

 Eskom	Report	Technology
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Title: **PTM&C DETAIL DESIGN DOCUMENT**

Project Name:

**Poseidon Temporary
Emergency 40MVA 220/66kV
Transformer**

Project Number:

C.TXF0238.C.SO.03F.\$\$LC

Substation Name:

Poseidon

Transmission Grid:

Southern

Area of Applicability:

Engineering

Documentation Type:

Report

Document Number:

Pos18P15-P-C12


Document Revision:

1

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Controlled Disclosure

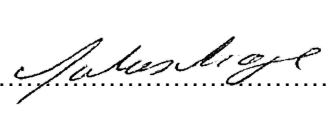
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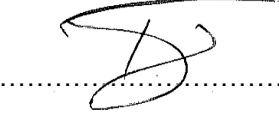
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Date: 18/05/2020

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Date: 22/05/2020

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1. PROJECT DESCRIPTION

The Poseidon 40MVA 220/66kV Transformer 11 failed the HV Bushings Tan Delta test in January 2018. No spare bushings were available as a replacement, therefore the Grid then made the decision to switch this unit out. To manufacture new bushings takes eight months lead time from placing the purchase order.

The situation posed a risk of a possible failure of the remaining Poseidon 80MVA 220/66kV Transformer 13, which is the only feed onto the 66kV busbar. This loss would have resulted in 28MVA unserved power for a very long duration, in the order of thirty days. For this reason, the grid had planned to temporarily place an Emergency Spare Transformer 40MVA 132/66kV between the 132kV and 66kV busbars to supply the Poseidon 66kV load, should Transformer 13 also fail. This additional measure or additional contingency was deemed to be necessary from the grid as the 66kV busbar feeds a municipality (Aberdeen) load that sustains a sewerage plant, which carries a risk of solidification and an ensuing environmental disaster, in the event of loss of power. Further, 5330 customers would be without supply under this Eskom N-2 contingency.

The transformation connection will be achieved via an existing wood-pole bypass, located between the 132kV and 66kV yard, which was originally built at 220kV for the purpose of emergency line-to-feeder reconfigurations on the 220kV busbar. It is noted

The designs for the proposed solution were completed and detailed in design report Pos18P15-SE-D87 rev 1. However the design solution did not materialise and Transformer 11 has since been restored.

This is due to the high cost associated with the solution since this transformer installation may never be used if the above mentioned contingency of Transformer 13 failure does not materialise in the period that Transformer 11 is switched out. It was also indicated by the Grid that once Transformer 11 bushings are restored, and the transformer re-commissioned, then the emergency transformer installation will be dismantled and the emergency spare transformer will be returned to its former storage facility.

Therefore the change in scope from the previous proposed solution only requires a storage plinth to host a spare Transformer 220/66kV 40MVA instead of a 132/66kV 40MVA, the spare transformer will not be operated on the storage plinth but when required will be moved to the position of the failed transformer as a replacement.

The high level scope of work:

- Construction of a Transformer Plinth suitable for a 220/66kV 40MVA unit,
- Inclusion of all associated civil works related to the above mentioned Plinth (Runway, bund wall & connection to emergency oil trap system).

There are two 132kV yards at Poseidon MTS's. This project involves 132kV Busbars 1 and 2, which are housed in the yard referred to as 132kV Yard A. Busbars 3, 4 and 5 are located in Yard B, located north-easterly from the 400kV busbar.

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2. SUPPORTING CLAUSES

2.1 SCOPE

This document provides an overview of the Secondary plant Engineering processes followed and the system design status. The document includes the technical assessments to determine compliance with the Grid Code and stakeholder requirements. This document does not provide design cost, schedule or other project management type information.

2.1.1 Purpose

This document is to state the concept design that will be employed to achieve the proposed scope of work. It specifies the technologies that will be used during the detail design phase of the project. The document is thus necessary for use as a reference during the detail design phase.

2.1.2 Applicability

This document shall apply to all Transmission Grids.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

- ISO 9001 Quality Management Systems.
- See documents listed under Related/Supporting Documents.
- Grid Planning URS.

2.2.2 Informative

- See **Reference Documents** bullet Point

2.3 DEFINITIONS

2.3.1 Disclosure Classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary)

2.4 ABBREVIATIONS

Abbreviation	Description
A	Amps
AUX	Auxiliary
BZ	Bus Zone
CB	Circuit Breaker

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Abbreviation	Description
CCRA	Condition Criticality Assessment
CLN	Customer Load Network
CT	Current Transformer
CVT	Capacitive Voltage Transformer
DC	Direct Current
ES	Earth Switch
HV	High Voltage
JB	Junction Box
kA	Kilo Amps
kV	Kilo Volts
LH	Left Hand
LT	Line Trap
M	Metering
MTS	Main Transmission Substation
OEM	Original Equipment Manufacturer
P	Protection
PDE	Power Delivery Engineering
PTM&C	Protection, Telecommunications, Metering & Control
RH	Right Hand
SED	Station Electric Diagram
URS	User Requirement Specification
V	Volts

2.5 ROLES AND RESPONSIBILITIES

The PTM&C Designer is responsible to ensure that the Secondary plant requirements for the project are adhered to.

2.6 RELATED/SUPPORTING DOCUMENTS

Document Type/Title	Drawing / Document Number	Revision Number	Originator
STATION ELECTRIC DIAGRAM	Pos18P15-SE-D6	0	Click here to enter the title
KEY PLAN	Pos18P15-SE-D9	0	Click here to enter the title
SURS/PLANNING URS	None	0	T.Mphephu

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GRID PLANNING Report	N/A	0	Click here to enter the title
Substation Engineering Detail Design Report	Pos18P15-SE-D87	1	N.Mazibuko

3. PRIMARY PLANT INFORMATION

3.1 HV EQUIPMENT

Info obtained from URS

System Voltage (kV)	Rated normal current (A, min)	Short-circuit withstand current (kA, min)	CT Bus Zone Ratio	BIL (kV, min)	Minimum Specific creepage distance (mm/kV, min)
220kV	2500	40	1/1200	900	25

3.2 FAULT LEVELS

System Voltage (kV)	1Ø Fault Level (kA)		3Ø Fault Level (kA)	
	Current (Year)	New (Year)	Current (Year)	New (Year)
220kV	16.9	22.40	13.6	18.6
66 kV	10.8	11.3	8.4	8.9

4. HIGH LEVEL SCOPE

4.1 275KV YARD

Qty	Bay	Scope of Work
1	220/66kV 40MVA Transformer	Transformer plinth

4.2 STATION DC VOLTAGE

220V DC

5. SECONDARY PLANT REQUIREMENTS

5.1 220/66KV 40MVA TRANSFORMER (SPARE)

Discipline	Requirements
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5.1.1.1 Protection	None
5.1.1.2 Control	None
5.1.1.3 Measurements	None
5.1.1.4 Teleprotection	None

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5.2 COMMON YARD REQUIREMENTS

5.2.1 Auxiliary/Construction Supply	N/A
5.2.2 AC Reticulation	Additional Plug Box for heater supply to the marshalling kiosk
5.2.3 Eskom Telecoms	Existing.
5.2.4 Operating Floodlighting/ Security Lighting	Existing
5.2.5 Safety and Security	Existing
5.2.6 Control Room	
5.2.6.1 Protection	N/A
5.2.6.2 Tele-Control (SCADA)	N/A
5.2.6.3 Teleprotection	N/A
5.2.6.4 Metering	N/A
5.2.6.5 DC Systems (50V)	N/A
5.2.6.6 DC Systems (220V)	Interface
5.2.6.7 Under-frequency load shedding	N/A
5.2.7 Office Furniture	Existing

5.3 RELATED PROJECTS

- Greater East London Strengthening Phase 3
- SVC Reactor Replacement Poseidon, Perseus & Hydra
- Golden Valley IPP
- Poseidon Neutral Earthing Resistor (NER)
- Poseidon 66kV Yard Refurbishment
- High Risk Transformers Phase 2 (Poseidon SVC Transformer No.31 Bay)
- Poseidon Emergency 132/66kV Transformer Bypass Project

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5.4 SPECIAL PROJECTS

- None.

6. DESIGN PHILOSOPHY

Reliability is the probability that a component, system or process will function without failure as required under stated conditions or design parameters for a stated period of time as per our **Reliability Engineering Manual (Unique Identifier :474-37)** and 240-53458797 PCM for PTMC.

The effects of failures on the protection scheme to be used for this project will be minimized with a “good” level of maintainability (a measure of how quickly the product can be repaired). All specifications submitted to our protection scheme suppliers ensure that the supplier have done everything that they can to provide Eskom with the best possible products. The equipment was evaluated throughout the design process and the analysis of failures in Eskom is another important source of reliability information.

This PCM (240-53458797) deals with the following:

- Perform PTM&C Systems Engineering
- Apply Selected Teleprotection Systems
- Select Technical Solutions
- Create Bill of Works for Cabling and Redundant Equipment
- Perform Settings
- Perform PTMC Detailed Design
- Determine Telecommunications Network Capability
- Establish Greenfield Feasibility
- Perform Telecommunications Pre-engineering

7. MAINTENANCE PHILOSOPHY

Maintenance of Eskom’s generation and network assets will be planned and executed ensuring that the following needs are met:

- Safety of people
- High reliability of assets
- Increase customer satisfaction

Approved maintenance plans shall include the following:

- Confirmation of resource availability to execute the plan
- Uninterruptable work, including resources, will not be interrupted due to emergency work
- Contingency plans will be developed for emergency work and resources

This will be done as per the Eskom Maintenance Policy: **unique identifier: 32-1205**

8. OPERATING PHILOSOPHY

The main function of equipment protection is to selectively and rapidly detect and disconnect a fault on the protected circuit to:

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- Ensure optimal power quality to customers
- Minimise damage to the faulted primary plant
- Sustain stability and integrity of the power system
- Limit safety hazard to the power utility personnel and the public
- Prevent damage to healthy equipment that conducts fault current during faults.

Operational philosophy ref: SPL46-101

This will be in line with the Eskom Operating Regulations for High Voltage Systems (ESKPVAEY6)

9. EXPECTED LIFE CYCLE

All materials are selected in such a manner as to prolong the life of the equipment and combat the corrosive effects of the environment. Same procedure will be done for this project as our protection scheme normally has a 10 to 20 year life cycle

10. TECHNOLOGY

Protection schemes and Tele – Control equipment are all available from existing Transmission National Contracts which were obtained using the **Secondary Plant Technology Development Procedure (474 – 313)** and **Process for Secondary Plant Technology Management (41-714)**

- Transformer Protection Contract – TRP004 (4600000487 TX)
- Junction Box Contract – 4600057494

11. PROCESSES

Various processes and guidelines were developed to guide the Engineering Design disciplines (see PDE Design Review Process and PLCM Overview files) for **Value Engineering** and **Design Simplification**, 240-53458797 PCM for PTM& C.

11.1 FUNCTIONAL SCOPE

To review available standard designs and select the appropriate design that will suit site conditions and stakeholder requirements. Protection settings are calculated to ensure correct operational levels for protective devices.

The Power Line Carrier (PLC) frequencies, optical fibre driver types or microwave requirements are determined.

Cable schedules are created and redundant equipment is identified. Detailed designs are created to include site specific drawings, databases and configurations for metering and control.

Further Telecommunications sites are analysed and selected based on availability and usability. Telecommunications pre-engineering work is determined including geotechnical, structural, environmental requirements and the need for applications for permits and approvals. The design review process for the standard designs used are captured in 47-313

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11.2 SETTINGS REQUEST PROCEDURE

A Setting Request Form: Doc No.: **SPF 0001** must be completed for each bay settings are required. All the required information including equipment nameplate details and pictures must be included with the request.

The assigned protection settings engineer obtains all the information necessary for correct setting calculations and applicability. The settings are then calculated according to the latest philosophy, using sound engineering principles. Pre-written programs may be used as a guide.

After calculation of the settings, it is important that another competent person checks them. The persons who calculate and who check the settings both sign the settings document.

Details of the settings calculation process are included in document **TRMSOP038 "Protection Settings Management Procedure"**.

The PSOP department keeps the settings sheets with original signatures and files a copy of the settings on the database.

The settings are issued to the applicable Transmission Grid, addressed to the relevant Secondary Plant Manager. After the setting is implemented, the applicable Transmission Grid informs the PSOP department in writing.

Only in cases of extreme urgency may an electronic message be used to request a setting change. Such communication will be specific on the change that needs to be done, and the bay on which such a change must be made. Updated setting documentation must then follow as soon as possible.

12. PROTECTION SCHEME DESIGN CRITERIA

The protection system shall be based on the principle of main and back-up protection.

Each of the dual-redundant protection systems, Main1 and Main 2, must be connected to separate DC auxiliary supplies.

The purpose of protection is to detect faults that the equipment can be exposed to timeously and to initiate appropriate tripping action.

The main requirements of this protection are following:

- Maximum sensitivity.
- Stability for load conditions..
- Stability for through-fault conditions.
- Stability for magnetising inrush with its accompanying decaying DC offset.

13. DESIGN AND MATERIAL ALTERNATIVES CONSIDERED/REJECTED

All protection schemes to be used are available on Transmission National Contracts and schemes used for this project will be determined by the capacity of the transformers as well as the substation layout design and according to the Electrical Area classification – Class IV according to the **Standard for Electronic Protection and Fault Monitoring equipment (TST41-1062) Section 2.1.5.2 Table 3**. The

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design and testing of the relays shall also comply with the **Standard for Electronic Protection and fault monitoring equipment (TST41-1062)**

The process for establishing these contracts as outlined in section 5(above) ensures that the best design alternatives have been considered for each type of application as specified in the equipment list.

14. SPECIFICATIONS

All protection equipment used is selected such that:

- It is standardised
- It is proven technology
- It shall be purchased from reputable suppliers
- It has built in self-diagnostics
- It is maintainable without the need for special tools and equipment.
- It has continuous monitoring systems which detects and provide indication of each failure

15. EQUIPMENT LIST

Refer to Appendix A for a list of all PTM&C Equipment to be installed

16. EQUIPMENT SELECTION CRITERIA

Equipment selection is based on the following criteria

- Technical suitability – Fit for intended use/purpose
- Life cycle cost, including the efficient use of electrical energy
- Capital cost
- Supplier support
- Standardisation

And the supplier have been evaluated and accredited by the Eskom team

17. CONTROL PHILOSOPHY

Mode of control will be either local or remote. Local control will have auto and manual mode. In auto mode the relays will do controls as per the uploaded settings e.g. tap changer control circuit tap up or down due to voltage required by the system. Manual mode control is from human action and could be in the form of push button or Operator in the Substation using Keypad or Laptop.

Remote control mode is done by National and Regional control centre via SCADA provided the local/remote switch is selected on remote. All safety and process interlocks to be maintained in the event of accidental control of equipment under such remote control. Viewing all alarms and condition status of the equipment will also be done local and remote. Control isolation shall be affected via a local/remote switch. Each control output signal will have a feedback indication to indicate a successful operation

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18. TRAINING

Due to the unlikely availability of the skills required, the project must include for the costs associated with the training of two support persons including courses and might be required to be present during the factory acceptance test.

19. EQUIPMENT AND UTILITY REQUIREMENTS

Protection panels to be build according to **Eskom's Standard for Electronic Protection and fault monitoring equipment TST41-1062 Item 2.2.13.**

Protection scheme panels (1 or 2 x 600/800mm) will be installed in the control rooms. Substation battery voltage is 220/110V DC, therefore the new protection scheme relays will be rated 220/110V DC supplied from the existing DC board (Main 1 and 2).

15A Plug sockets installed on the panels will be supplied from an earth leakage protected supply from the AC Board and looped between the panels. Inside the yard, this will be supplied from the Plug Boxes, where an Earth Leakage is installed, to the newly installed junction boxes. 230V AC supplies is also required and supplied from the installed AC Board inside the control room to the respective protection equipment.

All AC/DC installations shall be done and Certificates of Compliance (CoC) and / or Inspection and Test Certificates (ITC) issued in accordance with the COMPLIANCE OF LV AUXILIARY SUPPLY NETWORKS IN SUBSTATIONS Position Paper Nr. 240 - 64139234

20. ELECTRICAL SPECIFICATIONS

Heaters will be provided in each junction box and will be permanently energized. These heaters are required to keep the temperature in the cubicle above the dew point.

Gland plates will be properly sealed and all unused holes will be securely closed off (PVC plugs are not acceptable). Gland plates will be adequately protected against rust and oxidation.

Door rubber seals will be made from rubber and be securely glued into place.

Terminals must comply with Eskom's Standard for Electronic Protection and fault monitoring equipment TST41-1062, clause 2.2.14. Earthed wrist straps shall be worn by personnel removing any electronic Components/cards from protection relays

21. CADD/MODEL REQUIREMENTS

Drawings are cadded using the micro station software and once checked and signed off, the CAD operator register them on the Eskom Directa system as per the Drawing office standard (TST41-634) and according to Eskom's Standard for Electronic Protection and fault monitoring equipment TST41-1062 Item 2.3.3. This is only done by the authorised person using his or her personal provided password. Software (i.e. PCM600) and cables will be provided to communicate with protection relays.

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22. TRANSPORTATION AND STORAGE REQUIREMENTS

The scheme shall be packed in a high specification impact resistance Corrugated cardboard box or wooden crate. The packaging shall be waterproof and shall protect the contents from reasonable transport related wear and tear. It shall be clearly marked and where cabinet door locks, front panel switches etc. may cause damage to the packaging, these shall be removed and placed in a suitable plastic bag and securely tied to the interior of the cabinet for fitment on site.

Current Transformers have to be handled and **transported with care according to TPC41-542 - Procedure for Inspection of Current Transformers Item 12 & 13.**

The location in which equipment may be stored / installed will be specified by the supplier (Temperature and Humidity).

23. PRE-COMMISSIONING AND HANDOVER SEQUENCE REQUIREMENTS

Pre-commissioning and Commissioning (Energizing) tests will be as per **Standard for Commissioning Protection Assets (240-54615413)**, before handing over the equipment to the Grid or System Operations.

24. FUTURE EXPANSION REQUIREMENTS AND CONSTRUCTABILITY

The following documents were also used to determine if the project is **constructible from a Design perspective:-**

- 41-1022 Design Construct and Refurbish Process guide
- 240-44509564 Basic PCM – Perform Design Analysis Section 9.1.4:

Perform site layout

The placement and integration of systems and structures within the site or area to facilitate optimal functionality, operability and cost, while ensuring adequate clearance for the construction, installation, maintenance, safety, emergency access and egress routes.

25. MAINTENANCE REQUIREMENTS

All secondary plant maintenance shall be carried out as per maintenance manuals that can be found using the follow link: http://tx1.eskom.co.za/docManagement/part_b.htm - Secondary Plant Maintenance Manual.

26. REFERENCE DOCUMENTS:

- 240-53249157 PTM&C Operating Procedure
- 474-313 Secondary Plant Technology Development Procedure
- 41-714 Process for Secondary Plant Technology Management
- 41-1022 Design Construct and Refurbish Process guide
- 240-44509564 Basic PCM – Perform Design Analysis
- 240-53458797 PCM for PTMC
- 474-314 Transmission PMC Application Guideline
- 474-315 PTM&C Project File Guideline
- South African Grid Code (Network code ver. 8)

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- SPL46-101 Protection Settings Philosophy for Transmission and Sub – Transmission Grids
- TST41-1062 Standard for Electronic Protection and Fault Monitoring Equipment
- Standard for the Protection and Control of Transmission Transformers & Shunt Reactors on the Eskom Power System TST41-765
- South African Grid Code (metering code ver 8)
- NRS057:2009 Code of Practice for Electricity Metering
- Standard Minimum Requirements for the Metering of Electrical Energy & Demand DST34-1024
- Goods Information for Standard Meter Scheme TSP41-697
- Standard for Non-Lethal Energized Perimeter Detection System (NLEPDS) structure and associated equipment for the protection of Eskom Installations and its Subsidiaries 32-402
- Robust Energizer TSP41-766
- Secondary Plant Templates for Planned Maintenance 41-976
- Secondary Plant Maintenance of Transformer Bays TPC41-530
- Transmission Maintenance Planning, Scheduling and Control TST41-475
- Feeder Protection Maintenance TPC41-444
- Protection Maintenance of Bus Coupler and Bus section TPC41-146
- Secondary Plant Maintenance of Low Impedance Bus Zone TPC41-565
- Test, Maintenance & Fault Finding requirements for Recording Equipment TPC41-470
- Digital Fault Recorder Setting Philosophy TGL002
- Secondary Plant Maintenance of Simeas R Disturbance Recorder TPC41-760
- Measurements Equipment Maintenance TPC41-527
- Metering Equipment Maintenance TPC41-528
- Secondary Plant Security Systems Maintenance Procedure TPC41-245
- Secondary Plant Refurbishment Procedure TPC41-780
- Commissioning of Transformers and Reactor Bays TPC41-78
- Commissioning of Transformers and Reactor Bays TPC41-140
- Secondary Plant Commissioning of EHV or HV Feeder Bay TPC41-180
- Secondary Plant Commissioning of Bus coupler & Bus Section TPC41-149
- Commissioning of Metering Installations TPC41-561
- Secondary Plant Security Systems Commissioning Procedure TPC41-244
- Substation Fibre Optic Cable Installations TPC41-115
- Fibre Optic Cable System Acceptance Testing TPC41-5

27. REVISION TRACKING

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28. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- PTM&C Project Engineering Team

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29. ACKNOWLEDGEMENTS

- None.

30. APPENDIX

30.1 APPENDIX A – PDE DRT PRESENTATION SLIDES/EQUIPMENT LIST

30.2 APPENDIX B – CONTROL ROOM SIZING (IF REQUIRED) N/A

30.3 APPENDIX C – DC SYSTEMS SIZING (IF REQUIRED) N/A

30.4 APPENDIX D – SECONDARY PLANT SOW DOCUMENT

30.5 APPENDIX E – CABLE DOCUMENT