit breaker trips.

10.1.6. The circuit-breakers shall have a rated impulse withstand voltage of 12 kV.

10.1.7. The rated uninterrupted current shall be between 100 and 6300 A with the possibility of set trip threshold of L protection from 40A.

10.1.8. Different versions of circuit-breakers shall be available, divided into their category of use: A (current-limiting) and B (selective).

10.1.9. Different versions shall be available with rated ultimate breaking capacity from 42 to 150 kA at 440 V AC and from 42 to 100 kA at 690 V AC for circuit-breakers in category B and with 130 kA at 415 V AC, 85 kA at 690 V AC for circuit-breakers in category A.

10.1.10. The mechanical life shall be at least 12000 operations with a frequency of 60 operations/hour without the need for maintenance of the contacts and arcing chambers

- 10.1.11. The electrical life at a voltage of 440 V AC shall be (with a frequency of at least 10 operations/hour and without the need for maintenance of the contacts and arcing chambers):
- at least 9000 operations up to 2000 A
 - at least 5000 operations up to 3200 A
- These values are intended to be valid only for category B circuit-breakers.

10.2. Environmental characteristics

- 10.2.1. Operating temperature: -25 °C...+70 °C (-13 °F...158 °F) and storage temperature: -40
- 10.2.2. Altitude: operation without derating shall be up to 2000 metres above sea level. (6600 ft), and with derating up to 5000 metres above sea level. (16500 ft).
- 10.2.3. Suitability for use in a hot-humid environment. With regard to this, the circuit-breakers shall undergo a tropicalisation process which makes them suitable for use in a hot-humid environment, as established by the prescriptions of the main shipping registers and in accordance with the international IEC 60068-2-30 Standards.

10.3. Construction characteristics

- 10.3.1. All the models shall be available in the 3 and 4 pole versions both in the fixed (with rear horizontal, rear vertical and front terminals) and withdrawable (with rear horizontal, rear vertical, front and front terminals) versions.
- 10.3.2. There shall be total segregation between power and front shield, using double insulation where suitable so as to guarantee maximum operator safety.
- 10.3.3. Total segregation between the phases shall be guaranteed for safety reasons without need of phase barriers up to 1000V.
- 10.3.4. It shall be possible to inspect easily the arcing chambers easily and to check main contact wear with the circuit-breaker racked-out, by removing the arcing chambers.
- 10.3.5. All the circuit-breakers in the range shall have the same height and depth with the aim of standardising the supporting structures of the switchgear and the switchgear itself as far as possible.
- 10.3.6. IP30 degree of protection shall be guaranteed on the front part and IP20 on the rest of the circuit-breaker (excluding the terminals), with the possibility of having IP54 degree of protection (NEMA 3/3s/13) on the front, using the transparent cover which completely protects the front, but still leaves the panel underneath and the protection unit fully visible with the relative indications.
- 10.3.7. The whole range of air circuit-breakers shall be fitted with electronic protection releases. It shall be allowed the inter-changeability of protection releases from skilled personnel.

10.4. Special points for withdrawable versions:

- 10.4.1. The circuit-breakers in the withdrawable version shall be fitted with anti-racking-in locks to prevent racking a moving part into a fixed part with a different rated current.
- 10.4.2. In the case of the withdrawable version, the presence of a device shall prevent racking-out and racking-in with the apparatus closed.



10.5. Accessories

The following accessories shall be common to the whole range standard:

10.5.1. Electrical accessories:

- 10.5.1.1. Shunt opening/closing release.
- 10.5.1.2. Control and monitoring Test Unit - allows continuity of the different versions of the shunt opening releases to be checked;
- 10.5.1.3. Undervoltage release;
- 10.5.1.4. Time delay device for undervoltage release - allows release trip delay with established and adjustable times;
- 10.5.1.5. Geared motor for the automatic charging of the closing springs;
- 10.5.1.6. Mechanical and electrical signalling of overcurrent release trip;
- 10.5.1.7. Trip reset release;
- 10.5.1.8. Auxiliary contacts which allow signalling of the circuit-breaker state;
- 10.5.1.9. Current transformer for the neutral conductor outside the circuit-breaker;
- 10.5.1.10. Homopolar toroid for the main power supply earth conductor (star centre of the transformer).

10.5.2. Mechanical accessories:

- 10.5.2.1. Interlocks between 2 circuit-breakers or among three circuit-breakers can be used horizontally, vertically or in "L" position using different types of flexible cables:
- 10.5.2.2. Standard version (with maximum distance between two circuit breakers: up to 1200 mm if horizontally interlocked while up to 750mm if vertically interlocked).
- 10.5.2.3. Extended version (with distance between two circuit breakers: from 1200mm up to 1600 mm if horizontally interlocked while from 750 up to 1000 if vertically interlocked).
- 10.5.2.4. Mechanical locks to control enabling racking-in/out operations available also with interlocks. IP54 transparent front protection (NEMA 3/3S/13).

10.6. Protection Release

10.6.1. Basic Protection Functions

- 10.6.1.1. The release shall not require auxiliary power supplies since the power is taken from the current transformers.
- 10.6.1.2. The signals supplied by the release shall not operate with power supply supplied by internal batteries.

- 10.6.1.3. The protection against overload (L) with characteristic $t=k/I^2$ shall always have setting ranges with timing adjustable up to 144s with $I=3I_n$.
- 10.6.1.4. The protection of neutral shall be set at 50%, 100%, 200% and OFF of the phase currents without changing any component.
- 10.6.1.5. All the protection functions except protection against overload shall be excludable.

10.6.2. Measurement Functions

- 10.6.2.1. The release shall always be able to provide measurement of the currents and voltages in the three phases, in the neutral and of earth fault (ammeter function), both in self-supply and with an auxiliary power supply. Measurement function shall be active, even without external supply, starting from 140 A of single-phase current, independently from the circuit-breaker size. Accuracy of the ammeter measurement chain (current sensor plus ammeter) shall equal or better than 1.5% in the 30% - 120% current interval of I_n .
- 10.6.2.2. The release shall not normally require auxiliary power supplies since the power is taken from the current transformers. For measurements and programming at very low currents, a power supply at 24 V DC shall be available. As alternative the release shall be able to receive power supply directly from busbars or terminals, up to line voltage equal to 690 V AC.
- 10.6.2.3. The release shall be able to acquire the waveforms of electrical values with a sampling frequency selectable from 600 to 4.800 Hz and sampling interval from 3 s to 27 s. Acquisition shall be frozen after a trip or a configurable event. Acquisition data shall be retrieved from an external device (personal computer or similar) for fault analysis purposes. The release shall show voltage measurements on display, with a precision equal or higher than 1%.
- 10.6.2.4. Measurement functions that shall be available:
 - Current measurements
 - Voltage measurements
 - Power measurements
 - Power factor measurements.
 - Measurements of frequency and peak factor
 - Energy measurements
 - Historical measurements
 - The last 10 trips information
 - Complete trip information on display without batteries
 - Data logger included as standard

10.7. Advanced Protections Functions

- 10.7.1. Thermal memory for functions L (overload protection) and S (short circuit protection).
- 10.7.2. Protection against over-temperature. It shall be possible to signal the presence of anomalous temperatures on the release by means of two LEDs (Warning and Alarm) and, if decided during the unit configuration phase, when the temperature is over 85 °C, to simultaneously control circuit-breaker opening.

- 10.7.3. Protection against missing and unbalanced phase (U) with characteristic $t=k$ shall be possible.
- 10.7.4. Load control protection (K).
- 10.7.5. Undervoltage protection (UV)
- 10.7.6. Overvoltage protection (OV)
- 10.7.7. Residual voltage protection (RV)
- 10.7.8. Underfrequency protection (UF)
- 10.7.9. Overfrequency protection (OF)
- 10.7.10. Protection against reversal of active power (RP)

10.8. User Interface and Signalling LEDs

- 10.8.1. An alarm shall indicate by means of LEDs located on the release the disconnection of opening solenoid and current transformers. A trip shall also occur, after a short time delay, when the disconnection is detected.
- 10.8.2. The release shall allow parameterisation by means of keys and a LCD graphic display.
- 10.8.3. Access to control and configuration of the unit by means of a password (edit MODE).
- 10.8.4. The signals given by the permanent indicators shall guarantee maximum reliability.
- 10.8.5. Indication shall be available directly on display on request of the user for not less than 48 hours even without an auxiliary voltage and batteries and also be given in the case of re-losing on a fault. After 48 hours of inactivity the information shall be retrievable by external devices. Indication shall contain at least the protection tripped.
- 10.8.6. It shall be possible to read the current values and information on the last 10 measures (current values, protection tripped) at any time through external devices, some of which can transmit data via bluetooth;
- 10.8.7. In the event of CB tripped, shall be indicated the type of protective function that intervened.
- 10.8.8. Each alarm or warning alarm shall be clearly shown on the display, when it is active.
- 10.8.9. On the protection release two (2) led's shall be present.
- 10.8.10. Warning LED shall be in place indicating at least the following:
 - Presence of one or more phases with current values in the $0.9 \cdot I_n < I < 1.05 \cdot I_n$ range
 - Presence, between two or three phases, of unbalance higher than the value programmed during configuration
 - The first temperature threshold of $T=70^\circ\text{C}$ has been exceeded
 - Contact wear $> 80\%$
 - Harmonic distortion
 - Out of range frequency
 - Breaker status error
 - Warning threshold override

- 10.8.11. Alarm LED shall be in place indicating at least following:
- Presence of one or more phases under overload with current values $I > 1,3 \cdot I_n$ (Overload Protection - L under timing)
 - Timing in progress for protection function S (Selective short circuit protection)
 - Timing in progress for protection function G (Earth fault protection)
 - The second temperature threshold of $T=85^\circ\text{C}$ has been exceeded
 - Contact wear 100%.
 - Timing in progress for protection function D;
 - Timing in progress for protection function UV(Under Voltage), OV(Over Voltage), RV (Residual Voltage);
 - Timing in progress for protection function RP(Reversal of Active Power);
 - Timing in progress for protection function
 - Timing in case of unbalance between the phases higher than the value set during configuration with trip set to ON;
 - Current Sensors disconnected;
 - Opening solenoid (Trip Coil) disconnected
- 10.8.12. The communication function shall be implemented on the release by means of:
- An internal bus, with interface RS485;
 - An external bus, with Modbus RS485 protocol 2-Wire Twisted Pair, 19.2 kbit/s max.
- 10.8.13. There shall be the possibility of setting the release in remote and in local operating mode, and with the latter it shall not be possible to carry out data transmission from the system to the release. It shall be possible to automatically set the local mode by means of an external contact. An 24VDC auxiliary supply shall be used.
- 10.8.14. The protection release shall be able to send to the system these data:
Protection parameters set, phase and neutral currents, state of the circuit-breaker (open closed), position of the circuit-breaker (connected-isolated), state of the springs (charged discharged), number of circuit-breaker mechanical operations, total and for each protection number of trips, last interrupted current, contact wear, state of the protection functions (pre alarm function. L, timing function. L, S,G...), overtemperature protection function, state of internal communication bus.
- 10.8.15. The system shall transmit to the protection release the following data: protection parameters, circuit-breaker opening and closing commands, reset for tripping of some protection functions.
- 10.8.16. Adjustable inverse definite minimum time (IDMT) overcurrent release facilities are required in addition to the instantaneous fault trip for the air circuit breakers.

11. MOULDED CASE CIRCUIT BREAKERS (MCCB) SHALL CONFORM TO THE FOLLOWING CHARACTERISTICS.

11.1. Functional Characteristics

11.1.1. AC rated service voltage for currents over 160 A: 690 V AC (50-60 Hz).

11.1.2. DC rated service voltage: 500 V DC for currents of 160 A and 750 V DC for currents over 160A.

- 11.1.3. Rated uninterrupted current for 1000 V AC or DC applications: 800 A (three and four poles).
- 11.1.4. Minimum rated insulation voltage for currents equal or over 160 A: 8 kV.
- 11.1.5. Rated insulation voltage for currents equal or over 160 A: 800 V AC.
- 11.1.6. Rated uninterrupted current between 160 and 3200 A with trip units settings starting from 1A.
- 11.1.7. According to IEC 60947-2 (§ 4.4) starting from 400 A the circuit breakers shall be category B
- 11.1.8. MCCBs shall be available with different ultimate short breaking capacities between 16kA and 200kA @ 380/415 V AC.
- 11.1.9. Both line up and line down supplying shall be possible without decreasing MCCBs performances or functionality
- 11.1.10. For rated uninterrupted currents up to 160 A, the MCCB limiting features shall be enough to assure its conformity to IEC 60439-1 (§ 8.2.3.1) once installed into a type AS or ANS switchboard as general breakers. This shall be valid up to the MCCB's rated uninterrupted current (limiting versions are excluded).
- 11.1.11. A test bottom for the correct functionality checking (moving contacts opening) shall be place in front of the breaker.

11.2. Ambient Characteristics

- 11.2.1. Operating temperature: -25 °C. +70 °C (ambient temperature)
- 11.2.2. Storage temperature: -40 °C .. +70 °C (ambient temperature)
- 11.2.3. Reference temperature for setting the thermal element of the thermomagnetic trip unit: +40 °C
- 11.2.4. Maximum relative humidity: 98%
- 11.2.5. Maximum altitude: 2000 m above sea level, 5000 m above sea level with derating suitability for being used in hot-humid places. With regard to this, the circuit-breakers shall undergo a tropicalization process to make them suitable for use in hot-humid places, as established in the prescriptions of the major naval registers and in compliance with the International IEC 60068-2-30 Standards.
- 11.2.6. Circuit-breakers fitted with electronic trip units shall comply with the prescriptions of the International Standards on electromagnetic compatibility.

11.3. Construction Characteristics

- 11.3.1. The range of moulded case circuit-breakers shall cover a range of rated uninterrupted currents from 160 to 3200 A
- 11.3.2. By means of the double insulation technique, moulded case circuit-breakers shall guarantee complete separation between the power circuits and the auxiliary circuits.
- 11.3.3. Moulded case circuit-breakers shall have an operating lever which always indicates the exact position of the circuit-breaker contacts (positive operation), by means of safe and reliable signals (I= closed, O= open, yellow-green line= open due to trip unit).

- 11.3.4. The operating mechanism shall be designed to operate all poles of the circuit breaker simultaneously for making, breaking and tripping.
- 11.3.5. Moulded case circuit-breakers shall be suitable for isolation in compliance with § 7.2.7 of the IEC 60947-2 Standard. This indication shall be clearly and indelibly marked on the circuit-breaker (in accordance with § 5.2 of IEC 60947-2) and in a position where it is visible with the circuit-breaker installed.
- 11.3.6. Moulded case circuit-breakers shall be available in the three-pole and four-pole version both in the fixed, and in any possible plug-in or withdrawable versions.
- 11.3.7. Circuit-breakers in the plug-in version starting from 250 A shall be available. In the case of a plug-in or withdrawable version, the presence of a device shall prevent racking-in or racking-out with the apparatus closed.
- 11.3.8. In the withdrawable version, racking-out with the door closed shall be possible.
- 11.3.9. The same depth and installation on a DIN EN 50022 rail shall be guaranteed up to the rated setting of 250 A inclusive. The same depth shall be guaranteed. This characteristic shall allow the switchboard and their support structures to be standardized.
- 11.3.10. Moulded case circuit-breakers with rated uninterrupted current up to 250 A shall have a 45 mm high face which makes them suitable for installation on modular panels.
- 11.3.11. All the installation positions shall be possible without jeopardizing the function of the apparatus. Starting from 630 A up to 1600 A the withdrawable version shall be mounted and operated horizontally.
- 11.3.12. For the front parts of the circuit-breakers the degree of protection of at least IP20 (excluding the terminals) shall be guaranteed, IP30 when they are installed in switchboards, and up to IP54 for circuit-breakers installed in a switchboard fitted with transmitted rotary handle and special accessory.

11.4. Protection Trip Units

- 11.4.1. Moulded case circuit-breakers shall be equipped with interchangeable trip units. From 160 A up to 800 A it shall be possible to choose between a thermomagnetic and an electronic protection. For the sizes higher than 800 A, the trip unit shall only be electronic. The trip unit shall be integrated in the volume of the apparatus.
- 11.4.2. From the 250 A size circuit-breakers, the trip unit shall be interchangeable. Trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings

11.5. Thermomagnetic Overcurrent Trip Units

- 11.5.1. Thermomagnetic trip units shall be fitted with protection threshold against overload (whose thermal element shall consist of a bimetal) and with protection threshold against short circuit.
- 11.5.2. The protection threshold against overload shall be continuously adjustable starting from 0.7 times the rated current of the trip unit and up to its rated value.
- 11.5.3. The reference temperature for setting the thermal element of the protection trip unit is 40°C.

11.5.4. The temperature performance of the trip unit shall be indicated as the temperature varies.

11.5.5. The protection threshold against short-circuit shall be either the fixed or adjustable type with continuity from 5 and up to 10 times the rated current of the trip unit. In the four-pole version, the neutral pole shall always be protected. For current values equal to or higher than 125 A, protection of the neutral pole shall, at choice, be at 100% or at 50% of the rated current of the trip unit. Vice versa, for current values of less than 125 A, protection of the neutral pole shall always be 100%.

11.5.6. For circuit-breakers with rated uninterrupted current of 160 A, 250 A, 400 A and 500A, a thermomagnetic trip unit shall be available for generator protection with adjustable thermal threshold, starting from $0.7 \times I_n$, and fixed magnetic threshold at $3 \times I_n$ or adjustable magnetic threshold from 2.5 to $5 \times I_n$. Suitability for use in direct current.

11.6. Magnetic only overcurrent trip units

11.6.1. The overcurrent trip units with magnetic only threshold shall be suitable for protection against short-circuit.

11.6.2. The adjustable magnetic only trip units (suitable for motor protection) shall only be available in the three-pole version, whereas those with fixed threshold shall also be available in the four-pole version.

11.6.3. The adjustable magnetic only trip units shall be available for circuit-breakers up to 320 A. Suitability for use in direct current.

11.7. Electronic Overcurrent Release Trip Units

11.7.1. The electronic overcurrent trip units shall be self-supplied and shall be able to guarantee correct operation of the protection functions even in the presence of a single phase supplied with a current value equal to 20% of the phase current. They shall be unaffected by electromagnetic interference in compliance with the EMC directive on the matter.

11.7.2. The basic version shall be fitted with protection functions against overload (function L) and against short-circuit. The latter function can either be of the instantaneous type (function I) or, alternatively, with intentional delay selective short circuit protection (function S). The function of protection against short circuit shall be excludable.

11.7.3. A basic version shall also be provided with only the protection threshold against instantaneous short-circuit which cannot be excluded.

11.7.4. The complete version shall be fitted with protection threshold against overload (function L), against instantaneous short-circuit (function I) and with intentional delay (function S) and also with protection threshold against earth fault (function G). All the protection functions except for protection against overload shall be excludable.

11.7.5. The advanced version shall be suited for zone selectivity protection for the S and G protection functions. An integrated ammeter and many other additional features are provided over and above the protection functions. All the protection functions except for protection against overload shall be excludable.

11.7.6. The advanced version shall be suited for zone selectivity protection for the S and G protection

functions. An integrated ammeter and many other additional features are provided over and above the protection functions. All the protection functions except for protection against overload shall be excludable.

- 11.7.7. A version dedicated to ultra rapid short-circuit protection (with a detection time less than 5 ms) combined with zone selectivity shall be available.
- 11.7.8. An advanced version dedicated to motor protection shall be available with protection functions against overload (function L), against instantaneous short circuit (function I), against unbalanced or missing phase (function U) and against rotor block (function R).
- 11.7.9. A version dedicated to generator protection shall be available (up to 160A), with protection functions against overload (function L), against instantaneous short circuit (function I) and with intentional delay (function S). The S and I protection functions are not an alternative to each other. All these functions are imposed by the major naval registers.
- 11.7.10. All the advanced trip units shall be available with thermal memory.
- 11.7.11. All the protection functions shall be characterized by threshold and time tolerances according to the International Standards.
- 11.7.12. The trip unit shall allow parameterization of the trip thresholds and timing locally or remotely; in the case of any anomalies in remote parameterization, the protection shall automatically use the series of parameters set manually on the front of the circuit breaker.
- 11.7.13. On the advanced version, access to information and programming shall be allowed by a keyboard and graphic liquid crystal display.
- 11.7.14. Alarm signals for the protection functions will be available by means of LEDs located on the trip unit (complete version) and/or on the display (advanced version).
- 11.7.15. The size of the current sensors shall be a minimum of 10 A to a maximum of 3200 A so as to cover the widest possible current range.
- 11.7.16. Interchangeable rating-plugs shall be available starting from 400 A.
- 11.7.17. The four-pole circuit-breaker shall always be supplied with the neutral protected at 100% up to 125A excluded, and for higher values with protection selected between 50% and 100% of the rated current of the trip unit. Starting from 630A setting of the neutral at 150% and 200% shall be possible.
- 11.7.18. The current sensors for external neutral shall be optional.
- 11.7.19. Moulded Case Circuit breakers equipped with electronic releases shall be available a dedicated function to verify the correct connection between the trip unit, current sensor and trip coil. Eventual anomalies shall be signalled by a red led flashing.
- 11.8. Accessories for electronic trip units shall be available, such as the test unit for checking functioning of the tripping coil of the electronic trip unit, a trip signalling unit of the protections, a test and configuration unit which allows the electronic trip unit protections to be tested and configured, an actuation unit which allows circuit-breaker opening and closing by means of a motor operator

mounted on it, a battery unit which allows trip unit testing when the circuit-breaker and an external unit for wireless communication.

- 11.8.1. For both the complete and the advanced version a measurement module shall be available, in order to gauge the plant functioning parameters, such as phase and phase to phase voltages, powers and energies. On the advanced version all the available measurements can be displayed on the LCD. Furthermore, for the electronic trip units for motor protection, there shall also be a contactor control unit available.
- 11.8.2. The advanced version will be provided with a data logger function that automatically records and stores the instantaneous values of all the currents and voltages. Data shall be easily downloaded to any personal computer for elaboration. The data logger function freezes the recording whenever a trip occurs, so that a detailed analysis of faults can be easily performed. The sampling rate shall be adjustable up to 4800Hz, with total sampling time up to 27 s (@ 600Hz sampling rate). Tracking of up to 64 events shall be possible.

11.9. Protections

The minimum performances of the protection functions of the electronic protection trip unit for distribution, where present, shall be:

- 11.9.1. Function L: adjustable trip threshold $I1 = (0.4-1) \times I_n$, trip curves for the basic version with time settings from 3 to 12 seconds – 2 different trip curves - (at 6 times the set threshold), whereas for the advanced version with time settings from 3 to 18 seconds – 4 different trip curves - (at 6 times the set threshold). For the advanced version, L function according to IEC 60255-3 shall be available. *Cannot be excluded.*
- 11.9.2. Function S: adjustable trip threshold $I2 = (1-10) \times I_n$, trip curves for the basic version with time settings from 0.1 to 0.25 seconds – 2 different trip curves – (at 8 times the rated current of the trip unit), whereas for the advanced version with time settings from 0.05 to 0.5 seconds – 4 different trip curves with inverse short time with definite time characteristic or curves with definite time – (at 6 times the rated current of the trip unit). For circuit breakers from 250 A to 630 A, in the advanced version, $I2 = (0.6-10) \times I_n$. *Can be excluded.*
- 11.9.3. Function I: adjustable trip threshold $I3 = (1-10) \times I_n$ for the basic version (instantaneous trip), whereas for the advanced version $I3 = (1.5-15) \times I_n$ (instantaneous trip). *Can be excluded.*
- 11.9.4. Function G: adjustable trip threshold $I4 = (0.2-1) \times I_n$ with trip time settings from 0.1 to 0.8 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.5. Function U: adjustable trip threshold $I6 = (2\% \dots 90\%) \times I1$ with trip time settings from 0.5 to 60 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.6. Function OT: fixed at 85 °C (with instantaneous trip). *Can be excluded.*

- 11.9.7. Function UV: adjustable trip threshold $U8 = (0.5-0.95) \times U_n$ with trip time settings from 0.1 to 5 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.8. Function OV: adjustable trip threshold $U9 = (1.05-1.2) \times U_n$ with trip time settings from 0.1 to 5 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.9. Function RV: adjustable trip threshold $U10 = (0.1-0.4) \times U_n$ with trip time settings from 0.5 to 30 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.10. Function RP: adjustable trip threshold $P11 = (-0.3 \dots -0.1) \times P_n$ with trip time settings from 0.5 to 25 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.11. Function UF: adjustable trip threshold $f12 = (0.9-0.99) \times f_n$ with trip time settings from 0.5 to 3 sec with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.12. Function OF: adjustable trip threshold $f13 = (1.01-1.10) \times f_n$ with trip time settings from 0.5 to 3 s with curve with inverse short time and definite time characteristic. *Can be excluded.*
- 11.9.13. The minimum performances of the protection functions of the electronic protection trip unit for motor protection shall be:
- Function L: adjustable trip threshold $I1 = (0.4-1) \times I_n$, trip curves in class 10A, 10, 20 and 30 or 3E, 5E, 10E e 20E in compliance with the IEC 60947-4-1 Standard, with temperature compensation and sensitivity to missing/unbalanced phase. *Cannot be excluded.*
 - Function R: adjustable trip threshold $I5 = (3-10) \times I1 + \text{OFF}$, with 4 different trip curves with definite time with time settings $t5 = 1 \dots 10$ s. Automatic exclusion of the function during the motor starting phase, and automatically reactivated after this. *Can be excluded.*
 - Function I: adjustable trip threshold $I3 = (6-13) \times I_n$ (instantaneous trip) with recognition of the motor starting phase.
 - Function U: adjustable trip threshold $I6 = (0.4-0.9) \times I1$ e $t6 = 4$ s. *Can be excluded.*
 - Possibility of contactor control for trip of functions L and R.
 - Possibility of connection to a PTC (temperature probe) inserted in the motor.

11.10. Dialogue

For circuit-breakers from 250 A to 1600 A dialogue shall be available, making the following functions possible:

- 11.10.1. Remote setting of the protection function parameters, unit configuration and communication.

- 11.10.2. Transmission of measurements, states and alarms from circuit-breaker to system transmission of events to the system.
- 11.10.3. Dialogue units able to support different standard market protocols shall be available:
 - 11.10.3.1. Modbus RTU protocol, EIA RS485 physical transmission means, speed 9.6...19,2 Kbit/s, bus architecture.
 - 11.10.3.2. Profibus DP protocol, RS485 physical transmission, speed 9.6...19,2 Kbit/s, bus architecture.
 - 11.10.3.3. Device Net protocol, RS485 physical transmission, speed 9.6...19,2 Kbit/s, bus architecture. Wireless bluetooth protocol.
 - 11.10.3.4. The dialogue unit shall make all the parameterization and measurement information of the protection unit available on the field bus, as well as the state of the circuit-breaker (open/closed, racked-in/racked-out) and of the related trip units. Shall be providing a tool able to analyse all these data by PC.

11.11. Accessories

11.11.1. Electrical Accessories

- 11.11.1.1. Internal Accessories has to be the same up to 250A as well from 250A to 1000A.
- 11.11.1.2. Auxiliary contacts: these shall allow the state of the circuit-breaker (open or closed; contact on change-over) and trip unit to be known. Auxiliary contacts for use at 250 V AC/DC, 400V AC and 24 V DC (digital contacts) shall be available.
- 11.11.1.3. Releases: the shunt opening and under-voltage releases shall be available with different power supply voltages both in AC and DC.
- 11.11.1.4. With circuit-breakers up to 250 A the electrical accessories shall be available both in the pre- cabled version and with 1m long un-cabled cables.
- 11.11.1.5. The addition of the electrical accessories shall not increase the volume of the circuit breakers.

11.11.2. Mechanical Accessories

- 11.11.2.1. Terminals: different types of terminals (both front and rear) shall be available for all the sizes, suitable for connection with copper, copper-aluminium cable and bus bar connections.
- 11.11.2.2. Up to the 160 A size, the circuit-breakers can be fitted with different types of terminals combined in different ways (higher of one type, lower of a different type). Terminal covers and phase separators shall also be available.
- 11.11.2.3. Multi-cable terminals shall be available for circuit-breakers for the 250-320-400-630 A size. Support for fixing onto DIN rail: supports for fixing onto DIN EN 50022 rail shall be available up to the rated current of 250 A inclusive.
- 11.11.2.4. Mechanical interlocks: mechanical interlocks shall be available for the whole series of circuit-breakers; the interlock can be of the front type for circuit-breakers with rated

current up to 250 A. It shall be possible to interlock circuit-breakers of different sizes at least up to 250 A and between 250A and 630 A.

11.11.2.5. Rotary handle: a rotary handle operating mechanism both in the direct and transmitted version shall be available for the whole range of circuit-breakers, both padlockable in the open position and fitted, on request, with the following accessories: early contact for under-voltage release, compartment door lock and key lock in open position.

11.11.2.6. The whole range of moulded case circuit-breakers shall be fitted with motor operator (according to the rated current of the circuit-breaker, this can either be of the solenoid type, or with stored energy) for remote operation of the circuit-breaker.

11.12. Residual Current Release

11.12.1. General Aspects

11.12.1.1. The residual current releases used in low voltage installations shall be designed, constructed and tested in compliance with the International Standards and in particular with:

11.12.1.1.1. IEC 60947-2 appendix B and ANNEX M

11.12.1.1.2. IEC 60255-4 and IEC 61000: for protection against unwarranted trips

11.12.1.1.3. IEC 60755 for insensitivity to the continuous current components

11.12.1.2. It shall be possible to install the residual current releases in installations with line-to-line voltage up to 690 V.

11.12.1.3. They shall be able to be used in close connection with circuit-breakers and/or switch disconnectors.

11.12.1.4. Shall be guaranteed the normal operating up to -25°C

11.13. Construction Characteristics

11.13.1. It shall be possible to combine the range of residual current releases with all the circuit breakers making up the range of moulded case circuit-breakers so as to cover the whole current range of MCCBs.

11.13.2. It shall be possible to combine the residual current releases with circuit-breakers in fixed, plug-in and withdrawable version.

11.13.3. Their installation on a DIN rail shall be possible.

11.13.4. Control of correct operation shall be possible according to the prescriptions of the reference Standards, by means of a test pushbutton on the front of the apparatus.

11.13.5. Residual current releases shall be available both in the three-pole up to 250A and in the four-pole version.

11.13.6. Dedicated residual current releases shall be available up to 1600 A

11.13.7. Type B residual current protection shall be available



- 11.13.8. It shall be possible to select the maximum threshold of sensitivity to the residual current fault frequency (3 steps: 400 700 1000 Hz).

11.14. Electrical Characteristics and Performances

- 11.14.1. Up to the rated current of 250 A, the service voltage shall be between 85 and 500 V AC line-to-line (operation up to 50 V phase-neutral). Trip thresholds I_{dn} starting from 0.03A and up to 10 A shall also be available for the advanced version which shall also allow selection of the trip times (for the basic version, the trip shall be of the instantaneous type).
- 11.14.2. A contact signalling pre-alarm shall be available in the advanced version and the availability of an input for remote opening.
- 11.14.3. There shall be type A versions for alternating pulsed current, S selective and E for emergency stop of the residual current release.
- 11.14.4. The release shall be self-supplied and the power supply can come either from above or below.
- 11.14.5. Compliance with the International Standards on the matter of electromagnetic compatibility.
- 11.14.6. There shall be a switchboard residual current unit with voltage varying between 80 and 500 V AC and between 48 and 125 V DC. There shall be availability of several adjustment ranges from 0.03 to 30 A, with trip times from instantaneous to 5 s and pre-alarm threshold adjustment.
- 11.14.7. The toroidal transformers can either be closed (from 60 to 180 mm in diameter) or open (from 110 to 230 mm in diameter).

12. MINIATURE CIRCUIT BREAKERS SHALL CONFORM TO THE FOLLOWING CHARACTERISTICS.

12.1. Functional Characteristics (1 to 63 Amps)

- 12.1.1. Miniature Circuit Breaker for cable protection according to:
 DIN VDE 0641 Teil 11,
 EN 60898, IEC 60947-2, EN 60947-2,
 UL1077/C22.2 No.235, UL489/C22.2 No.5
- 12.1.2. Rated short-circuit capacity I_{cn} shall be: 6/10/25 kA unless otherwise indicated.

12.2. Tripping Characteristics/curves shall be as follows

B: In 6/10/13/16/20/25/32/40/50/63 A
 C: In 0,5/1/1,6/2/3/4/6/8/10/13/16/20/25/32/40/50/63 A
 K: In 0,2/0,5/1/1,6/2/3/4/6/8/10/13/16/20/25/32/40/50/63 A
 Z: In 0,5/1/1,6/2/3/4/6/8/10/16/20/25/32/40/50/63 A
Number of poles: 1/2/3/4/1+NA/3+NA
Energy Limiting Class: 3
Rated Voltage U_n :
 Single-pole: 230/400 VAC
 Multi-pole: 400VAC
Max. Operating Voltage U_{Bmax} DC:
 Single Pole: 72 VDC

Double Pole: 125 VDC
Suitable for isolation acc. IEC 60898-1

12.3. Environmental Characteristics

- 12.3.1. Operating temperature: -25 °C...+70 °C and storage temperature: -40 °C...+70 °C.
- 12.3.2. Altitude: operation without derating up to 2000 m (6600 ft), and with derating up to 4000 m.
- 12.3.3. Suitability for use in a hot-humid environment. With regard to this, the circuit-breakers shall undergo a tropicalisation process which makes them suitable for use in a hot humid environment, as established by the prescriptions of the main shipping registers and in accordance with the international IEC 60068-2-30 Standards.

12.4. Construction Characteristics

- 12.4.1. Guide edge for labels
- 12.4.2. Prepared for locking devices
- 12.4.3. Quick and easy removal of installed device

12.5. Wiring

- 12.5.1. Busbars: Terminals for in and out coming feeder on top of busbars. The MCB shall have a "safe terminal". Each pole shall have 2 connection points. Combining busbar and wire in same terminal shall not be permitted. Combining wire of un-equal sizes in the same terminal shall not be permitted.

12.6. Accessories

- 12.6.1. Retrofit accessories (extract):
 - Universal signal contact/auxiliary contact (right): 1SO
 - Auxiliary contact (right): 1SO
 - Auxiliary contact (left): 1NO/1NC, 2NO or 2NC
 - Bottom-fitting auxiliary contact: 1NO or 1NC (bottom fitted without increasing width of MCB)
 - Undervoltage- or Shunt trip release
 - Hand operated neutral
 - Motor operating device (remote control)
 - DDA-Block
 - Labelling system (marked or blank)
 - Locking devices

12.7. Functional Characteristics (80 to 100 Amps)

- 12.7.1. Miniature Circuit Breaker for cable protection according to:
DIN VDE 0641 Teil 11, DIN VDE 0660 Teil 101, IEC 60898, EN 60898, IEC 60947-2, EN 60947-2
- 12.7.2. Rated short-circuit capacity shall be minimum: 6 kA unless otherwise stated.

12.8. Tripping Characteristics

- 12.8.1. B mit In 80/100 A

C mit In 80/100 A
Number of poles: 1/2/3/4
Energy Limiting Class: 3
Rated Voltage:
Single-pole: 230 VAC and 60 VDC
Single-pole: 400 VAC and 125 VDC
Suitable for isolation acc.: IEC 60947-1/-3

12.9. General Features

- 12.9.1. Label holder
- 12.9.2. Prepared to get equipped with toggle-locking device

12.10. Wiring

- 12.10.1. Busbars: Terminals for in and out coming feeder on top of busbars. The MCB shall have a "safe terminal". Each pole shall have 2 connection points. Combining busbar and wire in same terminal shall not be permitted. Combining wire of un-equal sizes in the same terminal shall not be permitted.

12.11. Accessories

- 12.11.1. Auxiliary contact: 2 or 3 contacts (screw-able or push-in-able)
- 12.11.2. Auxiliary contact (low power): 1 or 3 contacts
- 12.11.3. Signal contact or signal contact/auxiliary contact: 3 contacts
- 12.11.4. Undervoltage release or shunt trip
- 12.11.5. Neutral conductor
- 12.11.6. Printed labels
- 12.11.7. Labels for individual printing
- 12.11.8. Locking devices

12.12. Functional Characteristics (DC Protection)

- 12.12.1. Miniature Circuit Breaker for cable protection according to: DIN VDE 0641 Teil 12, DIN VDE 0660 Teil 101, IEC 60898, EN 60898, IEC 60947-2, EN 60947-2, UL1077
- 12.12.2. Rated short-circuit capacity: 4,5/6 kA

12.13. Tripping characteristics shall conform to the following

B: In 6/10/16/20/25 A
K: In 0,2/0,3/0,5/0,75/1/1,6/2/3/4/6/8/10/16/20/25/32/40/50/63 A
In 0,5/1/1,6/2/3/4/6/8/10/16/20/25/32/40/50/63A
Number of poles: 1/2/3/4 (K,Z); 1/2 (B)

Rated Voltage:

Single-pole: 230/400 VAC and 220 VDC

Multi-pole: 400 VAC and 440 VDC

Suitable for isolation acc: IEC 60947-1/-3

12.14. General Features

12.14.1. Label holder

12.14.2. Prepared to get equipped with toggle-locking device

12.15. Wiring

12.15.1. Busbars: Terminals for in and out coming feeder on top of busbars. The MCB shall have a "safe terminal". Each pole shall have 2 connection points. Combining busbar and wire in same terminal shall not be permitted. Combining wire of un-equal sizes in the same terminal shall not be permitted.

12.16. Accessories

12.16.1. Auxiliary contact: 2 or 3 contacts shall be (screw-able or push-in-able)

12.16.2. Auxiliary contact (low power): 1 or 3 contacts

12.16.3. Signal contact or signal contact/auxiliary contact: 3 contacts

12.16.4. Undervoltage release or shunt trip

12.16.5. Neutral conductor

12.16.6. Printed labels

12.16.7. Labels for individual printing

12.16.8. Locking devices

13. CONTACTORS

13.1. Contactors shall comply with SANS 60947. Duty cycle shall be AC3. Contactor coil voltage may be either 230V or 400V unless otherwise stated.

13.2. Lighting contactors for 24 to 63 Amps (AC1) shall be DIN mounted on the same rail as the MCBs and feature a DC solenoid actuator and are thus hum-free. They shall have a switching position indicator, integrated coil protection circuits and overvoltage protection for the solenoid coil up to 5kV.

13.3. Contactors from 9 to 38 Amps shall be electronic coils.

13.4. For contactors from 50 to 300 Amps, standard coils will be accepted.

13.5. Contactors from 400 to 2050 Amps shall be electronic coils.

13.6. Mixture of contactors shall not be permitted.

13.7. Ambient characteristics

13.7.1. Climatic withstand according to IEC60068-2-0 AND 60068-2-11

13.8. Construction characteristics

13.8.1. Contactors with electronic coils 9 to 38 Amps AC3 shall have:

- 13.8.1.1. Maximum of two frame sizes from 9 to 16 amps AC3
- 13.8.1.2. Width not to exceed 45mm for contactors 9 to 38 amps AC3 rating
- 13.8.1.3. Contactor up to 16 amps to include built in auxiliary contact
- 13.8.1.4. Common auxiliaries for contactors 9 to 38 amps AC3

13.8.2. Contactors 9 to 110 Amps with standard coil shall have:

- 13.8.2.1. Mounting positions: only position 6 not permitted (see appendix 1)
- 13.8.2.2. Maximum of 4 frame sizes from 9 to 110 amps
- 13.8.2.3. Quick fixing on mounting rail according to IEC 60715 standards as:-
 - 35 x 7.5 mm for 9 to 40 amps contactors
 - 35 x 15 mm for 9 to 75 amps contactors
 - 75 x 25 mm for 50 to 110 amps contactors
 - Terminal with captive screws
 - Terminal screws to be of Pozidriv type up to 75 amps AC3
 - Terminal screws to be M8 Hexagon socket for main terminals and Pozidriv for coil terminals

13.8.3. Contactors 145 to 750 Amps AC3 with Standard or Electronic Coil shall have:

- 13.8.3.1. Maximum of 4 frame sizes from 145 amp to 750 amp
- 13.8.3.2. Mechanical design to incorporate power terminal at base of contactor, operating coil to be mounted on top of contactor. Coil removal to side of contactor shall not be permitted.
- 13.8.3.3. Shall have front access to coil , with no need to remove the power cables when changing coils
- 13.8.3.4. Shall have front access to main fixed and moving contacts , without the need to remove the power cables
- 13.8.3.5. Removal and replacement of the fixed and moving contacts shall be able to be accomplished without the need to remove the power cables
- 13.8.3.6. Contactor shall have quick release quarter turn screws for easy access to main contact inspection
- 13.8.3.7. Clear marking of contactor electrical information, marking to be clearly visible on front of contactor

13.8.3.8. Electrical characteristics and performances

- 13.8.3.8.1. All Contactors shall be electrically coordinated with upstream protection device, whether device or the fuse type, MCCB, or manual motor starter. All coordination to be backed up by Manufacturers coordination tables, available on request.

13.8.4. Contactors with electronic coils 9 to 38 Amps AC3

- 13.8.4.1. Same coil to cover both the AC or DC control supplies
- 13.8.4.2. Coil to be of torroidal design
- 13.8.4.3. Coil to have extended voltage operating limits.
- 13.8.4.4. 4 coil types only covering: 24..500 V 50/60Hz and 20..500 V DC
- 13.8.4.5. Coil Consumption not to exceed the following limits
- 13.8.4.6. On pull in 50VA
- 13.8.4.7. On holding 2.2VA
- 13.8.4.8. Built-in surge protection to be incorporated
- 13.8.4.9. Flexible position of Coil terminals i.e. can be transferred from the top to the bottom of contactor
- 13.8.4.10. With additional coil terminal block, it shall be possible to connect the coil both at the top and at the bottom.

13.8.5. Contactors with standard AC coil 50 to 30 Amps AC3 shall have:

- 13.8.5.1. Rated operational voltage 690V for contactors up to 40 amp AC3
- 13.8.5.2. Rated operational voltage 1000V for contactors 50 to 750 amps AC3.
- 13.8.5.3. Rated making capacity to be equal to 10 x AC3 rated operational current, or greater.
- 13.8.5.4. Rated breaking capacity to be equal to 8 x AC3 rated operational current, or greater.
- 13.8.5.5. Coil operating limits (according to IEC60947-4-1) 0.851.1 x rated Control circuit voltage, at temperature less or equal to 55degrees Celsius
- 13.8.5.6. Drop out voltage in %age of rated Control Voltage approximately 40 to 65%
- 13.8.5.7. Contactors 400 amp AC3 upward to incorporate electronic coil technology

13.8.6. Contactors with electronic coils 400 to 750 Amps AC3 shall have:

- 13.8.6.1. As above but to include the following
- 13.8.6.2. Same coil to cover both the AC or DC control supplies
- 13.8.6.3. Coil to have extended voltage operating limits.

- 13.8.6.4. Can withstand voltage interruptions or voltage dips in control supply up to 20ms.
- 13.8.6.5. Distinct opening and closing voltages as follows
- 13.8.6.6. Opening 0.55 x min operating voltage
- 13.8.6.7. Closing 0.85 x min operating voltage
- 13.8.6.8. Coil types only covering: 24..500 V 50/60Hz and 20..500 V DC

13.9. Accessories

- 13.9.1. All auxiliary contacts shall employ the “wipe action” mechanism for the self cleaning of the contact tips.
- 13.9.2. Front mounted auxiliary contact blocks rated insulation voltage equal to 690V a.c or greater
- 13.9.3. Rated operation voltage 24...690VAC
- 13.9.4. Rated making capacity 10 x AC-15 rated operational current
- 13.9.5. Rated breaking capacity 10 x AC-15 rated operational current
- 13.9.6. Rated short time withstand current 100amps for 1sec:, 140 amps for 0.1 sec
- 13.9.7. Electrical durability, max electrical switching frequency 1200 cycles per hour or greater

13.10. Side Mount Auxiliary Contact Blocks shall have:

- 13.10.1. Rated insulation voltage equal to 690V a.c or greater
- 13.10.2. Rated operation voltage 24...690V a.c
- 13.10.3. Rated making capacity 10 x AC-15 rated operational current
- 13.10.4. Rated breaking capacity 10 x AC-15 rated operational current
- 13.10.5. Rated short time withstand current 100amps for 1sec:, 140 amps for 0.1 sec
- 13.10.6. Electrical durability, max electrical switching 1200 cycles per hour or greater.

14. LIGHTNING AND SURGE PROTECTION

14.1. Main Distribution Board

- 14.1.1. According to the IEC 62305 recommendations, electrical installations shall be protected against direct lightning and surge impulses with din rail Class 1/Type 1 (10/350μs) lightning current arresters.
- 14.1.2. SPD shall use a triggered spark gap technology to allow high lightning discharge current, unpluggable type to avoid ejection of the cartridge during the discharge of the current and non-blow out technology to avoid fire risks.
- 14.1.3. The SPD shall provide either common protection in TNC network or common and differential mode protection in TT and TNS network according to the IEC60364 recommendations.

14.1.4. Lightning arresters shall have the following technical specifications:

- 14.1.4.1. Class of test (IEC 61643-1) I
- 14.1.4.2. Lightning impulse current: $I_{imp}/pole (10/350\mu s) \geq 25kA$
- 14.1.4.3. Nominal voltage U_n 230 / 400V
- 14.1.4.4. Maximum continuous AC voltage U_c 255V
- 14.1.4.5. Follow current extinguishing capability $I_{fi} \geq 50kA$
- 14.1.4.6. Protection level U_p : 2.5kV
- 14.1.4.7. Max. back up fuse gG/gL: 125A
- 14.1.4.8. Visual state indicator: Yes

14.2. Sub-Main Distribution Board

- 14.2.1. According to the IEC 62305 recommendations to avoid oscillations and magnetic coupling phenomenon, sensible equipments shall be protected against indirect surges with din rail Class 2 / Type 2 (8/20 μs) surge arresters.
- 14.2.2. The SPD shall have a safety reserve system and shall be pluggable for preventive and easy maintenance. The SPD shall provide either common protection in TNC network or common and differential mode protection in TNS and TT network according to the IEC 60 364 recommendations.
- 14.2.3. In case of common and differential mode protection the SPD shall use an association of MOV and GDT to provide isolation to the ground and low protection level in all protection modes. The associated switching element
- 14.2.4. (MCB/Fuse) (to insure a safe end of life) shall be the same brand as the SPD to insure a good coordination.
- 14.2.5. Surge arresters technical specifications:
 - 14.2.5.1. Class of test (IEC 61643-1) II
 - 14.2.5.2. Max. discharge current: $I_{max}/pole (8/20\mu s) \geq 40kA$
 - 14.2.5.3. Nominal current I_n / pole $\geq 20kA$
 - 14.2.5.4. Nominal voltage U_n 230 / 400V
 - 14.2.5.5. Maximum continuous AC voltage U_c 275 / 255V
 - 14.2.5.6. Protection level U_p at 20kA $\leq 1.5 kV$

14.2.5.7. Protection level Up at 3kA (Class 3 test)

14.2.5.8. Pluggable :Yes

14.2.5.9. Visual status indicator: Yes

14.2.5.10. Safety reserve: Yes

14.2.5.11. Remote indicator :Yes

14.3. Data line / Telecom line

14.3.1. The selection of the surge protection device shall be according the IEC 62305 recommendations and therefore shall be a type C2 SPD.

14.3.2. The SPD shall be pluggable type for easy maintenance and shall provide the dialling tone returns when the cartridge is withdrawn in case of end of life.

14.3.3. The cartridges, whatever the nominal voltage, shall be adaptable onto different base. The base shall be chosen according to the connection of the wire: it can be RJ11, RJ45 or screw connection. The connections to the earth shall be either by a DIN rail contact or by a screw terminal.

14.3.4. The SPD dimension shall not exceed 12.5 mm wide to save space. The SPD shall use two level of protection: the first one by GDT, the second one by zener diode. These two levels shall be coordinated and shall provide common and differential mode protection.

14.3.5. Low current surge arresters technical specifications:

14.3.5.1. Class of test (IEC 61643-21): C2

14.3.5.2. Nominal voltage U_n According to the Max.voltage of signal

14.3.5.3. Maximum continuous AC voltage U_c (L-N / N-G): According to the Max. voltage of signal

14.3.5.4. Loading current: 140mA

14.3.5.5. Max. discharge current: $I_{max} / \text{line} (8/20\mu s) \geq 10kA$

14.3.5.6. C2 Nominal discharge current $I_n / \text{line} (8/20\mu s) \geq 5kA$

14.3.5.7. Protection level Up (L-L / L-G): According to the Max. voltage of signal

14.3.5.8. Pluggable: Yes

15. ANTI-CONDENSATION HEATERS

15.1. Anti-condensation 220 Volt heaters shall be provided for all compartments. A switch with thermostat shall be provided to control the heaters.

15.2. The wiring from the heater elements to terminals shall be high temperature insulation covered, a suitable compression type gland shall be fitted for the incoming 231V supply.

16. INDICATING INSTRUMENTS

- 16.1. A flush mounted, industrial grade, 96 mm square voltmeters and ammeter conforming to SABS 1299 shall be mounted near the centre top of the front panel and connected to measure the busbar voltage and current.
- 16.2. The calibrated scale length shall be a minimum of 70 mm. Means shall be provided for zero adjustment from the front without any dismantling of the indicating instrument.
- 16.3. A voltmeters selector switch with phase to phase, phase to neutral, and "off" position shall be provided.
- 16.4. An ammeter selector switch shall be provided with an "OFF" position.
- 16.5. Meters shall indicate by means of colours the relevant phase that it is metering.

17. CURRENT TRANSFORMERS

- 17.1. Current transformers shall comply with BS 3938.

18. MECHANICAL CABLE GLANDS

- 18.1. Cable glands shall be of the compression type, manufactured in brass and/or bronze, and suitable for termination of earth-continuity conductor type cables where applicable.
- 18.2. The gland body shall incorporate a knurled cone for clamping the armouring and an integrally cast earth lug, complete with earthing screw.
- 18.3. All metal portions of the gland shall be electroplated for corrosion resistance.
- 18.4. The glands shall be supplied complete with weatherproof neoprene shrouds.
- 18.5. Entries for multi-core PVC, PVC, wire armoured, PVC sheathed cables shall comprise cone grip mechanical type glands mounted on robust gland plates.
- 18.6. The board shall be supplied complete with all glands for all outgoing and incoming circuits as indicated on the drawing.

19. LIGHT SENSITIVE CONTROL UNIT

- 19.1. Light sensitive control units shall be supplied by others.
- 19.2. A suitably rated single pole over-riding switch, for over-riding the unit in 19.1, and moulded case circuit breaker shall be provided, when called for in the drawings or appendices hereto.
- 19.3. The switch and circuit breaker shall be wired to a suitable terminal strip, mounted within the distribution board, to facilitate connection of the light sensitive control unit when installed.

20. EARTHING

- 20.1. The components shall be effectively bonded to the main frame of the distribution board, which shall also be bonded to the main earth bar. Earthing shall comply with SANS-10142 code of practice for the wiring of premises.

21. CABLING AND WIRING

- 21.1. All cables and wires used shall be stranded, 600/1000 V grade and comply with SABS 150, except where special cables have been otherwise specified.

22. LABELS

- 22.1. Labels shall be provided comprising conspicuous engraved black lettering on white background secured with rivets or screws on or adjacent to the items concerned, and worded in English.
- 22.2. Labels of embossed tape or labels secured with adhesive are not acceptable.
- 22.3. All fuse-switches, circuit breakers, isolators, contactors, relays, etc., shall be clearly designated.
- 22.4. The terminals of all outgoing circuits shall be provided with labels to correspond with the labelling of the units on the panel of the distribution board.
- 22.5. All terminal connections shall be provided with durable tags or clips, on which shall be clearly and indelibly marked, the identifying code letters of each wire. Such code letters shall correspond to those used on the wiring diagram.

23. PAINTING

- 23.1. All surfaces of the distribution board shall be light orange to SABS 1091 colour No. B26. (Transnet orange; Pantone 165C / 021U; Coats 50/50; Vermilion MW52; RAL 2004 rein orange; Trichromatic 70% magenta, 90% yellow), unless otherwise specified.
- 23.2. All surfaces shall be cleaned according to the appropriate method described in SABS 064 for the particular surface to be cleaned, the contamination to be removed and the primer to be applied.
- 23.3. Blast cleaning of components shall be in accordance with clause 4.3 of SABS 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 SABS 064 for the appropriate profile.
- 23.4. Sheet metal that cannot be blast cleaned shall be cleaned by pickling according to clause 4.6 of SABS 064.
- 23.5. Components that shall be powder coated shall be cleaned and prepared by the surface conversion process according to clause 5 of SABS 064 to a medium-weight classification of table 2 of that specification.
- 23.6. Oil and accumulated dirt on steel components where no rusting is present shall be removed according to clause 3 of SABS 064.
- 23.7. The powder-coating process shall be in accordance with SANS 1242 - type 4 : Corrosion-resistant coatings for interior use and using the thermosetting type high gloss coating.
- 23.8. All specified coatings shall be applied according to the relevant specification and the manufacturer's instructions shall be followed.

- 23.9. Coatings shall not be applied under conditions that may be detrimental to the effectiveness of the coating or the appearance of the painted surface.
- 23.10. 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.

24. ADDITIONS AND MODIFICATIONS TO EXISTING DISTRIBUTION BOARDS

- 24.1. Where the contractor needs to make modifications or additions to existing distribution boards, the following minimum criteria shall be adhered to :
 - 24.1.1. Re-labelling and proving of existing circuits in accordance with security of existing terminations to be confirmed
 - 24.1.2. Isolation barriers, cover blanks to be in place where required
 - 24.1.3. Panel modification in terms of architraves, DB covers, and the closing of redundant openings to be undertaken by an accredited switchboard manufacturer.
 - 24.1.4. Wiring to be examined for integrity correct sizing and tidied and/or replaced and neaten as required.
 - 24.1.5. A certificate of compliance shall be issued for the full distribution board and not the additions only.

25. INSPECTION

- 25.1. Transnet reserves the right to carry out inspection of any items of equipment and work at any time during the manufacture at manufacturer's works and to be present at any tests.
- 25.2. A final inspection by Transnet before delivery to site is required.

26. TESTS

- 26.1. All prescribed tests as referred to in the standard specifications may be called for at the discretion of Transnet.
- 26.2. Transnet also reserves the right to carry out any check tests on the equipment.
- 26.3. Notwithstanding the successful completion of tests, the tenderer shall still be responsible for the efficient operation of the equipment.
- 26.4. The tenderer shall bear all costs for any tests, which shall be required.

27. GUARANTEE

- 27.1. The Contractor shall undertake to repair all faults due to bad workmanship and / or faulty materials and to replace all defective apparatus or materials during a period of twelve (12) calendar months, calculated from the date of delivery.
- 27.2. Any defects that may become apparent during the guarantee period shall be rectified to the



satisfaction of, and free of cost.

- 27.3. The Contractor shall undertake work on the rectification of any defects that may arise during the guarantee period within 7 days of his being notified by Transnet of such defects.
- 27.4. Should the Contractor fail to comply with the requirements stipulated above, Transnet will be entitled to undertake the necessary repair work or effect replacement of defective apparatus or materials, and the Contractor shall reimburse Transnet the total cost of such repair or replacements, including the labour costs incurred in replacing defective material.

28. SPARES

- 28.1. The tenderer shall state whether a complete range of spares is held in stock by their local representatives for subsequent purchase by Transnet as and when required.



WITNESSES

1.

.....
TENDERER

2.

.....
DATE

**Transnet Port Terminals
Design Services**

**SPECIFICATION FOR EARTHING AND THE PROTECTION OF BUILDINGS AND
STRUCTURES AGAINST LIGHTNING.**

REVISIONS		
REV	DATE	APPROVED
	2025/06/11	

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1.0 SCOPE

- 1.1 This specification covers Transnet Projects requirements with respect to the protection of buildings and structures against lightning and the requirements for air terminal systems, down conductors and earthing of installation of this specification
- 1.2 This specification applies to assessing, testing and upgrading of existing lightning protection systems and earthing on existing buildings and structures.

2.0 STANDARDS, SPECIFICATIONS AND DRAWINGS

- 2.1 The following publications (latest editions and amendments) are referred to herein.

South Africa Bureau of Standards (South African National Standards)

SANS 10313	-	The protection of structures against lightning.
SANS 62305	-	Protection against lightning
SABS IEC 61643	-	Surge protective devices connected to low voltage power distribution systems.
SANS IEC 60950	-	Information technology equipment – safety.
SANS 10142	-	Code of practice for the wiring of premises
BS 6651	-	Code of practice for protection of structures against lightning.
BS 7430	-	Code of Practice for Earthing.
SABS 064	-	Code of Practice for the Preparation of Steel Surfaces for Coating.
SABS 086	-	Installation and Maintenance of Electrical Equipment used in Explosive Atmospheres.
SANS 10108	-	The Classification of Hazardous Locations and the Selection of Electrical Apparatus for use in such Locations.
SABS 0199	-	The design and Installation of Earth Electrodes SPECIFICATIONS
SABS 763	-	Hot Dip Zinc (galvanised) Coatings
SABS 1091	-	National Colour Standards for Paints.
SABS 1507	-	Electric Cables with Extruded Solid Dielectric Installation for Fixed Installations
SABS IEC 742	-	Isolating Transformers and Safety Isolating Transformers.

OCCUPATIONAL HEALTH AND SAFETY ACT OF 1993 (ACT 85 OF 1993).

3.0 SERVICE CONDITIONS

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

3.1.1 Ambient/Environment Conditions :

- 3.1.1.1 Altitude : Sea level.
- 3.1.1.2 Ambient temperature : -5° C to +45° C (daily average +35° C).
- 3.1.1.3 Relative humidity : As high as 96%
- 3.1.1.4 Lightning conditions : Severe, with a maximum lightning ground flash density 11 flashes per km² per annum.
- 3.1.1.5 Exposure conditions : Salt laden, industrial atmosphere as well as hazardous gases and dust atmosphere.
- 3.1.1.6 Electrolytic corrosion conditions prevail in all the areas owing to the proximity of direct current traction system and cathodic protection schemes.

4.0 EQUIPMENT AND MATERIALS

- 4.1 Equipment and materials to be used, shall be of high quality, and shall comply with all relevant specifications, codes as mentioned in this specification as well as the Occupational Health and Safety Act of 1993(Act 85 of 1993).
- 4.2 Where equipment and material does not comply with the relevant specifications it shall be submitted to Transnet Project's Engineer for approval.
- 4.3 All materials used for the lightning protection system shall withstand the electric and electromagnetic effects of lightning current and predictable stresses without being damaged.
- 4.4 Materials and sizes shall be chosen bearing in mind the possibility of corrosion of either the lightning protection system or the structure to be protected.
- 4.5 Components of the lightning protection system may be manufactured from the materials listed in Table 8 of SANS 10313, provided they have sufficient electrical conductivity and corrosion resistance.

5.0 LIGHTNING PROTECTION REQUIREMENTS

- 5.1 The contractor shall carry out the installation in accordance with SANS 10313: Code of Practice for the protection of structures against lightning and the requirements of this specification.
- 5.2 Where the local supply authority requirements differ from those specified herein Transnet Projects's Electrical Engineer shall be approached for a decision.
- 5.3 All equipment and material shall comply with the relevant National or International standard

specification. Where equipment does not comply it shall be submitted to the Transnet Projects Electrical Engineer for approval.

- 5.4 The system of protection will be finials/air terminals, down conductors and earth spike or roof conductors, down conductors and earth spike.
- 5.5 The earth resistance for separate earth electrodes if down conductors are not connected to a ring earth shall be not exceed the following;

 $R_t = 10 \text{ Ohm}$ for category A structures
 $R_t = 15 \text{ Ohm}$ for category B and C structures.

6.0 DESIGN OF LIGHTNING PROTECTION

The designer of lightning protection shall take into consideration the following principles and requirements during the design of the system.

6.1 GENERAL PRINCIPLES

- 6.1.1 **Basic Principles of Lightning Protection:** the requirements of the basic principles of lightning protection as detailed in SABS 0313 shall be taken into consideration to ensure proper protection of structures against lightning.
- 6.1.2 **Evaluation of Risk:** The risk of lightning stroke shall be evaluated as described in SANS 10313. For the purposes of tender, bidders to assume the most severe level of risk, class 1, for applications in hazardous locations and for structures with the most significant risk and potential damage from lightning strikes. For non-hazardous locations a risk requiring a class 2 LPL shall be assumed. Transnet requires that a lightning protection system is designed, supplied, and installed even if the risk evaluation results suggest that that is no risk. During execution, in a case where the risk evaluation shows that there is no significant risk, the risk results shall be submitted to Transnet's engineer and the Transnet's engineer will inform the contractor whether to omit the LPS application, continue with the LPS as per the bid, or to reduce the requirement to the lowest class of LPS.
- 6.1.3 **Effective height of a structure (H_e):** The effective height of the highest point shall be determined by considering the average height of building, trees and structures and land profile of the surrounding area.
- 6.1.4 **Ground flash density (N_g):** The ground flash density (N_g) for general buildings, structures and installations shall be estimated from the average ground flash density given in table 1 of SANS 10313 as a general guide. For important structures and installations, the value of the ground flash density shall be determined on the basis of at least 5 lightning years, or from existing records.
- 6.1.5 **Number of flashes to structure per 100 year (N_t):** The number of flashes to structures per 100 year shall be determined taking into consideration type and the height of the structure as described in SANS 10313.

6.2 HAZARD CATEGORY

- 6.2.1 Buildings and structures where lightning protection system will be installed shall be categorised prior to the installation. Hazard categories are based on the nature of the building, its content and occupancy.
- 6.2.2 The Hazard categories are classified as follows in SABS 03 -1985 Code of practice for the protection of buildings structures against lightning.

Category A: High Hazard

Category A1: Structures and areas containing explosives of Category Z.

Category A2: Structures and areas classified as

- a) Division 0 areas in accordance with SABS089: Part II, or
- b) Class I, Division 0 locations in accordance with SABS 0108.

Category A3: Strategic control and communications installations such as airport towers

Category A4: Thatched-roof structures of historic values or that contain irreplaceable works of art or like values.

Category B: Medium Hazard

Category B1: Structures and areas containing explosives of Category X or Y.

Category B2: Structures and areas classified as

- a) Division 1 or 2 areas in accordance with SABS089, Part II, or
- b) Class I, Division 1 or 2 locations, or Class II, Division 1 location in accordance with SABS 0108.

Category B3: All structures not included in Category A and to which the public normally has access or which are of historic value.

Category B4: Large temporary structures used for exhibitions and entertainment.

Category B5: Thatched roof dwelling houses.

Category B6: Communications towers, water towers and reservoirs.

Category B7: Caravans and Yachts.

Category B8: Buildings and areas used for livestock, fuel or flammable material.

Category C: Low Hazard

Category C1: Small buildings that are infrequently occupied.

Category C2: Dwelling houses other than thatched-roof houses.

Category C3: Farm buildings, other than those included in category B8.

6.3 ZONES PROTECTION AND SHIELDING ANGLES

6.3.1 The zone of protection shall be the area covered by either one of the following types of protection:

- a) Single Vertical air terminal
- b) Single horizontal air terminals
- c) Area between two or more air terminals
- d) Area between roof conductors.

6.3.2 The shielding angles β and β are given in table 3 of SABS03-1985, Code of practice for the protection of buildings and structures against lightning.

- 6.3.3 The zone protection for Shielding Angles on Steep Slopes and High Ridges is not considered effective beyond a horizontal distance from the nearest air terminal of greater than $2H_e$, where H_e is the effective height of the part of the air terminal above its immediate surroundings.
- 6.3.4 In roof areas away from the edges of tall structures (generally of $H_e > 50\text{m}$), shielding angles given in table 3, SABS 0313 can be used appropriate to hazard category of the roof area so protected and the effective height H_e of the air terminal above the roof area.

6.4 SELECTION OF AIR TERMINAL

- 6.4.1 Mast Protection:** An air terminal consisting of one or more masts that cover the structure or area to be protected with the appropriate shielding angle will, with the possible exception of a few weak lightning strokes, successfully intercept lightning strokes.
- 6.4.2 Air Terminals as Part of the Structure:** An air terminal as part of the structure may be one or more of the following:
- A continuous metal roof.
 - A metal roof structure supporting a metal roof
 - The metal reinforcement in the roof of a reinforced concrete structure with peripheral conductors and finials where necessary.
 - Roof conductors and finials, where necessary, on a non-conducting roof.
 - Finials in chimney, gable ends, parapet walls, etc.
- 6.4.3 Air Terminal Systems For Category A Hazards:** The protection is based on the principle that a primary air terminal system must be provided for the interception of major lightning strokes with, if necessary a secondary air terminal system for the interception of those weak lightning strokes that might penetrate the protection of the primary air terminal system. The secondary air terminal system shall not be intended to carry currents of major lightning strokes.

One of the following lightning protection systems shall be used as detailed in SANS 10313.

- Mast protection used as a primary air terminal
- Metal roof used as primary air terminal system
- Reinforced concrete structure used as primary air terminal system.

6.5 MASTS AND CATENARY CONDUCTORS OVER THE STRUCTURE TO BE PROTECTED

6.5.1 GENERAL

- 6.5.1.1 A lightning protection system consisting of free standing masts separate from the structure provides the highest degree of protection, subject to the correct positioning of the mast and to the correct choice of shielding angle.
- 6.5.1.2 The number and height of masts (and, where necessary, the provision of the catenary conductors between the masts) shall be based on cost, aesthetics, shielding angles and mechanical consideration

6.5.2 CLEARENCE FROM STRUCTURES

6.5.2.1 A safe clearance distance shall be kept between the mast and the catenary conductor strung between the masts and the structure to be protected by the mast or the catenary conductor. The clearance distance depends to various factors detailed in SANS 10313.

6.5.2.2 Where a common earth electrode is provided for mast and structures in close proximity, the following clearance distance “d” shall be maintained with a minimum of 100 m.

- a) Between the mast and any point of structure: $d \geq 0,06.h$ m.
- b) Between the catenary conductor and any part of the upper surface of the structure: $d \geq 0,1.(L/2)$ m for Category A hazard, and $d \geq 0,06.(L/2)$ m for Category B and C hazards.
- c) Between a network of conductors and any part of the upper surface of the structure: $d \geq 0,1.(D + (L - D)/N)$ m for Category A hazard, and $d \geq 0,06.(D + (L - D) / n)$ m for Category B and C hazards.

Where $L =$ length of path measured from the base of one mast along the catenary conductor to the base of the other mast between which the catenary conductor is suspended, m.
 $D =$ spacing between the mesh of the network measured along the catenary conductor, m
 $h =$ height of structure, m
 $n =$ number of cross bonds between two catenary conductors.

6.5.2.3 Where the earth electrode of a mast is separate from the metal water main, other services or the earth electrode of a structure, the following clearance distance “d” shall be maintained with a minimum of 1.00 m:

- a) Between the mast and any point of the structure: $d \geq 0,06.h + 0,1.R_s$ m.
- b) Between a horizontal catenary conductor and any part of the roof of the structure: $d \geq 0,06.(L/2) + 0,1.R_s$ m.

Where $R_s =$ numerical value of the earth electrode resistance of the mast or, where masts are connected together by a catenary conductor, of the mast thus connected together, measured in ohms.

6.5.2.4 The minimum clearance distance “d” where the structure has no earth electrode and has limited water or electricity supply, shall be maintained within the following minimum clearance distances:

- a) $d \geq 1,00$ m between the mast or catenary conductor and any part of the structure.
- b) $D \geq 0,1 R_s$ m between the mast and any water pipe or electric cable, whether buried or above ground unless the mast electrode is bonded to the metal pipe of the underground water main. If R_s is not known, the clearance distance D must be at least 3m.

6.5.3 MAST PROTECTION IN THATCHED ROOFS

6.5.3.1 Thatched roofs shall be protected by one or more free-standing masts only. The zone of protection of the masts must include gable ends, chimneys, antennas, vent pipes and any other metal objects.

6.5.3.2 Telephone wires, overhead services connections to the electricity supply, or other overhead metal wires or pipes, shall not enter the structure through or close to the thatch.

6.5.3.3 On remote chimneys or gable ends close to imaginary surface of the protection zone, install a finial and down conductor well away from the thatch.

6.5.3.4 Metal wires and metal-coated insulating sheets used in the construction of the thatched roof shall be bonded together and to the earthed metal water main or electrode of the structure.

- 6.5.3.4 Where metals used in the construction of the roof are not bonded and earthed, a minimum clearance distance c of 1m between metals of the roof and water pipes, vent pipes, tanks, gas pipes, antennas, telephone and bell wires, bugler alarms and electrical wiring and conduits shall be maintained.

7.0 INSTALLATION

7.1 AIR TERMINALS ON THE STRUCTURE TO BE PROTECTED.

- 7.1.1 The purpose of an air terminal on a structure to be protected shall be to intercept lightning strokes at preferential points of an air terminal, thereby:
- a) Minimizing penetration of a lightning discharge current which could have followed a random path in the roof structure with possibility of a resultant fire.
 - b) Preventing the loosening of masonry or the cracking of precast panels or reinforced concrete.
- 7.1.2 The selection of the air terminal system and the the position of down conductors shall be so selected such that at any likely point of incidence of lightning stroke, there are at least two parallel paths for the current to flee to earth.
- 7.1.3 Parallel routes shall not be necessary in the following cases.
- a) An air terminal on a small structure having only one prominent point of incident.
 - b) Dead-ended conductors, i.e those conductors of the air terminal for which it is not feasible to provide a connection to a down conductor.
- 7.1.4 Where a peripheral roof conductor is required for the protection of the outer side edge of a structure, the conductor shall be installed as close to the edge as is practicable (preferable not more than 100mm from the outer edge)
- 7.1.5 Where buttresses or parapet walls are not already equipped with an air terminal in the form of continuous metal cladding or similar metalwork and peripheral conductors are to be provided at an effective height H_e of 15 m or more, finials shall be added on all exposed outer corners and at intervals not exceeding 30 m between outer corners. The finials shall be placed as close as possible to the outer edge, and so position the down conductors such that their connection to the peripheral conductor is close to the finial.
- 7.1.6 Concrete masonry chimneys or gables ends that are not protected with the appropriate shielding angle of another structure shall be protected by means of a finial or metal cap. Where the chimney or gable end is of masonry, a peripheral conductor along the gable or around the chimney shall be used instead.
- 7.1.7 Where it is not feasible to provide a down conductor at one end of an air terminal or a connection to another part of the lightning protection system, a dead ended conductor shall be used provided it is not longer than 10 m and generally flows a horizontal or downward course from the free end to end connected to the remaining part of the lightning protection system.
- 7.1.8 Where a dead-ended conductor partly flows an upwards course, the dead-ended conductor shall be not longer than 7.5 m. If the top of the protected part is considerably lower than the ridge conductor to which

the dead-ended conductor is connected, a finial shall not be used at the free end, unless it is required for the enhancement of the protection of the surrounding area, in which case an additional down conductor at the free end is recommended.

- 7.1.9 Metal gutters shall be bonded along the outside perimeter of the roof to the nearest down conductor, or to the metal of the roof, where applicable.

7.2 METAL ROOFS AND NON-METAL ROOFS SUPPORTED BY METAL ROOF STRUCTURES

- 7.2.1 Structures having roofs covered with electrically continuous metal sheets do not require air terminals, but shall be earthed by down conductors.
- 7.2.2 Sheet metal separated from each other by insulating strips or by epoxy or plastic coating s, may be regarded as providing continuous metal roof. However where sparking between such roofing is considered undesirable because of magnetic interference, all sheets adjacent to the ridge conductor or peripheral conductor shall be bonded.
- 7.2.3 A non-metal roof consisting of non-combustible roofing material held by metal fasteners to a roof supporting structure of metal construction may be considered to be a metal if the metal structure is earthed by down conductors, or supported by earthed metal columns, and spacing between roof beams does not exceed 15m for Category B and C hazards.

7.3 REINFORCED CONCRETE STRUCTURES

- 7.3.1 Reinforced steel shall not be used as parallel paths to enable lightning discharge current to flow safely to general mass of the earth.
- 7.3.2 Air terminals or finials and where necessary peripheral conductors shall be installed, taking into consideration the likely points of incidence of lightning and the path of the current through internal down conductors.
- 7.3.3 Where the outer support columns of the structure may be regarded as continuous from roof to basement, the peripheral and air terminal conductors shall be bonded to the internal or external down conductors.
- 7.3.4 Peripheral conductors and finials shall be used for medium height structures with reinforced concrete. Where the peripheral conductor is on a parapet wall that surrounds a metal roof or the air terminals of other structures, the other air terminal shall be connected to the peripheral conductor, preferably close to a down conductor. The peripheral conductor and other air terminal shall be connected to internal or external down conductor.
- 7.3.5 If the upper edge of the structure with chimneys and cooling towers and of medium height is not metal clad, horizontal conductors around the upper circumference of the structure, equipped with finials at intervals of not more than 15 m, with a minimum of two shall be installed.
- 7.3.6 On tall reinforced concrete structures, one of the following shall be installed in order to increase the protective efficiency, depending on the risk and the degree of protection required, height and slenderness of the structure:
 - a) At intervals of not more than 10 m, install oblique finials along the upper perimeter, pointing upwards and outwards such that the tip of each finial points outwards at an angle of 30° to the vertical through the outer edge of the structure, and is at least 400mm above the structure, each

- finial being connected to a peripheral conductor.
- b) A horizontal conductor that follows the contour of the structure and that is so raised on oblique struts of length at least 500 mm that the conductor is displaced outwards at an angle of 30° to the vertical through the outer edge of the structure.
 - c) Oblique finials spaced as in (a) above, positioned on a horizontal conductor arranged as in (b) above and in line with the oblique struts, each finial pointing upwards and outwards at an angle of 30 to the vertical through the outer edge of the structure, and of length such that the tip of the finial is at least 800 mm above the outer edge of the structure.

Where the structure is slender, an air terminal as in (b) or (c) above is to be preferred to that in (a)

The air terminal shall be bonded to the internal down conductor at intervals not exceeding 10 m, or where the circumference exceeds 60 m, at appropriate intervals not exceeding 30m with a minimum of six bonds.

7.4 FINIALS AND ROOF CONDUCTORS

- 7.4.1 Roof conductors and finials shall be installed along the ridges of the roof and on other projections, in accordance to SANS10313 – code of practice for the protection of structures against lightning.
- 7.4.2 Protruding metal objects shall be bonded in a horizontal or in a downwards direction to the nearest roof or down conductor where the distance between the metal object and the conductor is less than 7.5m otherwise provide a separate down conductor. In all cases where the pitch of the roof is less than 30°, metal gutters and roof conductors shall be bonded or eaves conductors shall be provided.
- 7.4.3 In the case of large roofs of non-conducting material, additional conductors shall be installed across the surface of the roof, perpendicular to the long side of the roof and at extremely equal spaces not exceeding 15m. If the width of the roof exceeds 15m install conductors to form a grid at approximately equal spacing not exceeding 15m in either direction.
- 7.4.4 Roof conductors, finials and roof conductor grids shall be connected to the closest down conductor.
- 7.5.5 All roof conductors shall be manufactured from SABS approved single-core bare aluminium conductor with a minimum cross sectional area of 25mm².

7.5 DOWN CONDUCTORS

- 7.5.1 Down conductors shall be installed close to the point of the air terminal that are most likely to be struck by lightning and preferably run them vertically along the most direct route to the earth electrode.
- 7.5.2 At least two down conductors shall be provided in a building, such that in plan view no point of a structure is more than 15m from the nearest down conductor, except for masts and small structures having only one prominent point of incident, such as rondavels, these need only one down conductor.
- 7.5.3 Each down conductor shall be supplied with a separate earth electrode. This will reduce the current flow per down conductor, resulting in a lower voltage drop across the down conductor caused by the surge impedance of the conductor.
- 7.5.4 Down conductors shall not be placed close to doorways or entrances to buildings. Maintain a minimum clearance distance of the order of 1 m from the door and window frames, balustrades and other large metal objects.

- 7.5.5 Where down conductors deviate from a vertical route due to sharp bends and loops required to carry a conductor over eaves and parapet walls, shall be permitted, provided that all requirements stated in SANS 10313, clause 6.1.4 are met.
- 7.5.6 Steel columns and internal metal storm water drain-pipes shall be used as down conductors only if they are joined by screwing, bolting or welding.
- 7.5.7 External metal stair cases, fire escapes or other large frames shall be used as down conductors if they are electrically continuous over their full height. If not electrically continuous they shall be bonded to the lightning protection system at the top or at the bottom of the framework.
- 7.5.8 In the case of structures of Hazard Category A, Test joints shall be installed in down conductors at convenient heights above finished ground level.
- 7.5.9 Internal reinforcing steel of vertical concrete column, particularly those on the outer corners can be used as down conductors, provided that the reinforcement is electrically continuous.
- 7.5.10 Vertically discontinuous reinforcement shall be bonded between the reinforcement of each section to provide a continuous path to ground or an external down conductor shall be installed.
- 7.5.11 Large external metal frames, balconies and metal cladding on the top floors of tail structures (typically 30 floors or more) that may be exposed to direct lightning strokes must be bonded to the reinforcement of the structure or to a down conductor that is connected to the reinforcement of the roof.

8.0 STATUTORY REQUIREMENTS

- 8.1 The Contractor shall ensure that the installation satisfies the requirements of all relevant South African Statutory Regulations
- 8.2 Where applicable, equipment items shall carry the SABS mark to demonstrate compliance with the regulations.

9.0 RESPONSIBILITY FOR WORK

- 9.1 The tenderer shall be responsible for the complete installation of the lightning protection system including testing, earthing conductors, surge protection devices, spikes etc. as required for various buildings and structures. These installations shall include the review and the upgrading of the existing lightning protection systems. Due considerations shall be taken of the effects of lightning covered herein below in clause 8, in providing the lightning protection system.
- 9.2 The tenderer shall undertake to repair all faults due to bad workmanship and/or the use of faulty materials and to replace all defective materials within six months after the installation date.
- 9.3 The tenderer shall rectify all the defects to the satisfaction of Transnet Projects, that may become apparent during the guarantee period.
- 9.4 The tenderer may be required to carry out builders work such as cutting of concrete columns and coring of holes for testing of the continuity of the existing steelwork or cabling. Good contact between reinforcing bars should be ensured.

9.0 APPLICABLE INFORMATION

- 10.1 **Electrical effect** – The current discharged through the earth electrode resistance produces a resistive volt drop which may raise the potential of the system to a high value relative to true earth.
- 10.2 **Side-flashing** – The point of strike may be raised to a high potential, and there is a risk of flashover from the protection system to any metal or in the structure.
- 10.3 **Thermal effect** – The thermal effect of a lightning discharge is confined to the temperature rise of the conductor through which the current passes.
- 10.4 **Mechanical effect** – When a high current is discharged along parallel conductors in close proximity or along a single conductor with sharp bends, a different mechanical effect is exerted by a lightning flash. This is due to a sudden rise of 30 000K in air temperature and the resulting explosive expansion of the adjacent air in the channel along which the charge is propagated.

11.0 PROTECTION AGAINST CORROSION

- 11.1 The tenderer shall ensure that atmospheric, chemical and or electrolytic corrosion of copper and other metals is prevented from occurring when used for the lightning protection system.
- 11.2 The contact surfaces of dissimilar metals shall be kept completely dry and protected against ingress of moisture to prevent the acceleration of electrolytic corrosion.
- 11.3 Although copper is highly resistant to many types of chemical attack, lead coating shall be recommended wherever subjected to severe corrosion due to presence of sulphur compounds.
- 11.4 Stainless steel material of similar grading shall not be used unless prior approval is obtained.

12.0 EARTHING CODES OF PRACTICE

This part of specification details standards and codes of practice to be adhered to in the supply, installation and termination of earthing systems on all Transnet Sites.

12.1 National Standards

- 12.1.1 The requirements of the materials, design, layout, fabrication, assembly, erection, examination, inspection and testing of an earthing system on site shall be in accordance with the relevant sections of codes: -

- SABS 089 Part 2 1965 Electrical Code for Petroleum Industry
- SABS 0121 1977 Cathodic Protection of Buried and Submerged Structures
- SABS 0123 1976 The Control of Undesirable Static Electricity
- SABS 0198 Part 12 1988 Installation of Earthing System
- SABS 0199 1985 The Design and Installation of and Earth Electrode
- SABS 0200 1985 Neutral Earthing in Medium Voltage Industrial Power Systems

- SABS 0292 1999 Earthing of Low Voltage (LV) distribution systems
- SANS 10313 Latest amended Protection of Structures against Lightning
- SABS 1063 1998 Earth Rods and Couplers
- SABS IEC 61000-5-2 1997 Electromagnetic Compatibility (EMC)
Part 5: Installation and mitigation guidelines
Section 2: Earthing and Cabling
- SABS IEC TS 61312-2 1999 Protection against Lightning Electromagnetic
Impulse (LEMP) Part 2: Shielding of structures, bonding
inside structures and earthing
- SABS IEC 61024-1 1990 Protection of Structures against Lightning
Part 1: General principles
- SABS IEC 61024-1-1 1993 Protection of Structures against Lightning
Part 1: General principles
Section 1: Guide A – Selection of protection levels for
lightning protection systems
- SABS IEC 61024-1-2 1998 Protection of Structures against Lightning
Part 1-2: General Principles
Guide B – Design, Installation, maintenance and inspection
of lightning protection systems
- SABS IEC 61312-1 1995 Protection against Lightning Electromagnetic
Impulse Part 1: General principles
- SABS IEC 61312-4 1998 Protection against Lightning Electromagnetic
Impulse Part 4: Protection of Equipment in existing
structures
- SABS IEC 61643-1 1998 Surge Protective Devices Connected to Low
Voltage Power Distribution Systems
Part 1: Performance requirements and testing methods
- SABS IEC TS 61312-2 1999 Protection against Lightning Electromagnetic
Impulse (LEMP) Part 2: Shielding of structures, bonding
inside structures and earthing

12.1.2 Statutory Requirements

- a) The Contractor shall ensure that the installation satisfies the requirements of all relevant South African Statutory Regulations
- b) Where applicable, equipment items shall carry the SABS mark to demonstrate compliance with the regulations.

12.2 Technical Requirements

12.2.1 General

- a) A common integrated station earthing system shall be provided for electronic and electrical systems equipment, static and lightning protection in accordance with the requirements of this document.
- b) A soil resistivity survey shall be carried out by a specialist earthing consultant/contractor. The consultant/contractor shall prepare a detailed report on the conditions identified and provide the survey data recordings together with proposals, for a basis of the earthing system design. The survey shall be witnessed by the Transnet's Engineer.
- c) Major electrical equipment such as switchgear, transformers, lighting boards, floodlight towers on poles, control panels etc. and associated metallic support frameworks, shall be connected to the station safety earth via Electrical Earth bars located nearby.

Use of embedded conductors within a power cable (spare core earth) may be utilised as the primary equipotential bonding system provided the following conditions are met: (SABS 086-1:2001)

- The embedded conductor has a cross-sectional area equal to those of the live and neutral conductors or equal to the values in Table 1 of SABS 0142)

In addition, a second visual earth connection shall be provided to each item of electrical equipment, to prevent the potential to earth of such equipment rising above spark potential. (SABS 089-2:2000)

- d) The neutrals of generators and transformers shall be connected to the main earth grid either directly or via an earthing resistor, as required. Where neutrals of transformers are connected directly to earth, this shall be done via means of connections to both an individual earth rod located nearby as well as to the station earth mat by means of Electrical Earth bar located within the Switchgear Room.
- e) Frames of motors shall be connected to the earthing system in accordance with the following table:

Motors kW Rating	Minimum Earth Conductor Size
Up to 30	16 mm ²
37 – 132	50 mm ²
150 – 175	70mm ²

Note:

In order to minimize the number of different sizes of earth conductor, the above three sizes only shall be used throughout, unless specifically stated otherwise.

- f) Cables supplying lighting fixtures shall be 3 core for single-phase supplies and 5 core for 3 phase supplies, of which one core shall be used as the earth conductor.

- g) Plant Infrastructure such as manifold piping, tanks and metallic support frameworks, shall be connected to the station safety earth, either directly or by means of Electrical earth bars located nearby.
- h) Flanged joints in metallic pipelines shall be considered inherently continuous provided the surfaces of one of the bolts are cleaned and identified for earthing. Flanges of metallic pipelines that have insulated linings for purposes other than cathodic protection shall be bonded to ensure electrical continuity.

Pipelines shall only be connected to the earthing system where they enter and leave the battery limits.

- i) Storage tanks that are not cathodically protected shall be earthed through at least two separate connections to the tank. Tanks shall be earthed in accordance with the relevant SABS code.

Electrically continuous structural steel columns may be used as down conductors by means of which elevated tanks, vessels, etc. shall be deemed to be connected to the earthing system.

All tank covers, gauge floats and stirrers etc. as well as all pipes entering the tanks shall be earthed.

The steel roof shall be in a direct electrical contact with, or bonded to the tank shell.

Earthed grids, gauges, gratings and the like placed in or across the inlets of tanks are not to be used as a means of static discharge. Individual bonding shall be made to the earthing system.

- j) Cable trays and cable racks shall have continuous earth continuity. This shall be ensured by installing 10mm² earth straps across the racking fishplates (joints). Cable Trays shall be connected to the earthing system in two places - where they enter and leave the battery limits.
- k) Earthing connections to all equipment and process plant shall comprise of welded earth bosses in compliance with SABS 089 Part II:1965 regulation 5.1.4K with properly provided terminations i.e. 10mm diameter earth studs. Anchor bolts shall not be used.

Earth connections to all equipment shall be effectively bolted, using crimped lugs.

All cable connections shall be fitted with a "star" or serrated washer in addition to the backnut, to ensure good earth contact.

- l) All earthing connections between the station earth system and respective earth bars/lightning protection systems shall where possible be made above ground, by means of bolts, crimped lugs and PVC taped.

All cable connections shall be fitted with a "star" or serrated washer in addition to the backnut, to ensure good earth contact.

Earth connection points shall be clearly labelled.

In cases where earth connection points are required to be made underground (e.g. to earth

rods), inspection wells shall be provided comprising of pre-cast concrete/PVC surrounds complete with covers, to facilitate periodic inspection.

- m) Earthing conductors rising through paving or other concrete work shall be run in suitable protective sleeves which shall project above finished level.
- n) Earthing and bonding conductors shall be sized and installed in compliance with regulations detailed in the current SAIEE Standard Regulations for the Wiring of Premises and in SABS 03 as applicable.
- o) Extendable earthing rods shall be manufactured from stainless / copper clad / galvanized steel (dependant on soil acidity and chlorides and existence of cathodic protection systems) 16mm diameter, 1200 mm long sections, and shall have molecular bond between the two metals to prevent moisture ingress. Where it is necessary to join earth rods together, a non-ferrous corrosion resistant coupling device shall be used which shall prevent the ingress of moisture into the joint.
- p) Lightning and static earthing protection shall be provided for all tall steel, masonry and concrete structures, towers, vessels, tanks etc, as well as all buildings used to house sensitive electrical/electronic equipment. Lightning protection systems shall be connected both to individual earth rods as well as bonded to the station earth mat. Where possible, the mesh method (as defined in SANS 10313) should be utilised in the protection of buildings against lightning strikes i.e. the use of masts and catenary conductors are to be avoided.

Tall steel structures such as towers or structure columns, provided they are electrical continuous, shall be considered inherently protected against lightning by their connection to the earth.

- q) **The resistance of the common earthing system to the general mass of earth shall not exceed 1 Ohm.**
- r) Where a separate system is installed for other than electrical equipment in remote locations, e.g. storage tanks; its resistance to the general mass of earth shall not exceed 7 Ohms. (Note: This applies only for Lightning Protection and remote valve chambers that are not connected to the Station Earth).

12.2.2 Station Safety Earth

In cases where a new Station Safety Earth Mat is required to be provided, the following specifications shall apply for pricing:

The **Earth Mat** shall consist of a completely buried, lattice network of 40x3mm, bare copper tape. All the crossover points of the lattice shall be braised or cadwelded and protected with PVC insulation tape. Buried joints or splices shall not be clamped or bolted. The earth mat shall be buried, 1000mm minimum, below finished grade.

The interconnecting conductors shall be radially interconnected to form a common earthing system, for all electrical equipment, lightning protection and static earthing in accordance with relevant SABS requirements.

If required, additional earth electrodes may be installed to achieve the specified resistance, of the

common earthing system to the general mass of earth. Where earth rods are paralleled in a group to reduce the earth resistance to the permissible value, they shall be spaced apart for a distance at least equal to their buried depth length.

During the contract, the earth mat design shall be in accordance with IEEE80.

12.3 Switchgear Room Building and Equipment

12.3.1 A Main Safety/Electrical Earth Bar comprising of a copper bar, 50mm x 5mm min shall be installed in the basement/false floor of the Switchgear Room. Where possible, this Earth Bar shall be designated as the Primary Test Point for the station earthing system with the following equipment directly connected:

- **Station Earth Mat.** Where possible, a minimum of four separate connections shall be taken into the Switchgear Room via separate routes from the Earth Mat, by means of 40mm x 3mm Cu Earth tape. Connection to the Main Safety Earth bar shall be made in two places by means of 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductor, to facilitate testing of the Earth System.
- **Transformers.** By means of 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductor
- **MV/LV Panels.** By means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors
- **Generator.** By means of 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductor
- **Instrument Earth.** By means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors
- **Manifold Earth.** By means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors

Note that on existing sites, the earth mat has been connected to the station earthing system in multiple places (namely; the Switchgear Room, Control Room and Manifold), and thus designation of a single Primary Test point is not possible. Multiple test points have thus been defined as follows: Switchgear Room, Control Room and Manifold Mainline Pumps 1 & 4 (where possible).

12.3.2 All secondary earthing within the substation shall be attached to this station earth bar at appropriate demarcated points.

12.4 Control Room Building and Equipment

12.4.1 A secondary Safety/Electrical Earth Bar comprising of a copper bar, 50mm x 5mm min shall be installed in the basement/false floor of the Equipment/Control Room in an easily accessible position. Where possible, this Earth Bar shall be directly connected to the Main Safety/Electrical Earth bar located in the Switchgear Room, by means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors.

Note that all marshalling and equipment panels shall have an electrical earth bar, separate from an insulated instrument earth bar, installed and to which all electrical equipment earths shall be connected.

12.4.2 An Instrument Earth Bar comprising of a copper bar, 50mm x 5mm min shall be installed in the basement/false floor of the Equipment/Control Room in an easily accessible position. Where

possible, this Earth Bar shall be directly connected to the Main Safety Earth bar located in the Switchgear Room, by means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors.

Note that all marshalling and equipment panels shall have an insulated instrument earth bar, separate from the electrical earth bar, installed and to which all clean/instrument earths shall be connected.

12.4.3 Instrument and Electrical Earth systems shall be clearly labelled.

12.5 Manifold Area and Equipment

12.5.1 All manifolds shall have an insulated manifold earthing system installed, comprising of the following specifications:

- 40mm x 3mm min flat copper tape, to run the entire length of the main electrical racking reticulation and supported off of insulators at distances of no more than 2m apart. Use of existing electrical racking reticulation supports shall be permitted. All joints will require to be braised. Earthing reticulation shall be installed in such a manner so as to be unobtrusive and yet accessible and shall be positioned so as to avoid obstruction to walkways and access routes.
- The Manifold Earth bar shall be connected to the main safety/electrical earth located in the Switchgear Room, by means of dual 70mm², 600-volt class, green colored, PVC insulated, stranded copper conductors.

Note that on existing sites, the earth mat has been connected to the earthing system in multiple places (namely; the Switchgear Room, Control Room and Manifold), and thus designation of a single Primary Test point is not possible. Secondary test points have thus been defined where possible as follows: Switchgear Room, Control Room and Manifold Mainline Pumps 1 & 4.

12.4.2 All process plant and equipment located within the manifold area shall be attached to this manifold earth bar at appropriate demarcated points, via appropriately sized insulated PVC copper cable (green/yellow colored insulation), as follows:

- All electrical equipment shall be earthed via two separate earths, namely via the power cable earth core back to the respective Starter Panel electrical earth bar, and secondly via a separate visual earth from the motor frame to the manifold earth bar. Use of cable armouring as an earth conductor is not acceptable.
- All instrument stands and field junction boxes shall be separately earthed via means of an insulated 16mm² min PVC copper cabling.
- All process vessels (tanks, vessels and piping) and racking reticulation shall be earthed via insulated 70mm² min PVC copper cabling in two separate places.

All earth conductors utilized shall comprise of stranded, PVC insulated copper conductors with crimped cable lugs. All connections shall be fitted with a "star" or serrated washer in addition to the backnut, to ensure good earth contact.

12.6 Earth System Identification Standards

12.6.1 Earth Bar Labels

Earth bars shall be clearly labelled according to their functionality (e.g. "EB xx" to denote an electrical earth bar, "IB xx" to denote an instrument earth bar, where xx denotes a unique consecutive number). The Functional Identifier "EB 00" shall always denote the Station Earth Mat.

In addition, earth bars designated as Test Points shall be labelled accordingly.

Labels shall comprise of the Traffolyte engraved type, and fixed by means of stainless steel screws. Finish shall comprise of black letters against a white background, with text 40mm height.

Labels shall be readable/visible after the wiring has been done.

12.6.2 Earth cable Identification

Earth cables may be divided into two types, namely primary earth cabling running from subsystem earth bars directly or indirectly to the main station earth (and used for testing purposes), and secondary earth cabling running between the subsystem earth bars and equipment or infrastructure.

Only Primary earth cabling (i.e. those used for testing purposes) is required to be identified, by means of a Functional Identifier denoting both source and destination earth bars.

Identification numbers will comprise of the following specification:

- Grafoplast Targa Metal TGT System (Carrier Rail 58mm in length) 316 Stainless Steel Markers, with punched text 6 mm height minimum, fastened onto the cable at both ends via means of Stainless Steel cable ties

Examples:

EB01 – EB00 Cable Identifier for Earth cable running between Electrical Earth bar EB01 and the Station Earth Mat

IB01 – EB00 Cable Identifier for Earth cable running between Instrument Earth bar IB01 and the Station Earth Mat

12.7 Testing

12.7.1 Earth Resistivity and Electrode Testing

It will be the Contractors responsibility to carry out all necessary earth resistivity tests on site, where applicable. Tests will be in accordance with the requirements of BS 1013 as amended.

After all earth electrodes/trench earth's have been installed, an earth megger shall be used to test the earth resistance at the earth bar or connection point to the main station earth and the results recorded. Note that all ECC connections, and any other bonding material shall be disconnected from the earth connection point whilst the earth is being tested.

Earth Continuity Testing.

Earth continuity readings shall be measured and recorded from the earth bar to each item of equipment and process plant, and shall include all piping, vessels, transformers, motors, actuators, switchgear cabinets, marshalling enclosures and instrumentation.

12.7.2 The following are the maximum acceptable earth electrode resistances:

Electrical Earth

- a) Main substation - 1 ohm
- b) Miniature substations and kiosks - 2 ohms
- c) Highmasts - 5 ohms.

Instrument Earth

- a) Instrument Earth - < 1 ohm

13.0 INSPECTION AND GUARANTEE

- 13.1 Transnet Projects reserves the right to inspect the installation and the equipment to be used.
- 13.2 All lightning protection systems shall be inspected and certified by an accredited person after completion of the installation, to verify conformance as required by Code of Practice, SANS 10313.
- 13.3 All components of the lightning protection system shall be inspected to ensure that they are in good condition and are capable of performing their designed functions.
- 13.4 The tenderer shall ensure that all elements of the electrical installation have been incorporated into the protected space by bonding or extensions to the lightning protection system.
- 13.5 The mechanical condition of all conductors, bonds, joints and earth electrodes shall be checked and the observations noted. .
- 13.6 The tenderer shall undertake to repair and replace all faults and faulty materials due to bad workmanship during a period of six months.
- 13.8 The tenderer shall be required to guarantee the installation for a period of twelve (12) months.

END

SIGNATURE OF TENDERER: _____

DATE: _____

**TRANSNET PROJECTS
DESIGN SERVICES**

CONTRACT NUMBER:

REFURBISHMENT OF SUBSTATION 1A & 1B AT THE PORT OF NGQURA CONTAINER TERMINAL(NCT) FOR TRANSNET SOC LTD (REGISTRATION NO. 1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS (HEREINAFTER REFERRED TO AS "TPT") FOR NGQURA CONTAINER TERMINAL AS A ONCE-OFF SUPPLY.

ANNEXURE C

PART C2: PRICING DATA

Document reference	Title	No of pages
C2.1	Pricing instructions:	
C2.2	Pricing Schedule	

CONTRACT NUMBER:

REFURBISHMENT OF SUBSTATION 1A & 1B AT THE PORT OF NGQURA CONTAINER TERMINAL(NCT) FOR TRANSNET SOC LTD (REGISTRATION NO. 1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS (HEREINAFTER REFERRED TO AS "TPT") FOR NGQURA CONTAINER TERMINAL AS A ONCE-OFF SUPPLY.

C2.1 Pricing Assumptions:

C2.1.1 Pricing Instructions

a) Respondents are to note that if the price offered by the highest scoring bidder is not market-related, Transnet may not award the contract to that Respondent. Transnet may-

(i) negotiate a market-related price with the Respondent scoring the highest points or cancel the RFP;

(ii) if that Respondent does not agree to a market-related price, negotiate a market-related price with the Respondent scoring the second highest points or cancel the RFP;

(iii) if the Respondent scoring the second highest points does not agree to a market-related price, negotiate a market-related price with the Respondent scoring the third highest points or cancel the RFP.

If a market-related price is not agreed with the Respondent scoring the third highest points, Transnet must cancel the RFP.

b) Prices must be quoted in South African Rand inclusive of VAT.

c) Any disbursement not specifically priced for will not be considered/accepted by Transnet.

d) To facilitate like-for-like comparison bidders must submit pricing strictly in accordance with this pricing schedule and not utilise a different format. Deviation from this pricing schedule could result in a bid being declared non-responsive.

e) Prices are to be quoted on a delivered basis to..... .

f) Please note that should you have offered a discounted price(s), Transnet will only consider such price discount(s) in the final evaluation stage if offered on an unconditional basis.

g) Where a Respondent's price(s) includes imported goods/items, the rate of exchange to be used must be in South African Rands for purposes of determining whether the price is market related or not and must be the currency's rate published by the South African Reserve Bank on the date of the advertisement of the bid:

Currency rate of exchange utilised: _____

h) In respect of incoterms conditions, if applicable, please refer to paragraph 25 of the General Bid Conditions which is attached to the RFQ as Annexure

i) Manufacturing and delivery lead time calculated from date of receipt of purchase order: _____ weeks.

CONTRACT NUMBER:

REFURBISHMENT OF SUBSTATION 1A & 1B AT THE PORT OF NGQURA CONTAINER TERMINAL(NCT) FOR TRANSNET SOC LTD (REGISTRATION NO. 1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS (HEREINAFTER REFERRED TO AS "TPT") FOR NGQURA CONTAINER TERMINAL AS A ONCE-OFF SUPPLY.

C2.1.2 Pricing Schedule

Scope Item/ Component (Replace or Repair as per SOW)	Unit	Quantity	Unit Rate (Supply & Install)	Total Price
Preliminary & General Costs & Design & Engineering				
FIXED COSTS				
1. HEAD OFFICE / MANAGEMENT / PLANNING	Sum	1		
2. INSURANCE / BONDS	Sum	1		
3. MANAGEMENT / ENGINEERING SITE VISITS	Sum	1		
4. PR.ENG - DRAWINGS & DESIGN CHECK / ATTENDENCE	Sum	1		
TIME RELATED COSTS	Sum	1		
5. SITE ESTABLISHMENT	Sum	1		
6. SAFETY, INDUCTION & MEDICALS	Sum	1		
7. SITE SUPERVISION & SAFETY	Sum	1		
8. TOOLS & EQUIPMENT	Sum	1		
9. ACCOMMODATION / MEALS / LIVING OUT ALLOWANCES	Sum	1		
10. SHEQ	Sum	1		
11. TRAVELLING	Sum	1		
12. DISBURSEMENTS	Sum	1		
13. QA QC DOCUMENTS	Sum	1		
14. TRAINING	Sum	1		
SUBSTATION 001A				
Preparation works for the proposed substation upgrades				
1. Disconnect and removal of the existing MV switchgear and battery bank to be replaced.	Sum	1		
Medium voltage switchgear				

CONTRACT NUMBER:

REFURBISHMENT OF SUBSTATION 1A & 1B AT THE PORT OF NGQURA CONTAINER TERMINAL(NCT) FOR TRANSNET SOC LTD (REGISTRATION NO. 1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS (HEREINAFTER REFERRED TO AS "TPT") FOR NGQURA CONTAINER TERMINAL AS A ONCE-OFF SUPPLY.

2. Design, supply and install a new 1250A 11kV incomer VCB panel.	each	2		
3. Design, supply and store a new equipped 1250A 11kV spare incomer VCB panel.	each	1		
4. Design, supply and install a new 1250A 11kV bus section VCB panel.	each	1		
5. Design, supply and install a new 630 11kV feeder VCB panel.	each	5		
6. Design, supply and install new spare 630 11kV feeder VCB panel.	each	1		
7. Design, supply and store a new equipped 630A 11kV spare feeder VCB panel.	each	1		
8. Design supply and install a 11kV bus-riser panels/bus-bar Earth /VT panels.	each	1		
9. Design, supply, install and commission a complete arc ducting and protection system for the 11kV switchgear	Sum	1		
10. Design, supply, install a battery bank (enclosed in a cabinet) and battery terminal unit for the 11kV switchgear complete with protection and wiring.	Sum	1		
11. Provision of racking tools	Sum	1		
Electrical, Lighting and Power				
12. Design, supply and install a new lighting and small power	Sum	1		
Medium Voltage Cable Termination				
13. Supply new 630A Feeder MV plug type terminations designed to EN 50181 and DIN 47637.	each	24		
14. Supply new 1250A Incomer MV plug type terminations designed to EN 50181 and DIN 47637.	each	8		
Power System Protection				
15.1 Load flow, short circuit and protection grading study (of the entire network) and configuration (only for substation 1A)	Sum	1		
15.2 ETAP software as per annexure P	ea	1		
Earthing and Lightning Protection				
16. Design, supply and install earthing and lightning surge protection for the proposed substation upgrades.	Sum	1		
Cables, Routes and Building Modifications				
17. Provisional sum for the building refurbishments, including but not limited to the replacement of old chequered plates and sealing of cable entry/exit opening, making good the floor, wall painting, changing of the submissible pumps in the cable	Sum	1		R150 000

CONTRACT NUMBER:

REFURBISHMENT OF SUBSTATION 1A & 1B AT THE PORT OF NGQURA CONTAINER TERMINAL(NCT) FOR TRANSNET SOC LTD (REGISTRATION NO. 1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS (HEREINAFTER REFERRED TO AS "TPT") FOR NGQURA CONTAINER TERMINAL AS A ONCE-OFF SUPPLY.

management basement, repair and servicing of the air handling units in the transformer rooms.				
18.1 Testing, and commissioning of cables.	Sum	1		
18.2 Supply and installation of trifurcation joints.	ea	10		
19. Supply and install a new single core 11kV, XLPE, SWA, Cu cable. (This is to allow for EN 50181 pluggable terminations)	m	300		
20. Replacement of substation doors with 316 stainless steel material and provision of signages. (*Generator room excluded).	ea	7		
HVAC and Fire				
21. Design, supply and installation of the fire detection and suppression system.	Sum	1		
22. Design, supply and installation of the HVAC/climate control plant.	Sum	1		
Testing and Commissioning				
23. Test and commission the entire installation. The contractor shall issue test, certificates, user manuals and as-built drawings.	Sum	1		
SUBSTATION 001B				
Preparation works for the proposed substation upgrades				
24. Disconnect and removal of the existing MV switchgear and battery bank to be replaced.	Sum	1		
Medium voltage switchgear				
25. Design, supply and install a new 1250A 11kV incomer VCB panel.	each	2		
26. Design, supply and store a new equipped 1250A 11kV spare incomer VCB panel.	each	1		
27. Design, supply and install a new 1250A 11kV bus section VCB panel.	each	1		
28. Design, supply and install a new 630 11kV feeder VCB panel.	each	7		
29. Design, supply and install new spare 630 11kV feeder VCB panel.	each	1		
30. Design, supply and store a new equipped 630A 11kV spare feeder VCB panel.	each	1		
31. Design supply and install a 11kV bus-riser panels/bus-bar Earth /VT panels.	each	1		
32.Design, supply, install and commission a complete arc ducting and protection system for the 11kV switchgear	Sum	1		

CONTRACT NUMBER:

REFURBISHMENT OF SUBSTATION 1A & 1B AT THE PORT OF NGQURA CONTAINER TERMINAL(NCT) FOR TRANSNET SOC LTD (REGISTRATION NO. 1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS (HEREINAFTER REFERRED TO AS "TPT") FOR NGQURA CONTAINER TERMINAL AS A ONCE-OFF SUPPLY.

33. Design, supply, install a battery bank (enclosed in a cabinet) and battery terminal unit for the 11kV switchgear complete with protection and wiring.	Sum	1		
34. Provision of racking tools	Sum	1		
Electrical, Lighting and Power				
35. Design, supply and install a new lighting and small power	Sum	1		
Medium Voltage Cable Termination				
36. Supply new 630A Feeder MV plug type terminations designed to EN 50181 and DIN 47637.	each	32		
37. Supply new 1250A Incomer MV plug type terminations designed to EN 50181 and DIN 47637.	each	8		
Power System Protection				
38. Protection grading configuration.	Sum	1		
Earthing and Lightning Protection				
39. Design, supply and install earthing and lightning surge protection for the proposed substation upgrades.	Sum	1		
Cables, Routes and Building Modifications				
40. Provisional sum for the building refurbishments, including but not limited to the replacement of old chequered plates and sealing of cable entry/exit opening, making good the floor, wall painting, changing of the submissible pumps in the cable management basement, repair and servicing of the air handling units in the transformer rooms.	Sum	1		R 150 000
41.1 Testing, and commissioning of cables.	Sum	1		
41.2 Supply and installation of trifurcation joints.	ea	10		
41.3 Replacement of substation doors with 316 stainless steel material and provision of signages. (*Generator room excluded).	ea	7		
HVAC and Fire				
42. Design, supply and installation of the fire detection and suppression system.	Sum	1		
42. Design, supply and installation of the HVAC/climate control plant.	Sum	1		
Testing and Commissioning				
43. Test and commission the entire installation. The contractor shall issue test, certificates, user manuals and as-built drawings.	Sum	1		
Total Price, Exclusive of VAT				

CONTRACT NUMBER:

REFURBISHMENT OF SUBSTATION 1A & 1B AT THE PORT OF NGQURA CONTAINER TERMINAL(NCT) FOR TRANSNET SOC LTD (REGISTRATION NO. 1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS (HEREINAFTER REFERRED TO AS "TPT") FOR NGQURA CONTAINER TERMINAL AS A ONCE-OFF SUPPLY.

CSDG (0.25% factor)	
VAT 15% (if applicable)	
Total Price, Inclusive of VAT (where applicable)	

SUMMARY

Scope Item/ Component (Replace or Repair as per SOW for both substations)	Unit	Quantity	Total Price
1. Preliminary & General Costs & Design & Engineering			
2. Preparation works for the proposed substation upgrades	Sum	1	
3. Medium voltage switchgear	Sum	1	
4. Electrical, lighting and power	Sum	1	
5. Medium voltage cable terminations	Sum	1	
6. Power System Protection	Sum	1	
7. Earthing and Lightning Protection	Sum	1	
8. Cables, Routes, and Building Modifications	Sum	1	
9. HVAC and Fire	Sum	1	
10. Testing and Commissioning	Sum	1	
Total Price, Exclusive of VAT			
CSDG (0.25% factor)			
VAT 15% (if applicable)			
Total Price, Inclusive of VAT (where applicable)			

ANNEXURE D

T2.2-02: Eligibility Criteria Schedule - CIDB Grading Designation

Note to tenderers:

Tenderers are to indicate their CIDB Grading by filling in the table below. **Attach a copy of the CIDB Grading Designation or evidence of being capable of being so registered.**

CRS Number	Status	Grading	Expiry Date

1. Only those tenderers who are registered with the CIDB, or are capable of being so prior to the evaluation of submissions, in a contractor grading designation equal to or higher than a contractor grading designation determined in accordance with the sum tendered or a value determined in accordance with Regulation 25 (1B) or 25(7A) of the Construction Industry Development Regulations, for a **7EP or Higher** class of construction work, are eligible to have their tenders evaluated.

2. Joint Venture (JV)

Joint ventures are eligible to submit tenders subject to the following:

1. every member of the joint venture is registered with the CIDB;
2. the lead partner has a contractor grading designation of not lower than one level one level below the required grading designation in the class of construction works under consideration and possesses the required recognition status; and
3. the combined Contractor grading designation calculated in accordance with the Construction Industry Development Regulations is equal to or higher than a Contractor grading designation determined in accordance with the sum tendered for a **7EP or Higher** class of construction work or a value determined in accordance with Regulation 25(1B) or 25(7A) of the Construction Industry Development Regulations
4. the Contractor shall provide the employer with a certified copy of its signed joint venture agreement;
5. and in the event that the joint venture is an 'Incorporated Joint Venture' the Memorandum of Incorporation to be provided within 4 (four) weeks of the Contract Date.

SPECIFICATION FOR THE SUPPLY OF ETAP SOFTWARE LICENSE FOR TRANSNET SOC LTD (REG. NO. 1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS (HEREINAFTER REFERRED TO AS "TPT").

ANNEXURE P – ETAP SPECIFICATION

Document Reference	Title	Number Of Pages
	SPECIFICATION FOR SUPPLY OF ETAP SOFTWARE LICENSE FOR TRANSNET SOC LTD (REG. NO. 1990/000900/30) OPERATING AS TRANSNET PORT TERMINALS (HEREINAFTER REFERRED TO AS "TPT")	6
	Total number of pages	6

REVISIONS		
REV	DATE	APPROVED
	07/11/2024	

1. INTRODUCTION

TPT requests delivery from the contractor to provide an ETAP software modelling and simulation tool with a single standalone license.

2. BACKGROUND

ETAP is a software for electrical power systems modelling and simulation, optimizing customer electricity power systems from design and engineering to operations and maintenance.

ETAP delivers best-in-class, seamless customer experience and ensuring universal and Morden accessibility for designers, engineers, and operators empowering users to increase productivity, collaboration, and efficiency, and enabling the energy transition journey.

3. PURPOSE

Request for the supply of ETAP software.

4. SCOPE OF THE SPECIFICATION.

4.1 The *Contractor* shall in collaboration with the employer's ICT department ensure that the software, with all modules, is functional.

4.2 The *Contractor* shall arrange for training on all modules for four employer's personnel. The training shall be a formal training for users.

4.3 Details of software licence:

- The *Contractor* shall provide a new standalone licence with a standard support for the duration of 1 to 3 years.
- The bus level shall be **5000 buses**.

5. SPECIFIC DELIVERABLES FOR THE SUPPLY of ETAP SOFTWARE LICENSES

The most recent version of ETAP software shall be supplied with the modules and specifications listed below:

Item Description	Maintenance Term	Licence Metrics	Quantity

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ETAP New License – 1 Single Commercial SA, unlimited Bus:		In line with the standard offer.	Fixed/Standal one.	1
Base Module	Multi-Dimension Digital-Twin Platform, Revisions, Libraries, Wizards			
IEEE, ICEA, NEC	Cable Ampacity & Sizing - IEEE, ICEA, NEC			
IEC 60502 & 60364	Cable Capacity, Sizing & Shock Protection - IEC 60502 & IEC 60364			
Load Flow, AC	Power Flow, 3-Phase & 1-Phase Systems, Voltage Drop, Result Analyzer			
Panel Schedule	Schedules, Calculations, 3-Phase, 1-Phase, NEC, IEC			
Renewables	Wind Turbine Generator, PV Array - PV Pro, Controls, Libraries, Profiles			
HVDC	Control Schemes, Dynamic Modes,			

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	Rectification, Inversion			
Short Circuit, AC	ANSI & IEC, Balanced 3- Phase & 1- Phase, Duty Evaluation, Analyzer			
Arc Flash, AC	IEEE 1584 2018 & NFPA 70E 2021 - Analyzer, Work Permit, Safety Labels			
Star	Protection, Selectivity, Sequence of Operation, Protective Devices			
Star Auto-Eval	Auto-Evaluation of Protection, Selectivity, Zone, Arc Flash*			
Harmonics	Harmonic Load Flow, Frequency Scan, Harmonic Filters & Sizing			
Ground Grid	3D Ground Grid Systems, IEEE 80 & 665, Finite Element (Irregular Grids)			

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Cable UG Thermal	UG Raceways, Direct Buried, Neher-McGrath, IEC 60287			
Load Flow, DC	Voltage Drop, Power Losses, Reports, IEEE 946			
Battery Sizing	Battery Discharge & Sizing, IEEE 308, 485, 946, Integrated with Control Simulator			
Renewable energy				

The Service Provider is required to provide the following as part of the deliverables:

1. Provide the ETAP licence software inclusive of all design modules.
2. Installation and testing of all modules.
3. Technical and backup support for the period of licencing or as a standard offer for the licence.
4. Accredited/ETAP approved formal training on all modules for four users.