Eskom	Scope of Work	Technology

Title: **HIGH LEVEL SCOPE OF WORK/BASIC DESIGN - PTM&C EQUIPMENT FOR PAULPUTS & AGGENEIS SUBSTATION**

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Compiled by	Functional Responsibility	Authorized by
Nomfundo Gono	**Mario Petersen**	**Judith Malinga**
Project Engineer: PTM&C Engineering Planning & Project Support	**Acting Manager: PTM&C Engineering Planning & Project Support (Acting)**	**Senior Manager: PTM&C Engineering**
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Content

1. General

1.1 Background

The installed generation capacity in the Western Cape already exceeds the peak load in the province and this gap will continue to widen over the next ten years as the IRP 2019 generation aspirations come into fruition. This is due to the 3.3 GW committed renewable generation capacity and 10 GW end-state renewable generation expected within the province by 2030. The future constraints in the province will therefore be concerning the ability to evacuate the existing and expected renewable power out of the province to other load centres in the country

Establishment of an additional 500 MVA 400/132 kV transformation at Paulputs Substation by 2025 is required to enable the integration of additional renewable generation once the capacity on the existing 500 MVA transformation is depleted. The Paulputs substation falls under the Namaqualand CLN which will see 3.1 GW of renewable generation integrated in the area by 2030.

High Level Scope of Work:

- Establish 400/132 kV transformation at Paulputs Substation (Phase 1)
- Establish/Equip a 400 kV feeder bay at Aggeneis Substation
- Establish a 400 kV yard and associated equipment at Paulputs Substation
- Establish/Equip a 400 kV feeder bay at Paulputs Substation
- Operate the Aggeneis – Paulputs 400 kV line at 400 kV (as opposed to 220 kV)
- Install a new 500 MVA 400/132 kV Transformer 21 and associated transformer bays at Paulputs Substation

1.2 Scope

The provision of a complete turnkey protection, tele-control, measurements, metering, DC and AC solution for the proposed Establishment of 400/132 kV Transformation at Paulputs Substation (Phase 1), 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,

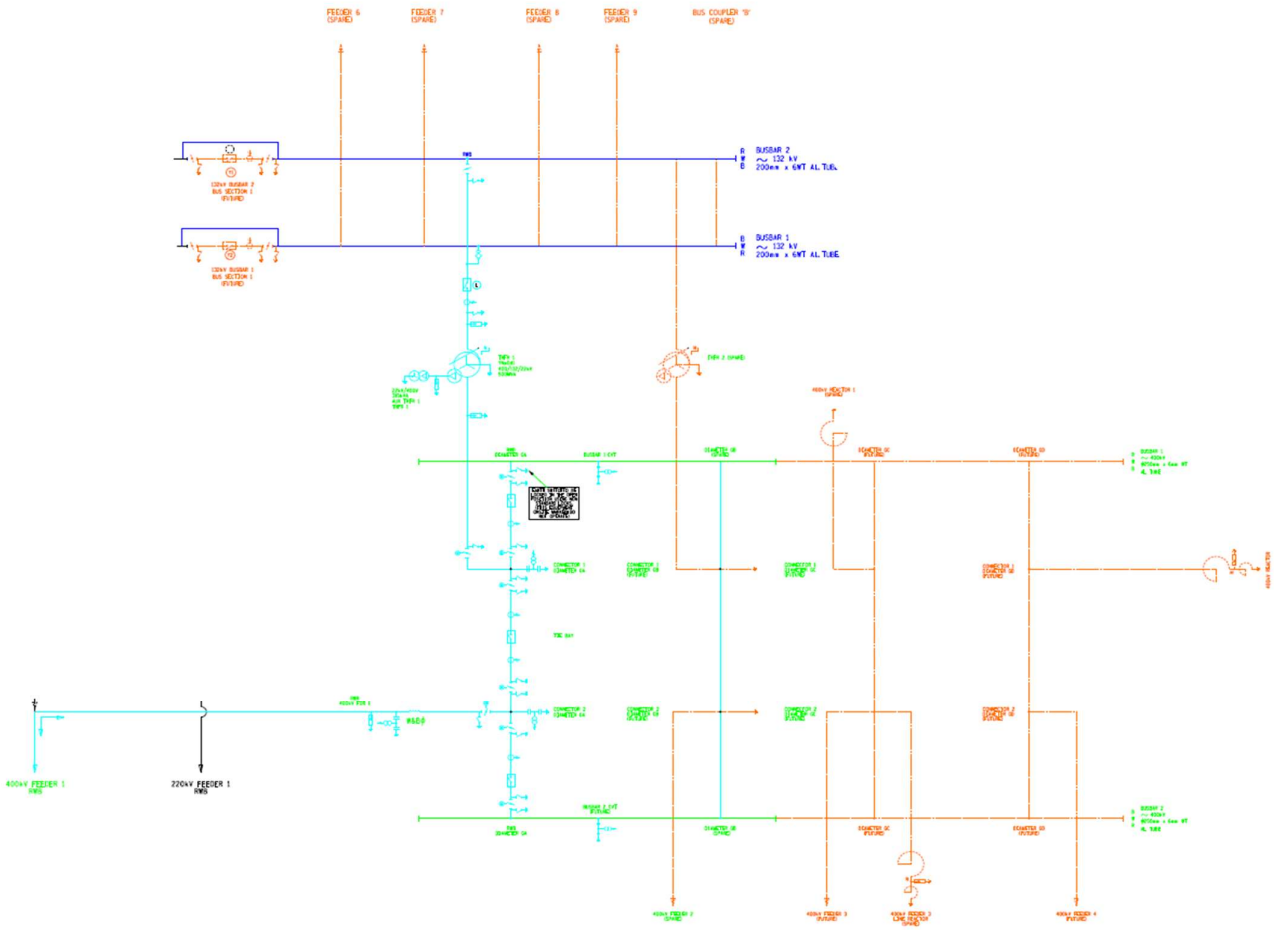
- Delivery, off-loading, erection, installation, cabling, application of configurations and settings, commissioning; to be accepted by Eskom
- Provision of documentation, as-built drawings, in Eskom standard format and to be accepted by Eskom
- Anything else deemed necessary by the tenderer for the provision 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.

1.3 Station Electric Diagram

See drawing number: Pau21P04-SE-D6 & Agg21P13-SE-D6



2. Protection

2.1 Protection scope of work

This section describes the material required for the protection scope for the proposed Establishment of 400/132 kV Transformation at Paulputs Substation (Phase 1)

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 and Tele protection inter tripping equipment (for impedance protection) 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 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 Breaker-and-a-half diameter interface schemes

For all breaker-and-a-half EHV transmission applications, the diameter interface solution shall comprise of a diameter closing control (manual and auto-reclosing) and diameter management system (ST_240-96621430_Rev_1).

Within a single closing control and management system, all the required functions shall reside within a single hardware device. This hardware device shall comprise the single node through which all controls and auto-reclosing shall occur for all internally generated commands, as well as through which all externally generated commands shall be routed.

The closing control and management systems will be housed within a cubicle within the control room building. The closing control and management system shall interface with the diameter primary equipment through IEC61850 process interface units located near the primary plant equipment. The closing control and management system shall interface with object 1 and object 2 protection systems through IEC61850 for the purpose of auto-reclosing and control of the primary plant equipment.

The breaker-and-a-half diameter interface scheme shall have one IED with all the required closing control and management functions integrated within a single IED.

The breaker-and-a-half diameter interface scheme shall be designed that the two object panels can be mounted on either the left hand or right hand or both sides of the diameter interface panel. The breaker-and-a-half diameter interface scheme shall be an independent design with an own set of scheme diagrams.

Process interface units (PIU) are required to interface (binary inputs and outputs) between the primary plant equipment and the diameter control IEDs. The PIUs shall be located within the relevant JB(s) or bay marshalling kiosks (GIS applications). The circuit-breaker PIU (breaker, isolator, earth switches, CT SF6 alarms, JB/BMK AC and DC supply monitoring, LOR switches, PIU health, Anti-pump, Trip circuit supervision and GIS alarms) shall be used to interface (IEC61850) with the diameter control IEDs. GIS alarms that are not included within the standard scheme designs shall be reported via the station RTU/IED to the gateway(s) and the station HMI(s).

The IEDs (protection and PIU) shall comply with the Generic Specification for Intelligent Electronic Devices (IEDs) Standard, Unique Identifier 240-64685228.

Each of the 400 kV diameters shall have dedicated diameter interface schemes.

2.4.1 Breaker-and-a-half diameter scheme requirements and options

The protection & automation equipment shall be sourced from one of the Eskom approved Protection and Control suppliers.

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

- Siemens (Pty) Ltd (Eskom development contract 4600059995) for the Phase VI breaker-and-a-half protection equipment in combination with the Siemens (Pty) Ltd (Eskom development contract 4600059995) telecontrol and substation automation equipment.

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

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

Following is the diameter interface scheme requirements and option selections per 400 kV diameter. Each diameter shall have dedicated diameter interface panels with equipment as per the table below:

Indicate levels for application

	Contract item	**Siemens**	**Conco**
1.	Phase VI Main 1 Diameter Interface Scheme *Mimics with local controls & indications and IED logics to be selected to match each diameter combination*	6DIP-2110-M1 (0.52/30553)	6DIP-7110-M1 (0.52/30600)
2.	Phase VI Main 2 Diameter Interface Scheme	6DIP-2110-M2	6DIP-7110-M2

	Mimics with local controls & indications and IED logics to be selected to match each diameter combination	(0.52/30554)	(0.52/30601)
3.	Fixed frame, rear entry panel for Protection schemes (2400x800x600, 19" rack mount)	x 2	x 2
4.	Supply, install and wiring of Tie Bay Breaker PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the BMK or panel adjacent to the BMK (all wiring are within scope of supply)	x 2 (Harting plug wiring as per 6IJB-#300 0.52/30571	x 2 (Harting plug wiring as per 6IJB-#300 0.52/30571
5.	Large Bay Switch (supply, fitment and wiring) Ruggedcom RSG-2100: 6GK6021-0AS23-3DB0-Z05+B05+C05+D05+E02+F00+G05+H00+J00+K01	x 2	x 2
6.	Duplex Multi mode 50/125 fibre optic patch cord (3 meter), non-Ruggedized for connection between the DCD and the Ethernet Switches and between the Fibre Patch Panels and the ethernet switches.	x 6	x 6
7.	1U 19" rack mount fibre optic patch panels. (Each box to accept 2 fibre optic cables. Per main in the DIP and per main in the JB/BMK)	x 2	x 2
8.	Engineering: Large Bay Switch	x 2	x 2
9.	Supply, install and wiring of 400 kV Busbar 1 VTJB within the BMK or panel adjacent to the BMK (all wiring are within scope of supply)	x 2 wiring as per 1JB-0700 0.54/6731	x 2 wiring as per 1JB-0700 0.54/6731
10.	Supply, install and wiring of 400 kV Busbar 2 VTJB within the BMK or panel adjacent to the BMK (all wiring are within scope of supply)	x 2 wiring as per 1JB-0700 0.54/6731	x 2 wiring as per 1JB-0700 0.54/6731
11.	Supply, install and wiring of 400 kV Diameter GA Connector 1 & 2 VTJB within the BMK or panel adjacent to the BMK (all wiring are within scope of supply)	x 2 wiring as per 1JB-0700 0.54/6731	x 2 wiring as per 1JB-0700 0.54/6731

12.	Supply, install and wiring of 400 kV Diameter GB Connector 1 & 2 VTJB within the BMK or panel adjacent to the BMK (all wiring are within scope of supply)	x 2 wiring as per 1JB-0700 0.54/6731	x 2 wiring as per 1JB-0700 0.54/6731
13.	Supply, install and wiring of 400 kV Diameter GC Connector 1 & 2 VTJB within the BMK or panel adjacent to the BMK (all wiring are within scope of supply)	x 2 wiring as per 1JB-0700 0.54/6731	x 2 wiring as per 1JB-0700 0.54/6731
14.	Line VTJB (1JB-0700) – where applicable (refer to the station electric diagram)	x 1	x 1
15.	132 kV Transformer VTJB (1JB-0700) – where applicable (refer to the station electric diagram)	x 1	x 1

2.5 Junction Boxes

The breaker JBs are required to provide for and interface with the equipment as per 6JB-#300 (0.52/30795 or 0.52/30798) or 6JB-#100 (0.52/30793 or 052/30796)

The Transformer JBs are required to provide for and interface with the equipment as per 6JB-#200 (0.52/30797 or 0.52/30794), transformer and online tap changer functionality.

JBs can be sourced from the Eskom approved suppliers.

The Eskom approved suppliers are:

ENC contract number 4600067642 supplied by Vithale Electrical CC

ENC contract number 4600067641supplied by Sivtek Holdings (Pty) LTD

2.6 Breaker-and-a-half line protection schemes

For all breaker-and-a-half EHV and HV transmission line protection applications, the line protection solution shall comprise of a Fault Clearance System (ST_240-96621426_Rev_1).

The Fault Clearance System shall comprise two independent and galvanically isolated Tripping Systems, plus the bay circuit-breaker and tie bay circuit-breaker. Each Tripping System shall comprise a Protection System, supplied from an independent DC source, receive its analogue inputs from a separate CT core and a separately protected VT core (line VT), interface to its own dedicated Teleprotection equipment, and be directly connected (via the process interface unit and via hardwire) to one trip-coil of the bay circuit-breaker and to one trip-coil of the tie bay circuit breaker. The two Tripping Systems shall operate in a one-out-of-two tripping mode.

Each Protection System shall provide the requisite primary, back-up, system and auxiliary protection functions. Within a single Protection System, all protection functions shall reside within a single hardware device. The Protection Scheme is that portion of the Fault Clearance System housed within a cubicle within the control room building. The Protection System shall interface with the diameter primary equipment through IEC61850 process interface units located near the primary plant equipment. The Protection System shall interface with other diameter primary equipment through IEC61850 process interface units for the purpose of transferring tripping and status signals between primary plant object connected to different diameters.

The breaker-and-a-half line protection scheme shall have one IED with all the required protection (distance and current differential protection) functions integrated within the IED. A maximum of two-line protection IEDs, where the distance based IED protection functionality is fully integrated within the one IED and the current differential based IED functionality is fully integrated within the second IED is permissible.

Process interface units (PIU) are required to interface (binary inputs and outputs) between the primary plant equipment and the line protection IEDs. The PIUs shall be located within the relevant JB(s) or bay marshalling kiosks (GIS applications). The circuit-breaker PIU (breaker, isolator and earth switches) shall be used to interface (IEC61850) with the protection IEDs.

The IEDs (protection and PIU) shall comply with the Generic Specification for Intelligent Electronic Devices (IEDs) Standard, Unique Identifier 240-64685228.

2.6.1 Breaker-and-a-half line protection scheme requirements and options

The 400 kV Phase VI protection & automation equipment shall be sourced from one of the Eskom approved Protection and Control suppliers.

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

- Siemens (Pty) Ltd (Eskom development contract 4600059995) for the Phase VI breaker-and-a-half protection equipment in combination with the Siemens (Pty) Ltd (Eskom development contract 4600059995) telecontrol and substation automation equipment.

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

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

Following is the line protection scheme requirements and option selections per 400 kV line. Each line shall have dedicated line protection panels with equipment as per the table and sections below:

Indicate levels for application

400kV Feeder 1 (Aggeneis 1)

	Contract item	Siemens
1.	Phase VI Main 1 Line Protection Scheme *Mimics to be selected to match each diameter combination*	6FZDB-2110-M1 (0.52/30551)
2.	Phase VI Main 2 Line Protection Scheme *Mimics to be selected to match each diameter combination*	6FZDB-2110-M2 (0.52/30552)
3.	Fixed frame, rear entry panel for Protection schemes (2400x800x600, 19" rack mount)	x 2
4.	Supply, install and wiring of Bay Breaker PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the BMK or panel adjacent to the BMK (all wiring within scope of supply)	x 2 (Harting plug wiring as per 6JB-#100 0.52/30793 0.52/30796
5.	1U 19" rack mount multi-mode fibre optic patch panel. (Each box can accept 2 fibre optic cables. One Per main panel).	x 2
6.	1U 19" rack mount single-mode fibre optic patch panel. (Each box can accept 2 fibre optic cables. One Per main panel if required for differential protection function).	x 2
7.	Duplex Multi mode 50/125 fibre optic patch cord (5 meter), non-Ruggedized for connection between the line protection IED and the Ethernet Switch within the diameter interface panel. One per main line protection IED.	x 4
8.	Duplex Single mode 50/125 fibre optic patch cord (3 meter), non-Ruggedized for connection between the line protection IED and the single mode fibre patch panel (if required for the differential protection function, one per main line protection IED).	x 2

9.	Procure, supply, fitment, wiring and commissioning of the Tele protection interface device per main protection at 400kV FDR1 and the remote line ends.	Per line, to be determined

400kV Feeder 2 (Paulputs 1)

	Contract item	**Siemens**
10.	Phase VI Main 1 Line Protection Scheme *Mimics to be selected to match each diameter combination*	6FZD-2110-M1 (0.52/30555)
11.	Phase VI Main 2 Line Protection Scheme *Mimics to be selected to match each diameter combination*	6FZD-2110-M1 (0.52/30556)
12.	Fixed frame, rear entry panel for Protection schemes (2400x800x600, 19" rack mount)	x 2
13.	Supply, install and wiring of Bay Breaker PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the BMK or panel adjacent to the BMK (all wiring within scope of supply)	x 2 (Harting plug wiring as per 6JB-#100 0.52/30793 0.52/30796
14.	1U 19" rack mount multi-mode fibre optic patch panel. (Each box can accept 2 fibre optic cables. One Per main panel).	x 2
15.	1U 19" rack mount single-mode fibre optic patch panel. (Each box can accept 2 fibre optic cables. One Per main panel if required for differential protection function).	x 2
16.	Duplex Multi mode 50/125 fibre optic patch cord (5 meter), non-Ruggedized for connection between the line protection IED and the Ethernet Switch within the diameter interface panel. One per main line protection IED.	x 4

17.	Duplex Single mode 50/125 fibre optic patch cord (3 meter), non-Ruggedized for connection between the line protection IED and the single mode fibre patch panel (if required for the differential protection function, one per main line protection IED).	x 2
18.	Procure, supply, fitment, wiring and commissioning of the Tele protection interface device per main protection at 400kV FDR1 and the remote line ends.	Per line, to be determined

2.6.2 400kV Feeder 1 (Aggeneis 1) local and remote line protection requirements

kV	400kV
Feeder No.	Feeder 1
Feeder name	Aggeneis 1
Line protection scheme	Refer to the Breaker-and-a-half line protection schemes and options section on the scheme selection (Dual main protection).
Panel main labels	Panel main labels – Front and Rear: Label size: 340 x 35 mm Text height: 12 mm Labelling standard: 240-62629353 Specification for panel labelling standard.
Main 1 – FIBRE Route for Current Differential Protection communication	**Paulputs - Aggeneis 1 400kV Line** Refer to the fibre optic section 3 & 4
Main 1 – Current differential protection fibre requirements	SM Duct cable from FDR Gantry to Fibre Optic Cabinet including patch panel where necessary. SM Duct cable from Fibre Optic Cabinet to corresponding Protection Panel where necessary.
Main 2 Tele protection	Power Line Carrier equipment which includes the following: • Line Traps • LMEs • Coaxial Cables • Carrier Combiner Unit • PLC Terminal Equipment • Z Cables

	• Telephone Cables Note: Line Trap phase positions and PLC frequencies to be determined by Eskom.
Remote Line end Main 2 Tele protection	Power Line Carrier equipment which includes the following: • Line Traps • LMEs • Coaxial Cables • Carrier Combiner Unit • PLC Terminal Equipment • Z Cables • Telephone Cables **Note:** **Line Trap phase positions and PLC frequencies to be determined by Eskom.**
Notes: The supplier/contractor to complete the detailed Teleprotection scope of work for this line/feeder using the document 240-141828918, "Scope of Work Template for Teleprotection Projects". Indicate levels for application	

2.7 Breaker-and-a-half Auto Transformer protection schemes

For all breaker-and-a-half EHV transmission auto transformer protection applications, the transformer protection solution shall comprise of a Fault Clearance System (ST_240-99870095_Rev _1).

The Fault Clearance System shall comprise two independent and galvanically isolated Tripping Systems, plus the 400 kV bay circuit-breaker, 400 kV tie bay circuit-breaker, 132 kV circuit-breaker. Each Tripping System shall comprise a Protection System, supplied from an independent DC source, receive its analogue inputs from a separate bay and tie bay CT core and separate CT cores within the transformer tank and be directly connected (via the process interface units and via hardwire) to one trip-coil of the 400 kV bay circuit-breaker, to one trip-coil of the 400 kV tie bay circuit breaker and to one trip-coil of the 132 kV circuit-breaker. The two Tripping Systems shall operate in a one-out-of-two tripping mode.

Each Protection System shall provide the requisite unit, back-up, system and auxiliary protection functions. Within a single Protection System, all protection functions shall reside within a single hardware device. The Protection Scheme is that portion of the Fault Clearance System housed within a cubicle within the control room building. The Protection System shall interface with the diameter primary equipment and transformer through IEC61850 process interface units located near the primary plant equipment. The Protection System shall interface with other diameter primary equipment through IEC61850 process interface units for the purpose of transferring tripping and status signals between primary plant object connected to different diameters.

The breaker-and-a-half auto transformer protection scheme shall have one IED with all the required protection functions integrated within the IED. An independent integrated REF is applied per main IED.

Breaker process interface units (PIU) (400 kV bay, 400 kV tie bay and 132 kV tie bay) are required to interface (binary inputs and outputs) between the primary plant equipment and the transformer protection IEDs. The PIUs shall be located within the relevant JB(s) or bay marshalling kiosks (GIS applications). Transformer process interface units (PIU) are required to interface between the transformer and the transformer protection IEDs. The PIUs shall be located within the relevant transformer JB(s) or transformer marshalling kiosks (GIS applications). The circuit-breaker PIUs (breaker, isolator and earth switches) and transformer PIUs shall be used to interface (IEC61850) with the protection IEDs.

The IEDs (protection and PIU) shall comply with the Generic Specification for Intelligent Electronic Devices (IEDs) Standard, Unique Identifier 240-64685228.

2.7.1 Breaker-and-a-half auto transformer protection scheme requirements and options

The 400kV Phase VI protection & automation equipment shall be sourced from one of the Eskom approved Protection and Control suppliers.

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

- Siemens (Pty) Ltd (Eskom development contract 4600059995) for the Phase VI breaker-and-a-half protection equipment in combination with the Siemens (Pty) Ltd (Eskom development contract 4600059995) telecontrol and substation automation equipment.

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

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

Following is the auto transformer (400/132/22 kV) protection scheme requirements and option selections per transformer. Each auto transformer shall have dedicated transformer protection panels with equipment as per the table below: Indicate levels for application

	Contract item	**Siemens**
1.	Phase VI Main 1 Auto Transformer Protection Scheme *Mimics to be selected to match each diameter combination*	6TAB-2300-M1 (With Low Imp REF) (0.52/30440)
2.	Phase VI Main 2 Auto Transformer Protection Scheme *Mimics to be selected to match each diameter combination*	6TAB-2300-M2 (With High Imp REF, Metrosil & Resistor) (0.52/30492)
3.	Fixed frame, rear entry panel for Protection schemes (2400x800x600, 19" rack mount)	x 2
4.	Disturbance recorder test block	x 2
5.	Supply, install and wiring of 400 kV Bay Breaker PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the BMK or panel adjacent to the BMK (all wiring within scope of supply)	x 2 (Harting plug wiring as per 6IJB-#300 0.52/30571
6.	Supply, install and wiring of 132 kV Bay Breaker PIUs (Male and Female half Harting Plugs, coding pins & wiring tail)	x 2 (Harting plug wiring as per 6JB-8300 0.52/30795

7.	Breaker JB 132kV	x 1 6JB-#300 0.52/30795
8.	Supply, install and wiring of Transformer PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the Transformer JB (all wiring within scope of supply)	x 2 (Harting plug wiring as per 6JB-#200 0.52/30794
9.	Transformer JB	x 1 6JB-#200 0.52/30794
10.	1U 19" rack mount multi-mode fibre optic patch panel. (Each box can accept 2 fibre optic cables. Two per main panel for connection to the HV breaker PIU, MV breaker PIU and transformer PIU per main transformer panel).	x 4
11.	Duplex Multi mode 50/125 fibre optic patch cord (5 meter), non-Ruggedized for connection between the transformer protection IED and the Ethernet Switch within the diameter interface panel. One per main transformer protection IED.	x 10

2.8 Breaker-and-a-half auto transformer on load tap change control scheme

Within the Eskom electrical supply networks practically all transformers of 10 MVA and above have on load tap-changing equipment fitted (ST_240-99870095_Rev_1). The principal use of OLTC equipment is for the voltage regulation within the network and for the control of MW and MVar flows across interconnectors. Location of the tapped part of a winding is partly a construction question. It is generally done on that winding which is placed outside. Bushing insulators are required when tapping is done at the line ends. With tapping's near the line ends, the number of bushing insulators is reduced and with tapping's near the neutral ends, the phase-to-phase insulation conditions are eased.

The tap changer compartment is normally segregated from the main transformer tank to prevent the contaminated oil from the tap changer mixing with that of the transformer in this way separate oil actuated protection is provided for within the tap changer.

2.8.1 Breaker-and-a-half auto transformer on load tap change scheme requirements and options

Following is the auto transformer (400/132/22 kV) on load tap change scheme requirements and option selections per transformer. Each on load tap change scheme shall have the equipment and requirements as per the table below:

	Contract item	**Siemens**
1.	Auto Transformer on load tap change Scheme	6TCP-2101 with 6TC2101-1 and 6TC2101-2 modules (0.52/30637, 0.52/30586, 0.52/30653)
2.	Fixed frame, rear entry panel for Protection schemes (2400x800x600, 19" rack mount)	x 2
3.	Large Bay Switch (supply, fitment and wiring)	x 1

	Ruggedcom RSG-2100: 6GK6021-0AS23-3DB0-ZA05+B05+C05+D05+E02+F00+G05+H00+J00+K01	
4.	Duplex Multi mode 50/125 fibre optic patch cord, non-Ruggedized for connection between the all the IEDs within the diameter (including the protection IEDs and the PIUs) and Ethernet Switch and the Fibre Patch Panels	Contractor to determine requirement.
5.	Supply, install and wiring of Tap Change PIUs (Male and Female half Harting Plugs, coding pins & wiring tail) within the Transformer JB (all wiring within scope of supply)	x 1 (Harting plug wiring as per 6JB-8200 0.52/30794
6.	1U 19" rack mount fibre optic patch panels. (Each box can accept 2 fibre optic cables. Per main in the DIP and per main in the Transformer JB)	x 2
7.	Engineering: Large Bay Switch	x 1
8.	Tap Change Documentation	x 1

2.9 400 kV & 132kV Bus zone

The 400 kV and 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: 400kV Bus Zone	**Quantity**
6BZB 2910 Bus zone Protection scheme 14X bay (2X Panel) – 110Vdc, Eskom Drawing number	1
1 – 14 Bay 2 Panel, swing frame front and rear entry, Eskom Drawing number XXX	1
Configuration	1

Item Description:132kV Buszone	**Quantity**
6BZ 2310 Bus zone Protection scheme 16X bay (2X Panel) – 110Vdc, Eskom Drawing number	1
1 – 16 Bay 2 Panel, swing frame front and rear entry, Eskom Drawing number XXX	1
Configuration	1

In the breaker and a half busbar arrangement the bays are allocated as per scheme design. It does not matter if the diameter #A starts form left or right.

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.

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. Teleprotection

All required Teleprotection equipment shall be sourced from an Eskom approved supplier. All work shall be done in accordance with the standards and specifications listed below:

- 240-141828918: Scope of Work Template for Teleprotection Projects.
- 240-75975613: Standard for the Installation of Power Telecommunications Equipment.
- 240-91461878: Teleprotection Trip Testing

- 240-96651735: Power Line Carrier and Associated Coupling Equipment: Commissioning and Major Maintenance Procedure.
- 240-122850198: Secondary Plant Line Trap Maintenance (TPC 41-89).
- 240-122859919: PLC System Coupling Device Maintenance (TPC 41-84).
- 240-141828918: Design Standard For Teleprotection Systems
- 240-103057370: Application Design Standard for Teleprotection Systems.
- 240-77422828: Teleprotection Equipment for use on Digital Telecommunications Channels or Dedicated Optical Fibre.
- 240-106920490: Specification for Power Line Carrier & Integrated Teleprotection Equipment.
- 240-106920412: Power Line Carrier – Line Matching Equipment.
- 240-57648739: Power Line Carrier Line Traps and Associated Post Support Insulators Standard.
- 240- 64813646: Data Cable Required for X.21 Interfaces.
- 240-64813538: High Frequency Coaxial Cable for Power Line Carrier Applications.
- 240-64813692: Miniature Control Cable Required for Teleprotection Signals (18Z Cables).
- 240-64813568: Standard Indoor and Outdoor Telephone Cable.

The Teleprotection project scope (design) shall follow the scope of works template listed in the document 240-141828918, “Scope of Work Template for Teleprotection Projects”. This scope of work document shall adhere to the standards, 240-90353855, “Design Standard for Teleprotection Systems” and 240-103057370, “Application Design Standard for Teleprotection Systems”. The scope of works template for Teleprotection shall be completed for each of the affected lines/feeders.

The scope of works and/or design for Teleprotection shall be supported by Eskom. The scope of works shall include all 400kV feeders and follow the scope of works template (240-141828918).

The Teleprotection and Power Line Carrier (PLC) terminal equipment are ‘links’ and need to be compatible at both station ends.

The position of Line Traps shall be allocated by Eskom Technology. The information listed in Table 1 shall be provided to Eskom for each feeder/line before the study can be completed. The information shall include the existing line as well as the new line or loop-in sections. Once all information is provided, 4 months is required to complete the Line Trap allocation study.

The PLC frequency allocation shall be completed by Eskom Technology. The information listed in Table 2 shall be provided before the study can be completed. Once all information is provided, 4 months is required to complete the PLC frequency allocation. Important to note, that the PLC frequencies can only be allocated after the Line Trap positions have been determined.

The PLC terminal equipment, Line Matching Equipment (LMEs) and Line Traps require the allocated PLC frequencies before any of this equipment can be ordered. This is to ensure the correct equipment is ordered.

The Teleprotection and PLC equipment installed in the cabinet/s shall comply with the standard 240-75975613 “Standard for the Installation of Power Telecommunications Equipment”.

The TPE equipment shall be installed in the corresponding Protection cabinet.

The X.21 circuits from ET shall be detailed in ET’s SOW and shall be connected to the TPE equipment.

The installation of the LME is detailed in the document 240-141828918, “Scope of Work Template for Teleprotection Projects”

The installation of the Line Traps shall be detailed in the Substations scope of works document.

The contractor must submit a list of test equipment available together with their current calibration test certificates.

The ‘sequence of events’ for the commissioning of the new Teleprotection equipment shall be discussed by Eskom.

The contractor shall note that the Teleprotection, PLCs and Fibre requirements and installation are affected by Lines and Substations and therefore a commissioning plan should be developed to mitigate the associated risks. A ‘sequence of events for commissioning shall be drafted by the contractor and discussed with Eskom.

The contractor shall supply, install, terminate and test the Teleprotection units and/or Line Traps and/or LME and/or PLC equipment. Since Teleprotection and PLCs operate as a link, the contractor shall be required to supply, install, terminate and test the Teleprotection and PLC equipment at the distant stations from the connecting feeders/lines.

All Teleprotection equipment must be tested in accordance with the latest revision of Eskom’s standard, 240-91461878: Teleprotection Trip Testing and 240-96651735: Power Line Carrier and Associated Coupling Equipment: Commissioning and Major Maintenance Procedure. The Tx Grid and/or WP&CS shall witness the commissioning and testing as well as accept the test results.

The contractor shall comply to all Eskom’s SHEQ (Safety, Health, Environment and Quality) requirements as stipulated by the Project Manager and/or Transmission Grid.

Eskom approved equipment and suppliers are as follows:

- LME: Supplier – ABB LME (High Pass).
- PLC: Supplier – ABB ETL 651 or ABB ETL 6101 PLCs.
- Teleprotection Equipment: Supplier – ABB NSD 570
- Line Trap Supplier – High Voltage Technologies, Trench Line Traps:
  - U2: 132 kV, 2500A, 40kA, 0.2mH
  - S3H: 275 kV, 2500A, 50 kA, 0,5 mH - Heavy Creep (25mm/kV)
  - S3HH: 275 kV, 2500A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV)
  - Q1H: 400 kV, 2500A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV)
  - Q1HH: 400 kV, 2500A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV)
  - Q3H: 400 kV, 2500A, 50 kA, 1,2 mH LT - Heavy Creep (25mm/kV)
  - Q3HH: 400 kV, 2500A, 50 kA, 1,2 mH LT - Extra Heavy Creep (31mm/kV)
  - Q6H: 400 kV, 3150A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV)
  - Q6HH: 400 kV, 3150A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV)
  - Q7H: 400 kV, 3150A, 63 kA, 0,5 mH LT - Heavy Creep (25mm/kV)
  - Q7HH: 400 kV, 3150A, 63 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV)
  - Q9H: 400 kV, 3150A, 63 kA, 1,2 mH LT - Heavy Creep (25mm/kV)
  - Q9HH: 400 kV, 3150A, 63 kA, 1,2 mH LT - Extra Heavy Creep (31mm/kV)
  - Q10H: 400 kV, 4000A, 63 kA, 0,5 mH LT - Heavy Creep (25mm/kV)
  - Q10HH: 400 kV, 4000A, 63 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV)
- Line Trap Supplier – Actom, Trench Line Traps
  - U4: 132 kV, 2500A, 40 kA, 0,5 mH LT – (Without PI)
  - S8H: 275 kV, 3150A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV)
  - S8HH: 275 kV, 3150A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV)
  - S9H: 275 kV, 3150A, 50 kA, 1,2 mH LT - Heavy Creep (25mm/kV)
  - S9HH: 275 kV, 3150A, 50 kA, 1,2 mH LT - Extra Heavy Creep (31mm/kV)
  - S10H: 275 kV, 4000A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV)
  - S10HH: 275 kV, 4000A, 50 kA, 0,5 mH LT - Extra Heavy Creep (31mm/kV)

- Q8H: 400 kV, 3150A, 50 kA, 1,2 mH LT - Heavy Creep (25mm/kV)
- Q8HH: 400 kV, 3150A, 50 kA, 1,2 mH LT - Extra Heavy Creep (31mm/kV)
- QB1H: 765 kV, 5000A, 50 kA, 0,5 mH LT - Heavy Creep (25mm/kV)
- QB1HH: 765 kV, 5000A, 50 kA, 0,5 mH LT – Extra Heavy Creep (31mm/kV)

- Line Trap Supplier – MegaHVT, Arteche, Trench Line Traps
  - U5HH: 132 kV Post Insulators – Extra Heavy Creep (31mm/kV)
  - S1H: 275 kV, 2500A, 50 kA, 0,2 mH LT - Heavy Creep (25mm/kV)
  - S1HH: 275 kV, 2500A, 50 kA, 0,2 mH LT - Extra Heavy Creep (31mm/kV)
  - S5H: 275 kV, 2500A, 50 kA, 1,2 mH LT - Heavy Creep (25mm/kV)
  - S5HH: 275 kV, 2500A, 50 kA, 1,2 mH LT - Extra Heavy Creep (31mm/kV)

Table 1: Line Parameters

Tower Type(s)	
Line Length (km)	
Line Voltage (kV)	
Phase Conductors (Type)	
Earth Conductors (Type)	
Number of Phase Conductors in Bundle	
Bundle Spacing (mm)	
Attachment Position (Horizontal (x) & Vertical (y)) for all 3 Phase Conductors (Red/White/Blue) (m)	
Attachment Position (Horizontal (x) & Vertical (y)) for all Earth Conductors (m)	
Sag Phase Conductors (if available) (m)	
Sag Earth Conductors (if available) (m)	
Number of Transpositions	
Transposition locations (km)	
Transposition Swap sequences	

Phasing drawing displaying the Line Phasing which corresponds to the substation phasing diagrams at both ends of the line. (Should be provided by Substations department)	

Table 2: Checklist for requesting PLC frequencies from PTM&C Telecoms

Checklist of Required Information when requesting PLC Frequencies			
No.	**Item**	**Comments**	**Check Y/N**
1	Powerline Network diagram	A diagram showing the power network topology.	
2	Project Execution Plan	The sequence of events for project execution	
3	Teleprotection plan for new project	To determine the new requirements	
4	As-built PLC frequency allocations at local and remote substations	Photographs of all Carrier Panels at local and Remote Substations clearly displaying the frequencies	

4. 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

- 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 DLO Substation Control Room Scope of Work Guideline. A working template can be requested from the Project Manager.

5. Disturbance recorder and travelling wave fault locator

The digital fault recorder and travelling wave fault locator equipment and scheme shall be sourced from DLO Energy Solutions which is the Eskom approved supplier. The Eskom contract number is: 4600072275.

5.1 400kV Scheme 1

The following equipment for the 400 kV scheme 1 shall be sourced, factory tested, delivered, installed, and commissioned:

Item Description	**Quantity**
Scheme: 2 Feeders B&H - 110 VDC	1
Loose: IDM+6U with 27A/96B c/w Chassis Plate & Loom - 110 VDC	1
SecuControl 8 Way Test Block (FLTP08015AD-SL17F-1523)	2
Additional Card for Traveling Wave Fault Locator	2

Internal GPS Receiver	1
Ethernet Switch: RSG2100 (RSG2100-6GK6021-0AS23-3DB0-Z-A05+B05+C05+D05+E00+F00+G01+H01+J01+K01)	1
Fibre Optic Patch Panel (IST 12-way Fibre Optic Splice and Patch Panel (Multimode including 12 Duplex LC Mid-Couplers with Pigtails)	1
PC Communications cable for DFRs (RJ45 for PC connection)	1
Offloading & positioning in control room - per panel	1
Delivery: 1201 - 1500km	1

5.1.1 400 kV scheme 1 type, drawing application levels and bay allocations

Scheme Type:	6DRB-7100
Master Drawing No.:	0.52/30114
Applicable drawing application levels:	1,2,10,14,15,33,36,46,47,48,64,66,68
DFR1-DAU1:	400 kV Feeder 1
DFR1-DAU2:	400 kV Feeder 2 (Future)
DFR2-DAU1:	400/132/22 kV TRFR1 HV
DFR2-DAU2:	400/132/22 kV TRFR1 MV

The scheme diagrams with only the applicable levels shall be provided to DLO Energy Solutions when the order for the equipment is placed.

5.1.2 400 kV scheme 1, current transformer test block allocation and labelling

CTTB 1-1	400kV FDR 1 BAY CURRENT TEST BLOCK
CTTB 2-1	400kV FDR 2 BAY CURRENT TEST BLOCK
CTTB 3-1	TRFR 01 HV BAY CURRENT TEST BLOCK
CTTB 4-1	TRFR 01 MV BAY CURRENT TEST BLOCK

CTTB 1-2	400kV FDR 1 TIE CURRENT TEST BLOCK
CTTB 2-2	400kV FDR 2 TIE CURRENT TEST BLOCK
CTTB 3-2	TRFR 01 HV TIE CURRENT TEST BLOCK
CTTB 4-2	NOT USED

5.2 Telecommunication connection requirements

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

6. 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.

The following standard shall be used:

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

7. Metering and measurements

7.1 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

7.2 400/132/22 kV Auto Transformer 2 metering equipment

The following equipment for 400/132 kV auto transformer 2 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.

7.3 Measurements

Measurements functions are performed by the protection control devices.

8. 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).
- 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.

8.1 Telecontrol and substation automation equipment

8.1.1 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.

9. Auxiliary supplies (AC & DC systems)

9.1 DC systems

The tenderer shall procure (from the Eskom approved suppliers), supply, install and commission.

- Dual 110 V DC system (2 x charger panels and 2 by DC distribution panels).
- Dual 50 V DC system (2 x charger panels and 2 by DC distribution panels).
- Dual 110V battery banks.
- Dual 50 V battery banks.
- DC power distribution and control cables.

The tenderers shall engage with COM10 (battery chargers) and First National Batteries to determine the equipment required for the complete dual 110 VDC and dual 50 VDC DC systems. The complete DC systems, per system, bill of material shall be submitted with the tender.

The Eskom contract holders and number are:

- Battery Chargers: COM10 – 4600062264; and,
- Batteries and Stands: First National Batteries – 4600061271.

9.1.1 Battery chargers

The battery chargers for 110 V and 50 V DC systems shall be sourced Eskom approved supplier, factory tested, delivered, installed and commissioned at Paulputs substation

The tender shall utilize the Eskom standard, 240-57649110, for the sizing of DC systems for substation applications.

Item Description	Quantity
110V/***A Dual Battery Charger & Dual DC Board ▪ ***A – Rating dependent on the required battery sizing.	1
50V/***A Dual Battery Charger & Dual DC Board ▪ ***A – Rating dependent on the required battery sizing.	1

9.1.2 Batteries and Stands

The batteries stand for 110 V and 50 V DC systems shall be sourced (from First National Batteries – Eskom approved supplier), factory tested, delivered, installed and commissioned at Paulputs Substation

The tender shall utilize the Eskom standard, 240-57649110, for the sizing of DC systems for substation applications.

Item Description	Quantity
BOTTLE: LEAD ACID BATTERIES	1
FUNNEL: LEAD ACID BATTERIES D9260	1
HYDROMETER:AREOMETER LEAD ACID BATTERY	1
THERMOMETER LEAD ACID BATTERIES	1
JUG LEAD ACID BATTERIES	1
RACK,MAINT AND SAFETY EQUIPMENT	1
BOOK,MAINT LOG LA BATT 52CELL	4
PAINT:TOUCH UP;1000 ML;BATTERY STAND	1

BRUSH,PAINT:WD 50 MM	1
SIGN,DCSS1 - BATTERY ROOM	1
BOTTLE,EYE IRRIGATING:500 ML	1
110 VDC FRCT Battery Stands – ▪ Dependent on the number of batteries as per the Amp Hour rating requirement	2
50 VDC DRST Battery stands ▪ Dependent on the number of batteries as per the Amp Hour rating requirement	2
Connector, Battery Inter-row – 110 VDC ▪ # Quantity dependent on Amp Hour rating requirement	#
Connector, Battery Inter-row – 50 VDC ▪ # Quantity dependent on Amp Hour rating requirement	#
Terminating device – 110 VDC ▪ # Quantity dependent on Amp Hour rating requirement	#
Terminating device – 50 VDC ▪ # Quantity dependent on Amp Hour rating requirement	#
Battery, individual cells – 110 VDC ▪ # Quantity dependent on Amp Hour rating requirement	#
Battery, individual cells – 50 VDC ▪ # Quantity dependent on Amp Hour rating requirement	#

9.2 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.
- AC/DC Reticulation equipment for Breaker–and–a–half substations (240-76628687).
- Supply, Install and commission 230 V AC Distribution Board (0.54/7106).
- Supply, Install and commission 400 V AC Substation Distribution Board (0.54/08596).
- 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.
- The Transmission Grid technicians shall witness the commissioning and testing as well as acceptance of the test results.

10. Telecommunications

Refer to Telecommunication Design Document 240-75975613 for the scope of work and BOQ:

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.

11. Protection application design

11.1 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 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

11.2 Control room layout

Extend the control room according to Substation design standard and sizing will be determined by the station electric diagram (including all existing and future bays).

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.

Control room layout shall be accepted by Eskom before construction.

12. 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 Paulputs 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.

12.1 Factory acceptance testing requirements of the schemes to be developed

Factory acceptance testing is required for the Paulputs Protection scheme. The tests shall be witnessed and accepted by PTM&C technology and Transmission Grid West.

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.
- 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.

12.1.1 Test template requirements of the schemes to be developed

The tenderer shall develop maintenance test templates for the Paulputs Protection scheme 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).

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 fault 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.

12.2 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 Paulputs 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

13. Security System

The existing fence is only an outer barrier fence, there is no non-lethal fence. Thus, the fence for the terrace extension will also only include an outer barrier fence

14. 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

15. 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 Paulputs substation Control Room.

16. General

- The following shall be presented to Eskom PTM&C DRT for acceptance,

  Station Network Diagram (Technical keys and IP address to be included)

  Bill of Materials for all disciplines

  Control Room/Carrier Room layout

  These designs are to be accepted by Eskom prior proceeding to the next stage. Acceptance of designs by Eskom does not relieve the contractor of their accountability for the design

- 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.

17. 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

	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
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 Komsberg MTS	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

18. Revision and tracking

Rev No	Description	Compiler	Date
1	Initial Scope of Work	N. Gono	2023/07/25
2	Revised Bay Numbers and Included Remote End.	N. Gono	2023/10/04