

**Scope of Work****Technology**

Title: **HIGH LEVEL SCOPE OF
WORK/BASIC DESIGN - PTM&C
EQUIPMENT FOR MERCURY
SUBSTATION 3RD
TRANSFORMER PROJECT**

Unique Identifier: **240-170001091**

Alternative Reference Number: **Mer23P13-P-D95**

Area of Applicability: **Engineering**

Documentation Type: **Report**

Revision: **1**

Total Pages: **22**

Next Review Date: **n/a**

Disclosure Classification: **Controlled
Disclosure**

Compiled by

Christinah Mohloki

**Senior Project Engineer:
Planning & Project Support**

Date: 15/09/2023

Functional Responsibility

Mario Petersen

**Manager: Planning &
Project Support (Acting)**

Date: 18/09/2023

Authorized by

Judith Malinga

**Senior Manager:
PTM&C Engineering**

Date: 18/09/2023

Content

	Page
1. General	3
1.1 Background.....	3
1.2 Scope.....	3
1.3 Station Electric Diagram	4
2. Protection	5
2.1 Protection scope of work	5
2.2 Sourcing.....	5
2.3 Engineering Resources	6
2.5 BUS COUPLER SCHEMES	8
2.6 BUS SECTION SCHEMES.....	8
2.8 BUS SECTION SCHEMES.....	10
2.9 400 kV Bus zone.....	11
2.10 132 kV Bus zone.....	11
3. Fibre optic requirements	12
3.1 Telecommunication connection requirements	13
4. Protection settings	13
6. Telecontrol and substation automation.....	14
6.1 Telecontrol and substation automation equipment.....	15
6.1.1 Siemens telecontrol and substation automation equipment	15
6.2 AC systems.....	15
7. Telecommunications	16
8. Protection application design	16
8.1 Protection application design requirements.....	16
8.2 Control room layout	16
9. Factory testing	17
9.1 Factory acceptance testing requirements of the schemes to be developed	17
9.1.1 Test template requirements of the schemes to be developed	18
9.2 Integrated substation solution factory testing	19
10. Security System	19
11. Commissioning	19
12. Delivery, off-loading and site erection.....	20
13. General	20
14. Scope Split.....	20
15. Revision and tracking.....	22

ESKOM COPYRIGHT PROTECTED

When downloaded from the WEB, this document is uncontrolled and the responsibility rests with the user
to ensure it is in line with the authorized version on the WEB.

1. General

1.1 Background

With limited or no capacity available in many of the transmission supply areas, and with a need to install 16 604 MW of renewable energy (RE) generation by 2027, it becomes crucial to attract and enable RE generation connections in the areas where grid capacity remains, especially those areas where minimal upstream network infrastructure is required. To this effect, areas have been identified for additional transformer capacity at substations that lie within the future areas of interest for RE generation.

Mercury Substation was identified as one such station. Mercury is located near the town of Orkney in the Freestate.

Mercury MTS is a 765/400/132/ kV substation. It consists of 2x 500 MVA 400/132 kV autotransformers. The substation utilises double busbars for all voltage levels. There are 3x 400 kV feeders, 10 x 132 kV feeders, 1x132kV bus coupler, 1x400kV bus coupler and 2 x 132 kV shunt capacitor bank. The 75kV yard is not mentioned because the scope is limited to 400/132kV yards.

A third 500 MVA 400/132 kV transformer is required at Mercury Substation to integrate an additional 980 MW to the 67.9 MW. This will ensure that the total of 1048 MW will be connected at an N-1 level of network redundancy.

1.2 Scope

The provision of a turnkey protection, tele-control, measurements, metering, DC and AC solution for the proposed Mercury substation, aligned with Eskom's current methodologies in this regard.

Standard tested and Eskom approved products are to be utilised.

The scope of works includes the

- sourcing of the Eskom approved products
- supply of all material,
- delivery, off-loading, erection, installation, cabling, application of configurations and settings, commissioning; to be accepted by Eskom
- provision of documentation, as-built drawings, in Eskom standard format and to be accepted by Eskom
- anything else deemed necessary by the tenderer for the provision of a working solution

Note:

- All engineering outputs and associated intellectual property shall become the property of Eskom, and
- Roles and Responsibilities, where defined in the references in this document, are not specifically applicable for the purpose of this enquiry and any ensuing contract.

ESKOM COPYRIGHT PROTECTED

When downloaded from the WEB, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the WEB.

2. Protection

2.1 Protection scope of work

This section describes the material required for the protection scope for the proposed Mercury 400/132kV 3rd Transformer project.

The scope includes all power system protection equipment and directly related infrastructure including networking equipment for the substation automation LAN, such as terminal patch panels / boxes and fibre optic cables between the bay Ethernet switches and the IEDs.

Telecommunication equipment is included elsewhere within this document.

2.2 Sourcing

Eskom Transmission's current installed base of Protection, Telecommunications, Metering, (Tele-Control) and associated equipment (PTM&C equipment) has typically been procured through a 2-stage procurement mechanism:

- Development contract, where a supplier will develop a product to meet Eskom's requirements and the product undergoes substantial acceptance testing before being accepted by Eskom. This may be extended for periods of up to 2 years and more in certain instances.
- Supply contract, where a supplier will supply products to Eskom as developed, tested and accepted during the development contract.

Product standardisation forms the backbone of Eskom Transmission's efforts to reduce the burden associated with sustaining the infrastructure and as such the above contracting may typically be extended for periods up to 10 years. Manufacturer specific interfacing may also dictate that only specific supplier's products can be used for infrastructure extension projects to ensure compatibility with the existing installed base.

Eskom's specification and adjudication criteria for PTM&C equipment in this enquiry are based on Eskom's deemed optimal approach (time and cost) to procure / engineer accepted products that are compatible with existing infrastructure and is prescriptive only in this regard. Products other than those previously accepted, as discussed above and sourced from the Eskom approved supplier, would necessitate an extensive testing and acceptance process as well as the development of associated design base documentation to support the configuration, operation and maintenance of the products. In addition, experience has shown that constructive involvement by Eskom during development greatly accelerates the development timeframes and, as such, this has also been specified where relevant in this scope of work.

Suppliers are advised that if they have alternative technology which they may deem appropriate for the current scope of works, they are at liberty to bring this to Eskom's attention as an alternative proposal (but not an alternative tender), which will be assessed at evaluation stage. The use of technology which has not been tested and accepted by Eskom may delay the project and may have cost implications, which delays will impact the delivery timelines, and which additional costs will be for the supplier's account. No product which

ESKOM COPYRIGHT PROTECTED

is proposed as an alternative technology as contemplated shall be supplied or used in respect of the works unless accepted by Eskom.

The tenderer(s) is encouraged to engage with the Eskom approved supplier to compile a detailed bill of material which shall be submitted with the proposal (tender).

2.3 Engineering Resources

Resources utilised for the scheme development and engineering of the protection and control solution must have previous experience developing and implementing protection and control solutions for Transmission high voltage networks.

2.4 EHV Double Busbar Transformer scheme requirements and options

The following protection and telecontrol and substation automation equipment will be permitted:

- Siemens (Pty) Ltd (Eskom contract 4600067750) for the Phase VI breaker-and-a-half protection/Double Busbar equipment in combination with the Siemens (Pty) Ltd (Eskom contract 4600067750) telecontrol and substation automation equipment.

Note that for the interface between the Protection equipment and the primary plant equipment (via JB's) is hardwire (DC supplies and tripping) and fibre that is connected to the process interface units (PIUs) that shall be located within the JB's. CT and VT interfacing with the protection & control schemes shall be hardwired.

The required protection Transformer Scheme is a 6TA-2300-M1 (DWG No 0.52/30434) and 6TA-2300-M2 (DWG No 0.52/30459)

Levels 6, 7, 13, 14, 15, 16, 20, 21, 22, 23 and 31

Equipment as per the table below from the Eskom ENC is required to build this scheme:

A Fixed frame, rear entry panel for transformer protection schemes (2400x800x600, 19" rack mount) x 2 is required. The ENC Contract number is 4600071130 and the supplier is Wirconn

Supply, install and wiring of M1 Transformer Breaker PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the EHV and HV breaker 6JB#100 DWG No 0.52/30793 or 0.52/30796, see 2.5 for approved suppliers

Supply, install and wiring of M2 Transformer Breaker PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the EHV and HV breaker 6JB#300 DWG No 0.52/30795 or 0.52/30798, see 2.5 for approved suppliers

Supply, install and wiring of Transformer PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within Transformer 6JB#200 DWG No 0.52/30794 or 0.52/30797, see 2.5 for approved suppliers

Panel main labels – Front and Rear: will be Label size: 340 x 35 mm, Text height: 12 mm and adhere to Labelling standard: 240-62629353 Specification for panel labelling standard.

ESKOM COPYRIGHT PROTECTED

Material	Siemens	
673631	Scheme: 6TA-2300-M1 Auto Transformer Protection with 1 x LoZ REF	1
673633	Scheme: 6TA-2300-M2 Auto Transformer Protection with 1 x HiZ REF	1
673522	Option - Busbar VT selection for HV (Two 7PA2341 relays)	3
673524	Option - Busbar VT selection for MV (Two 7PA2341 relays)	3
673520	Option - LV rural feeder CT interface	0
673543	Option: Legacy brownfield tap change control module for 6TA scheme	1
3000018 383	Engineering: 6TA-2300 Auto Transformer Protection	2
3000018 390	Engineering: Tap Changer	1
673536	Component: 6TA-#300 Mimic – Auto Transformer	2
673542	Component: Integrated Legacy Tap Change control	1
674036	2 metre LC-LC Duplex MM 50/125 fibre optic patch cord, non-Ruggedized	2
674037	3 metre LC-LC Duplex MM 50/125 fibre optic patch cord, non-Ruggedized	13
674038	5 metre LC-LC Duplex MM 50/125 fibre optic patch cord, non-Ruggedized	1
673991	Small Bay Switch: 2 x 1000BaseSx, LC; 4 x 100BaseFx, LC; 2 x 100BaseTx, RJ45; 19" rack; 88-300VDC Dual PS; rear ports; front display	1
673989	Large Bay Switch: 2 x 1000BaseSx, LC; 10 x 100BaseFx, LC; 2 x 100BaseTx, RJ45; 19" rack; 88-300VDC Dual PS; rear ports; front display	1
3000018 259	Engineering - Bay Switch	2
673972	Device: Breaker PIU	4
674642	Test plugs for Breaker PIUs	4
673963	Device: Transformer PIU	2
673964	Device: Tap Change PIU	1
674646	Test plugs for Transformer PIUs	2
674649	Test plugs for Tap Change PIUs	1

ESKOM COPYRIGHT PROTECTED

When downloaded from the WEB, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the WEB.

2.5 BUS COUPLER SCHEMES

The following protection and telecontrol and substation automation equipment will be permitted:

- Siemens (Pty) Ltd (Eskom contract 4600067750) for the Phase VI breaker-and-a-half protection/Double Busbar equipment in combination with the Siemens (Pty) Ltd (Eskom contract 4600067750) telecontrol and substation automation equipment.

Note that for the interface between the Protection equipment and the primary plant equipment (via JB's) is hardwire (DC supplies and tripping) and fibre that is connected to the process interface units (PIUs) that shall be located within the JB's. CT and VT interfacing with the protection & control schemes shall be hardwired.

The required protection EHV BUS COUPLER Scheme is a 6BC2110 (DWG No 0.52/30564 and 0.52/30565)
Level 31

Supply, install and wiring of Buscoupler Breaker PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the HV breaker 6JB#100 DWG No 0.52/30793 see 2.5 for approved suppliers

Equipment as per the table below from the Eskom ENC is required to build this scheme

Material	Siemens	
673389	Scheme: 6BC-2110 –M1 Bus Coupler Protection with Legacy Transfer	1
673391	Scheme: 6BC-2110 –M2 Bus Coupler Protection with Legacy Transfer	1
300001823 4	Engineering: Bus Coupler Protection with transfer	1
674037	3 metre LC-LC Duplex MM 50/125 fibre optic patch cord, non-Ruggedized	6
673991	Small Bay Switch: 2 x 1000BaseSx, LC; 4 x 100BaseFx, LC; 2 x 100BaseTx, RJ45; 19" rack; 88-300VDC Dual PS; rear ports; front display	2
300001825 9	Engineering: Bay Switch	2
673972	Device: Breaker PIU	2
674642	Test plugs for Breaker PIUs	2

2.6 BUS SECTION SCHEMES

The following protection and telecontrol and substation automation equipment will be permitted:

ESKOM COPYRIGHT PROTECTED

When downloaded from the WEB, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the WEB.

- Siemens (Pty) Ltd (Eskom contract 4600067750) for the Phase VI breaker-and-a-half protection/Double Busbar equipment in combination with the Siemens (Pty) Ltd (Eskom contract 4600067750) telecontrol and substation automation equipment.

Note that for the interface between the Protection equipment and the primary plant equipment (via JB's) is hardwire (DC supplies and tripping) and fibre that is connected to the process interface units (PIUs) that shall be located within the JB's. CT and VT interfacing with the protection & control schemes shall be hardwired.

The required protection EHV BUS SECTION Scheme is a 6BC2210 (DWG No 0.52/30566 and 0.52/30567)

Level 31

Supply, install and wiring of Bus Section Breaker PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the EHV breaker 6JB#100 DWG No 0.52/30793 or 0.52/30796, see 2.5 for approved suppliers

Equipment as per the table below from the Eskom ENC is required to build this scheme

Material	Siemens	
673393	Scheme: 6BC-2210-M1 Bus Coupler Prot without Transfer	1
673395	Scheme: 6BC-2210-M2 Bus Coupler Prot without Transfer	1
300001823 5	Engineering: Bus Coupler Protection without transfer	1
674037	3 metre LC-LC Duplex MM 50/125 fibre optic patch cord, non-Ruggedized	6
673991	Small Bay Switch: 2 x 1000BaseSx, LC; 4 x 100BaseFx, LC; 2 x 100BaseTx, RJ45; 19" rack; 88-300VDC Dual PS; rear ports; front display	2
300001825 9	Engineering: Bay Switch	2
673972	Device: Breaker PIU	2
674642	Test plugs for Breaker PIUs	2

2.7 BUS COUPLER SCHEMES

The following protection and telecontrol and substation automation equipment will be permitted:

- Siemens (Pty) Ltd (Eskom contract 4600067750) for the Phase VI breaker-and-a-half protection/Double Busbar equipment in combination with the Siemens (Pty) Ltd (Eskom contract 4600067750) telecontrol and substation automation equipment.

Note that for the interface between the Protection equipment and the primary plant equipment (via JB's) is hardwire (DC supplies and tripping) and fibre that is connected to the process interface units (PIUs) that shall be located within the JB's. CT and VT interfacing with the protection & control schemes shall be hardwired.

The required protection HV BUS COUPLER Scheme is a 6BC2810 (DWG No 0.52/30570)

Level 31

ESKOM COPYRIGHT PROTECTED

Supply, install and wiring of Bus Section Breaker PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the HV breaker 6JB#300 DWG No 0.52/30795 or 0.52/30798, see 2.5 for approved suppliers

Equipment as per the table below from the Eskom ENC is required to build this scheme

Material	Siemens	
673403	Scheme: 6BC-2810 Bus Coupler Prot Single Panel without Transfer	1
3000018234	Engineering: Bus Coupler Protection without transfer	1
674037	3 metre LC-LC Duplex MM 50/125 fibre optic patch cord, non-Ruggedized	6
673991	Small Bay Switch: 2 x 1000BaseSx, LC; 4 x 100BaseFx, LC; 2 x 100BaseTx, RJ45; 19" rack; 88-300VDC Dual PS; rear ports; front display	2
3000018259	Engineering: Bay Switch	2
673972	Device: Breaker PIU	2
674642	Test plugs for Breaker PIUs	2

2.8 BUS SECTION SCHEMES

The following protection and telecontrol and substation automation equipment will be permitted:

- Siemens (Pty) Ltd (Eskom contract 4600067750) for the Phase VI breaker-and-a-half protection/Double Busbar equipment in combination with the Siemens (Pty) Ltd (Eskom contract 4600067750) telecontrol and substation automation equipment.

Note that for the interface between the Protection equipment and the primary plant equipment (via JB's) is hardwire (DC supplies and tripping) and fibre that is connected to the process interface units (PIUs) that shall be located within the JB's. CT and VT interfacing with the protection & control schemes shall be hardwired.

The required protection HV BUS SECTION Scheme is a 6BC2910 (DWG No 0.52/30598)

Level 31

Supply, install and wiring of Bus Section Breaker PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the HV breaker 6JB#300 DWG No 0.52/30795 or 0.52/30798, see 2.5 for approved suppliers

Equipment as per the table below from the Eskom ENC is required to build this scheme

Material	Siemens	
673405	Scheme: 6BC-2910 Bus Coupler Prot Single Panel without Transfer	1
3000018235	Engineering: Bus Coupler Protection without transfer	1

ESKOM COPYRIGHT PROTECTED

674037	3 metre LC-LC Duplex MM 50/125 fibre optic patch cord, non-Ruggedized	6
673991	Small Bay Switch: 2 x 1000BaseSx, LC; 4 x 100BaseFx, LC; 2 x 100BaseTx, RJ45; 19" rack; 88-300VDC Dual PS; rear ports; front display	2
3000018259	Engineering: Bay Switch	2
673972	Device: Breaker PIU	2
674642	Test plugs for Breaker PIUs	2

2.9 400 kV Bus zone

The 132kV Bus zone protection scheme shall be sourced from Siemens which is the Eskom approved supplier. The Eskom contract number is: 4600001551.

The following equipment shall be sourced, configured, factory tested, delivered, installed and commissioned:

Item Description	Quantity
6BZ2310 Bus zone Protection scheme 24 bay (3 Panel) – 220Vdc, Eskom Drawing number 0.52/30448	1
1 - 24 Bay 3 Panel, swing frame front and rear entry, Eskom Drawing number XXX	1
Configure 17 Bay	1

2.10 132 kV Bus zone

The 132kV Bus zone protection scheme shall be sourced from Siemens which is the Eskom approved supplier. The Eskom contract number is: 4600001551.

The following equipment shall be sourced, configured, factory tested, delivered, installed and commissioned:

Item Description	Quantity
6BZ2310 Bus zone Protection scheme 24bay (3 Panel) – 220Vdc, Eskom Drawing number 0.52/30448	1
1 - 24 Bay 3 Panel, swing frame front and rear entry, Eskom Drawing number XXX	1
Configure 22 Bay	1

In the Double Busbar arrangement, the scheme needs to be configured according to the SED

AC and DC shall not be in the same cable. Therefore, the CT's shall have its own cable and the Isolators shall have its own cable. The M and N auxiliary contacts shall be used for isolator indication.

The configuration of the Buszone will be done by Eskom. The tenderer shall request from Eskom the configuration file 5 weeks prior factory testing.

ESKOM COPYRIGHT PROTECTED

The tenderer shall compile a factory and site commissioning test plan and shall be submitted to Eskom for review 4 weeks prior the testing activity.

The Bus zone scheme is fitted with an Ethernet switch. The ethernet switch shall be engineered and connected to the substation automation fibre network.

The Bus zone scheme, interface with the main 1 and main 2 protection systems via copper. The cabling between the protection bays (main 1 and main 2) shall appear on the specific protection bay's cable schedule.

The cabling to the DC board and the IDF shall be on the Bus zone cable schedule.

3. Fibre optic requirements

All fibre optic cables and ODFs shall be sourced from an Eskom approved supplier – see below. All work shall be done in accordance with the standards and specifications listed below:

- IEC 61073-1, Fibre optic interconnecting devices and passive components — Mechanical splices and fusion splice protectors for optical fibres and cables
- 240-46264031, Fibre-Optic Design Standard Part 2 Substations
- 240-70733995, Optical Distribution Frame / Patch Panel
- 240-60725641, Specification for standard (19 inch) equipment cabinets
- 240-70732888, Fibre optic cable system acceptance testing procedure
- 240-46263618, Labelling of fibre optic cables
- 240-722740830, Multimode Fibre Optic Duct Cable Specification
- NRS 088-1, Duct and direct-buried underground fibre-optic cable – Part 1: Product specification
- NRS 088-2, Duct and direct-buried underground fibre-optic cable – Part 2: Installation guidelines
- 240-106030205, Fibre Optic Gantry to Substation Control Room Scope of Work Guideline

Single Mode Duct Cable

- Single mode duct cable shall adhere to NRS 088-1 and 240-46264031 and where there is a discrepancy, 240-46264031 shall take precedence.
- No armoured duct cables shall be installed.
- Between Control rooms, single mode cable shall be installed within an HDPE pipe.
- Single mode duct cables shall be 8, 24 or 48 cores dependant on application.
- Single mode cables are installed for Teleprotection and Eskom telecommunication purposes, hence they will be installed between Joint boxes on gantry towers and the control room as well as between control rooms.
- Single mode cables for Main 1 and Main 2, from the same gantry feeder, shall follow diverse routes to the control room.
- These cables will terminate in the Fibre Optic Cabinet in the control room. The patch panel shall adhere to 240-70733995 Option A.
- The substation installation shall follow 240-46264031.

Multimode Duct Cable

ESKOM COPYRIGHT PROTECTED

- Multimode duct cable shall adhere to 240-722740830.
- No armoured duct cables shall be installed.
- Multimode duct cable shall be 24 cores.
- Multimode cables are installed for telecontrol purposes. Hence, they will be installed between the HV yard and the Control room.
- Multimode cables for Main 1 and Main 2 from the same Junction Box/Kiosk, in the HV Yard, shall follow diverse routes to the control room.
- These cables will terminate in the Fibre switching cabinet in the control room. The patch panel shall adhere to 240-70733995, Option B. The patch box, installed in the HV yard Protection junction box, shall adhere to 240-70733995, Option C.
- The substation installation shall follow 240-46264031.

Suppliers/OEMs

- Approved Fibre optic duct cables are sourced from CBi and MTEC (SA).
- Approved Patch Panel sourced from Prysmian (SA).
- Approved Multimode Patch Panel sourced from Instelec
- Approved Multimode Patch Box sourced from Instelec

	Multimode Fibre Optic Cables	Fibre Requirements for Breaker and a Half Schemes
1.	Between Junction Boxes in HV yard and Control Rooms	MM Duct cable (50/125 µm) from Junction Box in HV yard to Fibre Switching Cabinet in 400kV control room. Including termination in the patch panels shall be installed in the Fibre Switching Cabinet. Including termination in the patch boxes in the Junction Boxes.
2.	Between Panels within the Control Room	MM Duct cable (50/125 µm) from Fibre Switching Cabinet/s to Protection/Control and Fibre Switching Cabinets according to requirements from Control (section xxx).

Note: All work to be done shall complete scopes of work according to 240-106030205, Fibre Optic Gantry to Substation Control Room Scope of Work Guideline. A working template can be requested from the Project Manager.

3.1 Telecommunication connection requirements

1 x Ethernet circuit (copper) at 128 kbps per scheme for use by national control.

4. Protection settings

Eskom will be responsible to calculate, verify and issue of protection equipment settings. The standard Eskom settings process shall be followed. The tenderer shall be responsible for the implementation and testing of the settings.

The final schemes, IED logic designs and IED documentation, for the schemes to be developed by the tenderer (appointed contractor), shall be submitted to Eskom 8 weeks prior factory testing for compilation of the settings templates.

The request for settings shall be submitted 6 weeks and available prior factory testing.

ESKOM COPYRIGHT PROTECTED

The following standard shall be used:

- 342-242 – Protection settings management standard.
- SPF-0001 – Protection settings request form

5. Metering and measurements

5.1 Metering

The Eskom approved suppliers are:

- Sabi Switchboards Contract number: 4600071721
- Landis & Gyr Contract number: 4600070082
- Actom Contract number: 4600069855
- ADC Energy Contract number: 4600068637

5.2 400/132/22 kV Auto Transformer metering equipment

The following equipment for 400/132 kV auto transformer shall be sourced, factory tested, delivered, installed, and commissioned. Refer to 240-132226392 Application Guide for Tx Metering Commodities rev 3 for the additional meter point. Master Drawing No 0.52-30131.

5.3 Measurements

Measurements functions are performed by the protection control devices.

6. Telecontrol and substation automation

The telecontrol and automation solution to be utilised will depend on which Eskom approved protection equipment and solution is chosen. The following protection, telecontrol and substation automation equipment combinations will be permitted:

- Siemens (Pty) Ltd (Eskom development contract 4600059995) for the Phase VI protection equipment in combination with the Siemens (Pty) Ltd (Eskom development contract 4600059995) for the Telecontrol and Substation Automation equipment.

The following requirements for the protection and telecontrol and substation automation equipment shall apply:

- Eskom requirements in respect of switches and routers must be applied as per the Standard Networking Devices for the Substation Environment Standard: 240-68111223 and the network architecture shall comply with the Substation Automation – Network Architecture Standard for Transmission Substations: 240-612689959.
- GPS time synchronisation equipment must be provided for the time synchronisation of all Transmission Protection and Automation equipment as per Standard 240-100176258.
- The control interlocking must be performed by the Gateway as per the Substation Gateway and Station RTU/IED Standard 240-68234842.
- All equipment must meet its functional and interface requirements as specified in Substation Gateway and Station RTU/IED standard: 240-68234842
- GIS alarms that are not included within the standard scheme designs shall be reported via the station IED/RTU to the gateway(s) and the station HMI(s).

ESKOM COPYRIGHT PROTECTED

- The contractor shall be responsible for the engineering and configuration of all telecontrol, substation automation equipment. This includes but is not limited to the Ethernet network equipment, the GPS equipment, the Gateways and HMIs and the Station IEDs.
- The contractor shall be responsible for the IEC61850 engineering and configuration of all the protection and substation automation equipment.
- The contractor shall be responsible for the configuration of all the ethernet switches.
- The contractor shall be responsible for the assignment of the technical key names for IEDs as per the Eskom guide: Substation IEC61850 Physical Device Naming Structure Rev 13.
- The contractor shall produce a substation network diagram inclusive of technical key names for all IEDs that require an IP address. An example diagram may be requested from Eskom.
- Device IP Addresses will be allocated by Eskom PTM&C. The Contractor shall supply a completed application form on the ESKOM PTM&C standard template provided with a substation network diagram. Three weeks' notice is required following receipt of a complete IP address application form.
- The contractor shall update the substation network diagram with the IP addresses provided by Eskom.
- The tenderer shall compile the database for the gateway and station HMI. The database shall be based on the standard commodity database templates and the station IED signal list.
- The IEC60870-5-101 signal database for National Control, Standby National Control and Regional Control Centres shall be created by Eskom PTM&C. The signal lists for each of the protection schemes and station IEDs to be used for the aforementioned signal database must be provided to Eskom PTM&C at least 6 months prior to the factory testing of the SCADA. Standard Eskom PTM&C templates to be used and templates to be created for the schemes to be developed.

6.1 Telecontrol and substation automation equipment

6.1.1 Siemens telecontrol and substation automation equipment

The telecontrol and substation automation equipment shall be as per document: Substation Control and Automation Application Guide for SIEMENS Solution.

The tenderers shall engage with Siemens and utilise this document to determine the equipment required for the complete substation automation system. The complete substation automation bill of material shall be submitted with the tender.

Note: The KVM modules are no longer used in the Gateway Panel and the HMI server has been relocated from the Gateway Panel to a standalone HMI Panel. These changes have not been effected in the Application Guide.

6.2 AC systems

All products shall be sourced from Eskom approved supplier and this shall be as per the following standards:

- AC Boards and Junction boxes for substations: 240-64139144.
- AC Reticulation philosophy for substations: 240-55151946.
- Supply, Install and commission Type 1 Transformer Distribution Boards (0.52/20252).
- Supply, Install and commission Plug Boxes – 1PB0100 (0.52/20251).
- The basic and detailed design shall be presented to Eskom PTM&C DRT for approval prior to purchase.

ESKOM COPYRIGHT PROTECTED

- The Transmission Grid technicians shall witness the commissioning and testing as well as acceptance of the test results.

7. Telecommunications

Applicable standards:

- 240-56362336 - Installation of a Telecoms Equipment Cabinet Standard.
- 240-132190480 - Telecommunication Equipment Installation Standard.
- Earthing of the telecommunications equipment (indoor and outdoor), cabinets, shall be done according to the Technology specification 240-56872313 - Radio Station Earthing and Bonding.
- The testing of fibre and recording the test results based on Technology Document 240-70732888 - Fibre Optic cable system ATP.
- 240-62629353 - Specification for Panel Labelling Standard.
- 240-67907017 - Fibre Optic Core Allocation Standard; and,
- 240-70732902 - Fibre Optic Connectors.

8. Protection application design

8.1 Protection application design requirements

The protection application design, interface between the Eskom standard protection schemes and the primary plant and secondary plant equipment, shall be the responsibility of the tenderer. The standard Eskom scheme design diagrams, which include applications levels and the interface requirements to the primary plant equipment and the substation control/relay room equipment, shall be used. No checking or reviewing of the application drawings will be done by Eskom before and/or during the construction phase of the project. No changes to the standard scheme design are permitted, the application design focus only on the interface between the primary plant and the standard protection schemes and equipment. Eskom will supply drawing numbers. The remote end application drawings shall be done by Eskom. The tenderer shall provide all the required information on time for the remote end including but not limited to primary plant equipment, relays etc. The integration, cabling and wiring of all the Transmission PTM&C equipment within the Mercury relay room shall be within the tenderer's scope of supply. The final set of application design for construction shall be made available prior to energisation of the primary plant for Settings purposes. The stringing, cabling, earthing and erection specification for transmission substations – 240-82736997 shall be adhere to. The installation of cables and cable racking shall be in strict accordance with the law, SABS codes of practice and standards. The tenderer shall provide all the secondary plant package including but not limited to, application drawings, primary plant equipment, BOM etc. during the project hand over phase. The tenderer shall submit the application drawings 'As Built' after final commissioning as revision 0 to be registered by the Eskom CAD Office.

The following standard shall be used:

- 240-68980568 – Standard for the Application of Transmission and Distribution Protection Schemes; and,
- 240-96632721 Secondary Plant Drawing Practice Standard for Transmission and Distribution

8.2 Control room layout

The Main 1 and Main 2 equipment shall be located in separate rows in the control room (Phase VI equipment only).

ESKOM COPYRIGHT PROTECTED

The location of the HMI workstations shall be subject to agreement between Eskom and the Contractor: either in a separate room or in a designated section of the control room

The control room layout shall make provision for equipment associated with all bays identified as “future” in the substation single line diagram.

9. Factory testing

The tender shall submit a project schedule which shall include all the required factory testing requirements and activities for the PTM&C equipment at Mercury substation.

The successful tenderer shall compile a detailed factory test plan, which include the standard developed schemes and the new schemes to be developed, 8 weeks prior commencement of the individual scheme testing, and shall be agreed between the tenderer and the Eskom representative prior to the commencement of any of the required factory tests. It shall be noted that Eskom representatives shall witness all of the tests. The tenderer shall on conclusion of the factory testing produce a signed factory testing report.

The successful tenderer's engineers shall carry out functional tests to verify each individual scheme's wiring, IED logics and overall scheme functionality with Eskom participation prior the integrated substation factory testing. All the scheme IED settings shall be available 6 weeks prior functional testing per scheme and per bay.

The primary plant equipment (breakers and isolators) as per the station electric diagram shall be simulated for all the factory testing activities and requirements and shall be connected to the individual PTM&C schemes prior the individual scheme testing, factory acceptance testing and shall remain connected for the integrated substation solution testing.

The following high-level testing are required, but not limited to:

- Scheme inputs and outputs, binary and analogue.
- Signals between main 1 and main 2 systems.
- Signals between object protection systems within the same diameter.
- Signals between the protection schemes and the process interface units (applicable to the Siemens and Conco equipment);
- Etc.

9.1 Factory acceptance testing requirements of the schemes to be developed

Factory acceptance testing is required for all Protection schemes. The tests shall be witnessed and accepted by PTM&C technology and Transmission Grid.

The tender shall submit to Eskom a detailed factory acceptance testing plan for verification 8 weeks prior commencement of factory acceptance testing.

Settings shall be requested from Eskom and implemented 8 weeks prior factory acceptance testing.

The scheme diagrams for the schemes to be developed shall be finalised (signed) prior factory acceptance testing.

The tenderer's engineers shall, with the participation of the Eskom representative(s):

- Verify that the equipment is of sound construction and, so far as can be ascertained, meets the requirements of the standard and the offered equipment within the tender submission documentation.
- Carry out functional tests to verify each individual scheme's wiring, IED logics and overall scheme functionality with Eskom participation prior the integrated substation factory testing.

ESKOM COPYRIGHT PROTECTED

- Carry out performance tests to demonstrate its performance is in accordance with the functional requirements within this document and applicable standards. The performance tests shall be performed at 120% of the normal the DC voltage (264 VDC). The tenderer shall correct and retest any identified error or deviation from the requirements.
- Verify the required test templates. The tenderer shall ensure transfer of knowledge for the usage of the test templates, on the functioning of each of the IED functions and on how such functions need to be tested to yield the desired response.

9.1.1 Test template requirements of the schemes to be developed

The tenderer shall develop maintenance test templates for all Protection schemes to be verified and accepted by Eskom during factory acceptance testing. The test templates shall be for the test equipment being utilised by Eskom. The test routine shall be designed for use by the commissioning and maintenance staff with minimal experience. The IED settings shall be imported automatically from the settings database and/or settings template into the test template without any user interaction. Note that the settings shall not be downloaded from the IED and then be dumped into the test template. Also no manual typing in of settings or any other form of manual interference is permissible while the settings are imported into the test template.

The test template shall be interactive and prompt the user with specific and complete instructions (e.g. 'Connect binary input 1 to relay panel terminal X4.1') whenever any action needs to be taken by the user, any wiring changes need to be made to the test set up.

The test template shall be non-intrusive, no settings changes or disabling/enabling of functions shall be permitted. The test execution shall be paused for any such user interaction, and the user must acknowledge having completed such instruction (e.g., click on 'OK' or 'Continue') before the test template shall continue execution.

If a function is disabled (not used) in the IED via settings, the test template shall automatically disable all the tests associated with such a function.

When printing a test report, only the enabled test modules shall be printed.

If no automatic feedback can be obtained from the IED (e.g., if no pick-up contact is available / if only an indication on the HMI is given or a LED light up), the user shall be prompted with a specific instruction for such manual feedback (e.g., 'Read XYZ on HMI and enter the value in this dialogue', before clicking on 'Continue').

All IEDs shall be tested using IEC 61850 GOOSE messages. The test template shall make use of a 'TEST' GOOSE to 'trigger' for a specific test, i.e., the feedback from the IED to stop injection. The TEST GOOSE shall contain the pick-up (Instantaneous and delayed) of all functions within the IED. The benefit will be must faster testing by using instantaneous pick-up GOOSE messages as well as un-ambiguous results as one triggers on the GOOSE message issued by a specific logical node.

The purpose of testing is, that for each IED function the settings associated with this function needs to be 'checked' with a test at 10% below and 10% above the setting, i.e., to confirm that the settings have been entered and downloaded correctly to the IED. A test is assessed as passed if these two tests result in a definite pick-up for inside the zone and no pick-up for outside the zone and failed if any of these two tests do not result in the expected response from the IED. Please note that no search test to find the actual level of pick-up (e.g. zone reaches for an impedance element) as well as no type tests (e.g. 'plotting' the whole impedance characteristic of an impedance element) should be conducted.

In addition to checking the pick-up setting, the trip time for each IED function shall be measured, compared to the nominal timer setting of this function and assessed for pass or fail.

The test report shall provide a summary of the number of test modules, number of test modules tested, number of passed tests, number of failed tests, and number of tests with errors (e.g., no connection to test set / manual assessment).

ESKOM COPYRIGHT PROTECTED

The test template shall include an application-oriented power system test, i.e., to ensure that the IED operates for all types of in zone faults and stabilized for all types out of zone faults. For example, this kind of test would simulate a transmission line with the appropriate source impedance and ensures that the IED pick-up and trips instantaneously for all types of faults on the primary transmission line and stabilizes (or trips in back-up time) for faults beyond the primary transmission line. Purpose of this kind of test is to not only verify the settings application process, but also the settings calculation process.

9.2 Integrated substation solution factory testing

The PTM&C equipment shall be pre-commissioned as an integrated substation solution in the factory environment before delivery to site. This will allow for the minimisation of site commissioning time and allow for the detection and resolution of problems prior to product delivery to site.

Factory testing shall include the testing of application-specific device settings and the configuration and testing of the gateway and HMI (including interlocking) for Mercury SS.

The integrated substation solution factory testing plan shall be submitted by the tenderer to Eskom 6 weeks prior start of the factory testing. The following high-level testing are required, but not limited to:

- Signals between the schemes, the gateway and the station HMI.
- Interlocking rules.
- SCADA controls.
- SCADA Analogues
- All Hardwired signals to the Common Equipment Panel

10. Security System

A non-lethal outer barrier fence is required

11. Commissioning

The assets shall be commissioned to Eskom's standards and specifications. This is intended to protect the safety, integrity, and security of the Transmission system.

The pre-commissioning and commissioning activities shall be the responsibility of the tenderer (appointed contractor), and shall be witnessed and the results verified, accepted, and approved by the Eskom Transmission representative(s). The tenderer (appointed contractor) shall utilise the Eskom approved pre-commissioning and commissioning procedures and shall compile the required documentation for handover purposes prior energisation.

The tenderer (appointed contractor) shall submit to Eskom, the pre-commissioning and commissioning test plans and program, which shall comply with the Eskom requirements, for approval.

Eskom Transmission has test routines for most of the protection IEDs and these shall be obtained from Eskom and shall be used by the tenderer (appointed contractor) during commissioning, where applicable. Test routines that are not available for IEDs within the schemes that will be designed by the appointed contractor shall be developed by the tenderer (appointed contractor).

The following standard shall be used:

- 240-54615413 – Standard for Commissioning Protection Assets.
- 240-55197966 – Standard for the commissioning of metering installations (HV and MV).
- 240-137465740 – Standby Battery storage and commissioning in Eskom

ESKOM COPYRIGHT PROTECTED

12. Delivery, off-loading and site erection

The tenderer shall include the delivery, off-loading and site erection of all the PTM&C equipment within this scope of supply to Mercury substation Control Room.

13. General

- All work shall comply with
 - 240-64636794 – Generic Equipment Specification Wire, Wire Marking, Cable Numbering, Fibre Optical Cable Installation and Labelling
 - 240-62629353 – Labelling
 - 240-64100247 – Earthing
 - 240-96632721 – Eskom Drawings
 - 240-132496539 – JB specs
 - 240-60725641 – Panel spec
 - 240-82736997 – The stringing, cabling, earthing and erection specification for transmission substations
- The installation of cables and cable racking shall be in strict accordance with the law, SABS codes of practice and standards, any deviations to be approved by Eskom.
- Eskom will supply drawing numbers. The tender shall request drawing numbers from Eskom.
- The tenderer shall be given all the scheme drawings accompanied with the relevant application & drawing standards.
- Eskom will review the application drawings before the construction phase of the project commences. A title block for a Eskom representative to sign on the first page of every application needs to be shown on the applications
- The tenderer shall provide all the PTM&C plant package including but not limited to application drawings, primary plant equipment, BOM etc. during the project handing over phase.
- All "As built" drawings shall be submitted to Eskom as revision 0.
- Eskom's Systems Operator requires minimum six weeks' notice to provide protection settings. Finalised scheme application drawings and CT and VT specification data shall be provided to the System Operator together with the request for settings. Protection CT ratio selection shall be done in consultation with the System Operator.

14. Scope Split

This section describes the responsibilities of the IPP (including its appointed EPC contractor, subcontractors, and consultants) and Eskom in the execution of the scope of works. The scope split is presented in tabular format below according to the various secondary plant disciplines. The listed tasks apply to all works at Substation MTS and remote ends. The following notation is used in the table:

- P: Primary responsibility (party executes task / produces deliverable)
S: Secondary responsibility
A: Accept (party reviews and accepts task / deliverable)
W: Witnesses activity

ESKOM COPYRIGHT PROTECTED

	Task	EPC/Self Build	Eskom
1	Protection		
1.1	Application drawings	P	A
1.2	Control room layout drawing	P	A
1.4	Update/Create SCD File	P	A
1.5	Station network diagram	P	A
1.6	Cable schedules	P	A
1.7	Cable block diagrams	P	A
1.8	Protection settings	-	P
1.9	Relay configuration and settings application	P	A
1.10	Factory acceptance testing	P	W
1.11	Cold commissioning	P	W
1.12	Hot commissioning	S	P
	Task	EPC/Self Build	Eskom
2	Metering		
2.1	Application drawings	P	A
2.2	Factory acceptance testing	P	W
2.3	Cold commissioning	P	W
2.4	Telecoms channels and integration to Eskom metering management system	-	P

	Task	EPC/Self Build	Eskom
3	Control		
3.1	Generate spreadsheet with technical keys and names	P	A
3.2	Generate Substation Network Diagram	P	A
3.3	Populate application form for IP addresses	P	-
3.4	Create and issue IP addresses	-	P
3.5	Supply IED SCD/CID files for I/O	P	A
3.6	Update all SCADA configurations (D20 & D400)	-	P
3.7	Create new configurations	-	P
3.8	Update I/O list per bay	P	A
3.9	Develop interlocking rules by means of a workshop	P	A/W
3.10	Provide telecontrol drawing package including updated IDF	P	A
3.11	Factory Acceptance Testing	P	W
3.12	Update existing HMI	P	A/W
3.13	Signal testing and commissioning	P	W
3.14	Create the Database for NCC / RCC	S	P
3.15	Create/Update FSP drawings	P	A

	Task	EPC/Self Build	Eskom
4	DC		
4.1	Application drawings	P	A
4.2	Cold commissioning	P	W

	Task	EPC/Self Build	Eskom
5	AC		
5.1	Update LV distribution single line diagrams	P	A
5.2	Application drawings	P	A

ESKOM COPYRIGHT PROTECTED

5.3	Cold commissioning	P	W
-----	--------------------	---	---

	Task	EPC/Self Build	Eskom
6	Telecoms		
6.1	Balance of telecoms design (BOQ, label specifications, application drawings, network architecture drawings)	P	S
6.2	All telecoms installation at Mercury SS	P	A
6.3	Quality Assurance	P	S
6.4	Test all Circuits	S	P
6.5	Update Workplace with site data	-	P
	Task	EPC/Self Build	Eskom
7	Teleprotection		
7.1	Application drawings	P	A
7.2	Pre-Commissioning	P	W
7.3	Hot commissioning	S	P

15. Revision and tracking

Rev No	Description	Compiler	Date
1	Initial Scope of Work	C Mohloki	2023/09/15

ESKOM COPYRIGHT PROTECTED

When downloaded from the WEB, this document is uncontrolled and the responsibility rests with the user to ensure it is in line with the authorized version on the WEB.