

 Eskom National Transmission Company South Africa TM	Report	Technology
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Title: PTM&C DETAIL DESIGN DOCUMENT

Project Name: East Grid High Risk IMBA/E CT Replacement Project - Tugela

Project Number: C.TXL0094

Substation Name: Tugela

Transmission Grid: East Grid

Area of Applicability: Engineering

Documentation Type: Report

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Date: 19/02/2025.....	Date: 19/02/2025.....	Date: 19/02/2025.....

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1. PROJECT DESCRIPTION

The project is required to replace high risk current transformers at Tugela substation.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document provides an overview of the PTM&C Engineering processes followed and it also 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 detail design that will be employed to achieve the proposed scope of work. It specifies the technologies that will be used during the execution 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 the East Grid and all relevant stakeholders.

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 Report.
- SURS

2.2.2 Informative

240-61713594	Self build doc
240-53249157	PTM&C Operating Procedure
240-65336348	Standard for Transmission and Distribution Protection Schemes: Common Requirements
240-75757022	Overview of Requirements for Transmission Protection, Telecontrol and Substation Automation Equipment
SPL46-101/ 240-56364481	Protection Settings Philosophy for Transmission and Sub-Transmission Grids
	South African Grid Code (network code ver 10)
240-56362025	Power Line Carrier Frequency Planning Design Guide
240-68234842	Substation Gateway and Station RTU/IED Standard Specification for EHV Substations
240-55151946	AC Reticulation Philosophy for Substations
240-55151908	AC Reticulation Application Design Guideline for Substations

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240-78980848	Specification for Non-Lethal Energized Perimeter Detection System (NLEPDS) for protection of Eskom Installations and its Subsidiaries
240-67712833	Specification for Transmission and Distribution Protection Schemes: Transformers and Reactors
240-46264031	Substation Fibre Optic Design Standard – Part 2: Substations
240-56362378	PMC Application Work Instruction
240-83684419	PTM&C Technology Development
240-53113685	Design Review Procedure
240-53458797	Process Control Manual for Perform PTM&C Systems Engineering
240-64685228	Generic Specification for Protective Intelligent Electronic Devices (IEDs)
240-57649110	Sizing of DC Systems for Substation Application
34-999	Design Standard for DC & Auxiliary Supplies
TSP41-766	Robust Energizer Specification
41-976	Secondary Plant Templates for Planned Maintenance
TST41-475	Transmission Maintenance Planning, Scheduling and Control
240-54615413	Standard for Commissioning Protection Assets
TPC41-244	Secondary Plant Security Systems Commissioning Procedure
240-70732888	Fibre Optic Cable System Acceptance Testing
240-44509564	PCM for Perform Design Analysis
41-1062	Standard for Electronic Protection and Fault Monitoring Equipment for Power Systems
41-1022	Design, Construct and Refurbish guidelines
32-1205	Eskom Maintenance Policy
TPC41-148	Decommissioning and Removal of Protection Panels

2.3 DEFINITIONS

- PTM&C: Protection, Telecommunication, Metering, Control & DC

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
CCRA	Condition Criticality Assessment
CLN	Customer Load Network
CT	Current Transformer
CVT	Capacitive Voltage Transformer
DC	Direct Current
ES	Earth Switch

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Abbreviation	Description
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	Tug25P08-SE-D6	0	Mpho Tshabalala
Grid Planning report / URS	C.TXL0094	2	Jimmy Khosa
Substation Design Report	Not presented	1	Mpho Tshabalala

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3. PRIMARY PLANT INFORMATION

3.1 HV EQUIPMENT

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)
275kV	4000	50	1/1200	1425	31
132kV	2500	40	1/1200	550	31

Info obtained from the Substation Design Report

3.2 FAULT LEVELS

System Voltage (kV)	1Ø Fault Levels (kA)		3Ø Fault Levels (kA)	
	Existing	New	Existing	New
132	10.8	10.8	8.9	8.9
275	8.1	8.1	8.8	8.8

Info obtained from the Planning URS

4. HIGH LEVEL SCOPE

4.1 275 & 132KV YARD

Qty	Bay	Scope of Work
6	275/132kV TRFR 1	Replace CT's
3	275/132kV TRFR 3	Replace CT's
6	132kv Bus coupler	Replace CT's

4.2 STATION DC VOLTAGE

110 V

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5. SECONDARY PLANT REQUIREMENTS

5.1 132KV SYSTEM

5.1.1 132 kV Bus Coupler A

Discipline	Requirements
5.1.1.1 Protection	Existing Phase 2 Protection Scheme- 2BC-0101 Interface the new CT to the existing JB Update Application drawings New Cables between CT's and JB Buszone scheme:Phase 1
5.1.1.2 Control	N/A
5.1.1.3 Measurements	N/A
5.1.1.4 Teleprotection	N/A

5.1.2 275/132 kV Transformer 1

Discipline	Requirements
5.1.2.1 Protection	Existing Phase 2 Protection Scheme- 2TA-2102 Interface the new CT to the existing JB Update Application drawings New Cables between CT's and JB
5.1.2.2 Control	N/A
5.1.2.3 Measurements	N/A
5.1.2.4 Teleprotection	N/A

5.1.1 275/132kV Transformer 3

Discipline	Requirements
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5.1.1.1 Protection	Existing Phase 1 Protection Scheme- 1TC-0200 Interface the new CT to the existing JB Update Application drawings New Cables between CT's and JB
5.1.1.2 Control	N/A
5.1.1.3 Measurements	N/A
5.1.1.4 Teleprotection	N/A

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5.2 COMMON YARD REQUIREMENTS

5.2.1 Auxiliary/Construction Supply	N/A
5.2.2 AC Reticulation	N/A
5.2.3 Eskom Telecoms	N/A
5.2.4 Operating Floodlighting/ Security Lighting	N/A
5.2.5 Safety and Security	N/A
5.2.6 Control Room	
5.2.6.1 Protection	Protection Drawings Update
5.2.6.2 Substation Automation and 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)	N/A
5.2.6.7 Battery Room (50V)	N/A
5.2.6.8 Battery Room (220V)	N/A
5.2.6.9 Under-frequency load shedding	N/A
5.2.7 Office Furniture	N/A

5.3 ENGINEERING WORK REQUEST FORM(EWR)

A form that is to be completed and returned to the Substation Automation Integration Section (Email address) when requesting project related Gateway Configurations, Databases, IED Configuration Files or SCD Files that Eskom are accountable for. This form contains fields detailing the information required to complete the request by the Self Build or EPC contractor. This form needs to be submitted 6 weeks prior to the Self Build or EPC contractors required date. A Project schedule and latest signed SED is also required.

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The Request Template and request can be sent to the following Email Address: -

SAIWorkRequest@ntcsa.co.za

5.4 IP ADDRESSES ALLOCATION REQUEST FORM

A form that is to be completed and returned to the Substation Automation Integration Section when requesting project related Allocation of IP addresses that Eskom are accountable for. The form contains fields detailing the information required for the allocation of IP addresses which are required by the Self Build or EPC contractor. This form needs to be submitted 6 weeks prior to the Self Build or EPC contractor required date.

The Templates and request can be sent to the following Email Address: - IPArequest@ntcsa.co.za

5.5 IED PROTECTION CONFIGURATION FILES OR BAY SPECIFIC SCD FILES

Files that Eskom are responsible for must be requested by sending a request with a full Scope to the following Email address:- PACconfigupdate@ntcsa.co.za

Any external files need to be requested directly from the OEM and a copy of these files must be sent to the Eskom Email address for storage on their configuration file system.

Email address:- PACconfigupdate@ntcsa.co.za

5.6 RELATED PROJECTS

- Tugela protection upgrade
- Sorata strengthening project

5.7 SPECIAL PROJECTS

- None.

5.8 MATERIAL LIST

Description	Type	Quantities
Cables	BVX12DCV	Measure

5.9 REVISION CONTROL

Date	Rev	Compiler	Remarks
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6. DESIGN PHILOSOPHY

The applicable document is SAGC Network code (latest version) and **240-75757022** Overview of Requirements for Transmission Protection, Telecontrol and Substation Automation Equipment and 240-53458797 PCM for Perform PTM&C System Engineering.

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

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

7. MAINTENANCE PHILOSOPHY

Maintenance of Eskom's 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

The applicable documents are Maintenance Planning, Scheduling and Control **TST41-475**, Secondary Plant Templates/Manuals for Planned Maintenance **41-976** & can also be found using the follow link: http://tx1.eskom.co.za/docManagement/part_b.htm and Eskom Maintenance Policy **32-1205**.

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8. OPERATING PHILOSOPHY

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

- 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: 240-56364481

This will be in line with the Protection Settings Philosophy for Transmission and Sub-Transmission Grids.

9. COMMISSIONING PHILOSOPHY

The document is aimed at standardizing the procedure for commissioning and handover of Protection schemes in a substation.

The objective is that:

- Tests required for the commissioning of protection systems are specified in enough detail.
- Skilled and accredited resources are allocated to perform the tests.
- Accountability for performance of the tests rests with the resource allocated.

Since the work content involved in the commissioning process is the same regardless of what resource undertakes the work, this document is binding to all categories of resources undertaking the work, namely:

- Internal Eskom resources executing the commissioning work.
- External Eskom resources (i.e. from another division in Eskom) that are employed as a contractor to execute the commissioning work.
- External contractors who are not Eskom employees executing the commissioning work.

The applicable commissioning document is Standard for Commissioning Protection Assets **240-54615413**

10. 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. PTM&C equipment normally has a 10 to 20 year life cycle.

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11. TECHNOLOGY

Standard schemes, aligned with Technology Plans, are identified / developed such that they may be applied across the Transmission & Distribution network. Long term procurement agreements may be established to facilitate ongoing purchases thereof.

In the case of a once-off turnkey type project, the contractor proceeds with the installation and commissioning of the system at site. This is followed by Site/Factory Acceptance Testing (S/FAT). After successful completion of the S/FAT, the system is formally handed over to Eskom.

12. PROCESSES

PTM&C (Protection, Teleprotection, Measurement and Control) is accountable for technology management, Engineering Planning, Project Support and Engineering Applications within Eskom NTCSA. Engineering Planning, Project Support and Engineering Applications entails the site specific application of a standardised methodology towards the delivery of engineering designs. Various processes and guidelines were developed to guide the Engineering Design disciplines for Value Engineering and Design Simplification (i.e. Design Review Procedure 240-53113685). The detail design was presented and reviewed at the PTM&C Design Review Team (DRT) Forum in accordance with Design Review Procedure **(Ref: Pg 14 of 19, Section 3.3.1.7)**.

The standard applicable documents for Value Engineering and Design Simplification are PCM: Perform PTM&C Systems Engineering **240-53458797 (Ref: Pg 53 of 77, Section 9.1.5)** and Design Review Procedure **240-53113685 (Ref: Pg 16 - 18 of 19, Section 3.3.2 - 4)**.

12.1 FUNCTIONAL SCOPE

To review available standard designs and select the appropriate design that will suit site conditions and stakeholder requirements, Design Review Procedure is followed.

redundant equipment is identified.

Telecoms to be consulted via URS submission.

12.2 SETTINGS REQUEST PROCEDURE

A Setting Request Form: Doc No.: **SPF 0001** must be completed for each bay that the settings are required.

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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.

13. PROTECTION SCHEME DESIGN CRITERIA/PTM&C DESIGN CONTROL

The protection system shall be based on the principle of dual main and/or main & back-up protection for system security and redundancy refer to **240-75757022** Overview of Requirements for Transmission Protection, Telecontrol and Substation Automation Equipment ().

14. DESIGN AND MATERIAL ALTERNATIVES CONSIDERED/REJECTED

The selected schemes are based on the standardized secondary plant, available on contracts and cater for AIS/GIS systems, unless a unique non-standard design is required. **UTILITY REQUIREMENTS**

All AC/DC installations shall be done by an accredited/certified NTCSA electrician. The Certificates of Compliance (CoC) and / or Inspection and Test Certificates (ITC) will be issued in accordance with document, **240-64139234** – Compliance of LV Auxiliary Supply Networks in Substations.

14.1 STANDARD SPECIFICATIONS & EQUIPMENT SELECTION

All equipment used is selected such that:

- It is standardised.
- It is proven technology.
- It shall be purchased from established contracts.
- 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 Secondary Plant Requirements (Section 5) for a list of all PTM&C Equipment to be installed.

16. CONTROL PHILOSOPHY

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The design of the substation automation network architecture What is the standard is primarily based on a two-tier design. The top tier consists of high capacity, high speed backbone Ethernet switches which provide the physical connectivity only to the bay level switches. The lower tier switches provide physical connectivity to the bay IEDs, the Gateway(s), HMI(s), router and other network equipment. In order to meet high system availability criteria, each bay level switch connects redundantly to two backbone switches. The protocol to be used between the new protection scheme IED's and SCADA/network devices shall be IEC61850.

refer to **240-75757022** Overview of Requirements for Transmission Protection, Telecontrol and Substation Automation Equipment

17. TRAINING

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

18. ELECTRICAL SPECIFICATIONS

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

19. SOFTWARE (CADD/MODEL) REQUIREMENTS

Drawings are cadded using MicroStation software. The draughtsperson register the drawings on the ProjectWise™ system once checked and signed off as per the Drawing office standard **TST41-634 (240-96632721)** The applicable configurations or software for secondary plant equipment is provided by the OEM service provider.

20. TRANSPORTATION AND STORAGE REQUIREMENTS

The secondary plant equipment shall be packed as per the requirement of the equipment specification. The location in which equipment may be stored / installed will be specified by the supplier.

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21. PRE-COMMISSIONING AND HANDOVER SEQUENCE REQUIREMENTS

Pre-commissioning and Commissioning (Energizing) tests will be done as per Standards for Commissioning all of the secondary plant equipment before handing over the equipment to the Grid. (eg Protection 240-54615413)

22. FUTURE EXPANSION REQUIREMENTS AND CONSTRUCTABILITY

The following documents were applied to determine if the project is constructible from the design perspective:

Design, Construct and Refurbish process guide 41-1022

PCM for Perform Design Analysis 240-44509564

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

23. MAINTENANCE AND OPERATING REQUIREMENTS

The Grids, as owners of the Plant prepares and implements the plant maintenance execution strategies and procedures as influenced by the maintenance strategy set during the design phase.

All Grids will have their own maintenance plan specific to the Grid. The Grid will create the site-specific operating procedure based on **240-674449796**, once the plant has been handed over to the Grid.

24. DECOMMISSION

To overcome any negative impact to the system from decommissioned secondary plant equipment, it shall be removed from the station.

25. DEVELOPMENT TEAM

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

- PTM&C Project Engineering Team

26. ACKNOWLEDGEMENTS

- None.

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27. ADDITIONAL REFERENCE DOCUMENTS

27.1 NTCSA DRT PRESENTATION SLIDES

27.2 CONTROL ROOM SIZING

27.3 DC SYSTEM SIZING

27.4 TELECOMS URS