

Title: **PTM&C DETAIL DESIGN
DOCUMENT: CITY OF CAPE
TOWN STRENGTHENING
(ERICA SUBSTATION)**

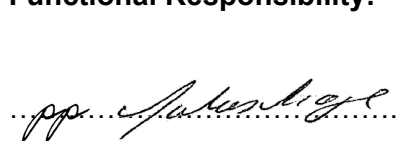
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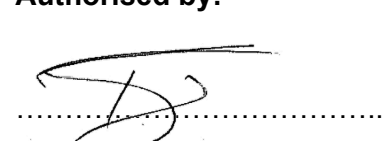
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1. PROJECT DESCRIPTION

The City of Cape Town (CoCT) Strengthening Report (GP_08/70) of 2008 highlighted the problems experienced in the Peninsula Area, especially the supply of power to the CoCT's network. The preferred option to address this is the establishment of a Transmission substation (Erica Substation) next to the existing CoCT's Mitchells Plain Substation.

A project identification and engineering document, compiled by the CoCT for the reinforcement of the Cape Town Electricity Eskom intake capacity in the Mitchells Plain area supported this proposal.

Erica Substation will deload Philippi and also cater for load growth due to new projects within the CoCT network. Eskom Distribution has also planned several projects which are dependent on Erica Substation.

Phase 1 of the project is to integrate Erica Substation to the 400 kV network as per the Addendum Report of May 2013 (GP_13/47) by looping the Stikland-Pinotage 400 kV line into Erica Substation via a 12.5 km 400 kV double circuit line.

Phase 2 of the project as per the Philippi Substation Extension Report of February 2014 (GP_14/01) is to extend Philippi Substation, establish a 400 kV busbar, cater for a future 3rd 400/132 kV 500 MVA transformer and construct a 7 km 400 kV line from Philippi Substation to Erica Substation.

Further challenges are currently being experienced with the EIA and servitude acquisition for the loop-in portion of the Stikland-Pinotage 400 kV line. The additional delays in commissioning of the Erica Substation pose a huge risk to the security of supply to the CoCT despite the mitigation measures that will be implemented in the short term.

It is therefore recommended to continue with the project but to implement it in stages as follows:

1. Extend Philippi Substation, establish a 400kV busbar and install a 3rd 400/132 kV 500 MVA transformer (as a hot standby).
2. Establish Erica Substation and construct a 10km 400 kV line from Philippi Substation to Erica Substation.
3. Integrate Erica Substation further by looping the Stikland-Pinotage 400 kV line into Erica Substation via a 12.5km 400 kV double circuit line.

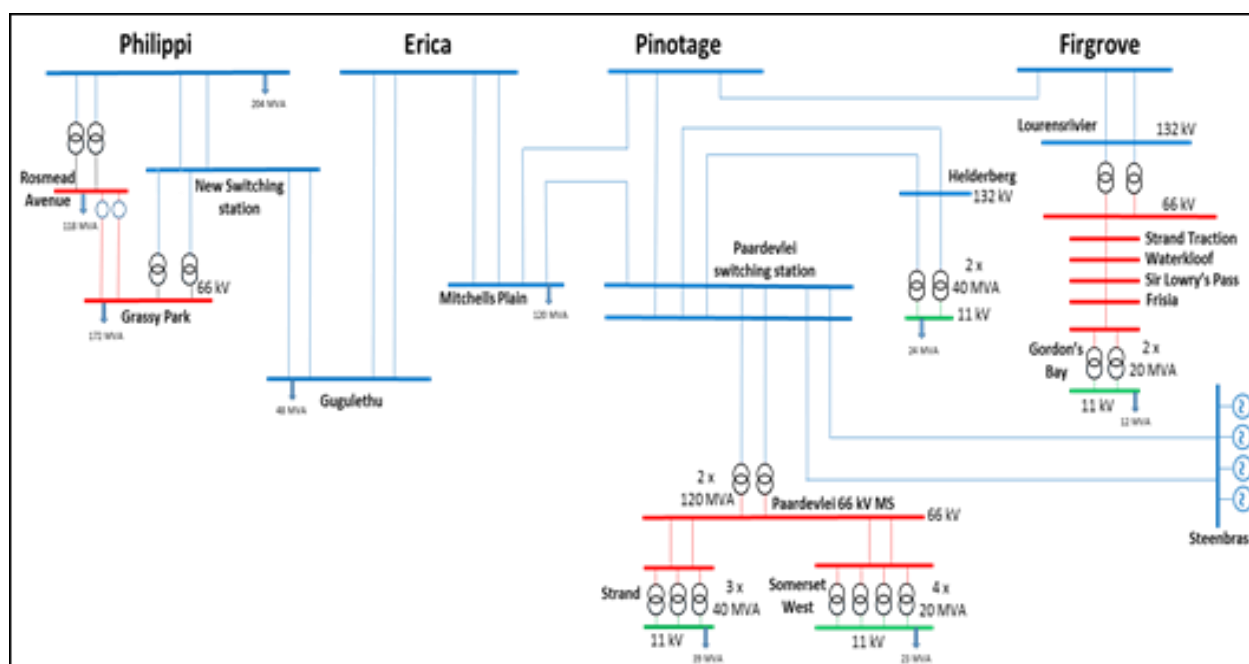
Grid Planning takes cognisance of the fact that Erica Substation supply will be unfirm after implementation of stage 2 due to integration via a single 400 kV line. The risk will have to be managed until stage 3 is completed.

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Figure 1: Proposed Integration of Erica Substation

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2. SUPPORTING CLAUSES

2.1 SCOPE

This document provides an overview of the PTM&C Engineering processes followed and it also includes the technical assessments to determine compliance with the Grid Code and stakeholder requirements. This document does not provide design cost, schedule or other project management type information.

2.1.1 Purpose

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

2.1.2 Applicability

This document shall apply to the Western Grid and all relevant stakeholders.

2.2 NORMATIVE/INFORMATIVE REFERENCES

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

2.2.1 Normative

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

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2.2.2 Informative

- See **Reference Documents** bullet Point

2.3 DEFINITIONS

- N/A

2.3.1 Disclosure Classification

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

2.4 ABBREVIATIONS

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

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2.5 ROLES AND RESPONSIBILITIES

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

2.6 RELATED/SUPPORTING DOCUMENTS

Document Type/Title	Drawing / Document Number	Revision Number	Originator
STATION ELECTRIC DIAGRAM	WMit12P01-SE-D6	0	P. Seboco
KEY PLAN	WMit12P01-SE-D7	0	P. Seboco
SURS/PLANNING URS	None	1	A. Hansa
ADDENDUM REV 1 - CITY OF CAPE TOWN STRENGTHENING (ERICA SUBSTATION)	GP_13/47	1	A. Hansa
ERICA SUBSTATION REVISED IMPLEMENTATION PLAN	—	—	L. Naidoo

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3. PRIMARY PLANT INFORMATION

3.1 HV EQUIPMENT

System Voltage (kV)	Rated Normal Current (A, min)	Short-circuit Withstand Current (kA, min)	CT Bus Zone Ratio	BIL (kV, min)	Minimum Specific Creepage Distance (mm/kV, min)
400 kV (GIS)	4000	50	1/2400	1425	31
132 kV (GIS)	3150	40	1/1600	550	31

Info obtained from Substation Design Report

3.2 FAULT LEVELS

System Voltage (kV)	1Ø Fault Levels (kA)		3Ø Fault Levels (kA)	
	Existing	New	Existing	New
400 kV	—	21.8	—	21.8
132 kV	—	26.2	—	22.9

Info obtained from Grid Planning URS Report

4. HIGH LEVEL SCOPE

4.1 400 KV YARD

Qty	Bay	Scope of Work
3	Feeder 1, 2 & 3	Fully Equipped Feeder bays
3	Transformer 11, 12 & 13	Fully Equipped Transformer bays
1	Diameter GA	Fully Equipped Diameter bay (Bay 1, Bay 2 & Tie Bay)
1	Diameter GB	Fully Equipped Diameter bay (Bay 1, Bay 2 & Tie Bay)
1	Diameter GC	Fully Equipped Diameter bay (Bay 1, Bay 2 & Tie Bay)
2	Busbar 1 & 2 VT	Fully Equipped Busbar 1 & 2 VTs (GIS)

4.2 132 KV YARD

Qty	Bay	Scope of Work
4	Feeder 3, 4, 5 & 6	Fully Equipped Feeder bays
3	Transformer 11, 12 & 13	Fully Equipped Transformer bays
2	Bus Coupler 'A' & 'B'	Fully Equipped Bus Coupler bay
3	Busbar 1A, 1B & 2 VT	Fully Equipped Busbar 1A, 1B & 2 VTs (GIS)

4.3 STATION DC VOLTAGE

220V DC

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5. SECONDARY PLANT REQUIREMENTS

5.1 400 KV SYSTEM

5.1.1 400 kV Diameter GA (Feeder 1 – Philippi 1 & 400/132/22kV Transformer 11)

Discipline	Requirements
5.1.1.1 Protection	EHV CB & ½ Feeder Protection Scheme (Current Diff) – 6FZDB-2110 M1 EHV CB & ½ Feeder Protection Scheme (Current Diff) – 6FZDB-2110 M2 EHV CB & ½ Diameter Interface Scheme (IEC61850) – 6DIP-2110 M1 EHV CB & ½ Diameter Interface Scheme (IEC61850) – 6DIP-2110 M2 EHV CB & ½ Auto Transformer Protection Scheme – 6TAB-2300 with LoZ REF M1 EHV CB & ½ Auto Transformer Protection Scheme – 6TAB-2300 with HiZ REF M2 Tap Change Panel – 6TCP-2101 Tap Change Control – 6TC-2101-1 4 x 6IJB-#300 with PIUs – Next to BMK (The IJB aesthetics to be similar to the BMK incl height) 1 x 6JB-8200 with PIUs – Foundation required next to transformer 3 x VTJBs (included in the BMK & construction/design layout to be in line with the 1JB-0700) 1 x VTJB0700 (Coastal) 1 x TDB Type 1 – Foundation required 7 x 800 x 600 x 2400 Panels Bay 1 Mimic – with bay feeder controls Tie Bay Mimic – with bay controls only Bay 2 Mimic – with bay transformer & MV Side double busbar controls Cables NOTE: DGA & Online Dryer to be included
5.1.1.2 Control	Fibre Patch Panels (1U) Fibre Patch Boxes Ethernet Switches (RSG2100) Multi-mode Fibre Patch Leads Multi-mode HDD Fibre Optic cables
5.1.1.3 Measurements	Incorporated in the Diameter Interface Panel (IEC61850)
5.1.1.4 Teleprotection	M1: 48 core Single Mode OPGW. Line Length ≈ 10km M2: 48 core Single Mode OPGW. 2 x 8 core Single Mode HDD (GCO) Fibre cable (unarmoured cable), Complete Fibre Patch Panel (1U) with accessories & Fibre Patch Leads

NB: For Primary Plant Equipment, refer to the Substation Engineering Design Report

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5.1.2 400 kV Diameter GB (Feeder 2 – Pinotage 1 & 400/132/22kV Transformer 12)

Discipline	Requirements
5.1.2.1 Protection	EHV CB & ½ Feeder Protection Scheme (Current Diff) – 6FZDB-2110 M1 EHV CB & ½ Feeder Protection Scheme (Impedance) – 6FZDB-2110 M2 EHV CB & ½ Diameter Interface Scheme (IEC61850) – 6DIP-2110 M1 EHV CB & ½ Diameter Interface Scheme (IEC61850) – 6DIP-2110 M2 EHV CB & ½ Auto Transformer Protection Scheme – 6TAB-2300 with LoZ REF M1 EHV CB & ½ Auto Transformer Protection Scheme – 6TAB-2300 with HiZ REF M2 Tap Change Control – 6TC-2101-2 4 x 6IJB-#300 with PIUs – Next to BMK (The IJB aesthetics to be similar to the BMK incl height) 1 x 6JB-8200 with PIUs – Foundation required next to transformer 3 x VTJBs (included in the BMK & construction/design layout to be in line with the 1JB-0700) 1 x TDB Type 1 – Foundation required 6 x 800 x 600 x 2400 Panels Bay 1 Mimic – with bay feeder controls Tie Bay Mimic – with bay controls only Bay 2 Mimic – with bay transformer & MV Side double busbar controls Cables NOTE: DGA & Online Dryer to be included
5.1.2.2 Control	Fibre Patch Panels (1U) Fibre Patch Boxes Ethernet Switches (RSG2100) Multi-mode Fibre Patch Leads Multi-mode HDD Fibre Optic cables
5.1.2.3 Measurements	Incorporated in the Diameter Interface Panel (IEC61850)
5.1.2.4 Teleprotection	M1: 48 core Single Mode OPGW. Line Length ≈ 28km M2: PLC with 3 tripping channels. Allocate new frequencies. 2 x LT 400kV, 4000A, 50kA, 0.5mH, 31mm/kV 2 x LME, Tuning Unit 101-500kHz 1 x 8 core Single Mode HDD (GCO) Fibre cable (unarmoured cable), Complete Fibre Patch Panel (1U) with accessories & Fibre Patch Leads NOTE: M2 scope will be done on the COCT Phase 3 Project

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5.1.3 400 kV Diameter GC (Feeder 3 – Stikland 1 & 400/132/22kV Transformer 13)

Discipline	Requirements
5.1.3.1 Protection	EHV CB & ½ Feeder Protection Scheme (Current Diff) – 6FZDB-2110 M1 including 3 rd Party Relay (ABB RED670) EHV CB & ½ Feeder Protection Scheme (Impedance) – 6FZDB-2110 M2 EHV CB & ½ Diameter Interface Scheme (IEC61850) – 6DIP-2110 M1 EHV CB & ½ Diameter Interface Scheme (IEC61850) – 6DIP-2110 M2 EHV CB & ½ Auto Transformer Protection Scheme – 6TAB-2300 with LoZ REF M1 EHV CB & ½ Auto Transformer Protection Scheme – 6TAB-2300 with HiZ REF M2 4 x 6IJB-#300 with PIUs – Next to BMK (The IJB aesthetics to be similar to the BMK incl height) 3 x VTJBs (included in the BMK & construction/design layout to be in line with the 1JB-0700) 1 x TDB Type 1 – Foundation required 6 x 800 x 600 x 2400 Panels Bay 1 Mimic – with bay feeder controls Tie Bay Mimic – with bay controls only Bay 2 Mimic – with bay transformer & MV Side double busbar controls Cables
5.1.3.2 Control	Fibre Patch Panels (1U) Fibre Patch Boxes Ethernet Switches (RSG2100) Multi-mode Fibre Patch Leads Multi-mode HDD Fibre Optic cables
5.1.3.3 Measurements	Incorporated in the Diameter Interface Panel (IEC61850)
5.1.3.4 Teleprotection	M1: 48 core Single Mode OPGW. 1 x 8 core Single Mode HDD (GCO) Fibre cable (unarmoured cable), Complete Fibre Patch Panel (1U) with accessories & Fibre Patch Leads. Line Length ≈ 19km M2: PLC with 3 tripping channels. Allocate new frequencies. 2 x LT 400kV, 4000A, 50kA, 0.5mH, 31mm/kV 2 x LME, Tuning Unit 101-500kHz NOTE: M2 scope will be done on the COCT Phase 3 Project

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5.1.4 400 kV Busbar 1 & 2 CVT

Discipline	Requirements
5.1.4.1 Protection	2 x VTJBs (included in the BMK & construction/design layout to be in line with the 1JB-0700)
5.1.4.2 Control	N/A
5.1.4.3 Measurements	N/A
5.1.4.4 Teleprotection	N/A

5.2 132 KV SYSTEM

5.2.1 132 kV Feeder 3 – Gugulethu 1

Discipline	Requirements
5.2.1.1 Protection	HV Single Panel Feeder Protection Scheme without Transfer – 6FZD-2910 (M & BU) including 3 rd Party Relay (ABB RED670, COCT version). 6IJB-#300 with PIUs – Next to BMK (The IJB aesthetics to be similar to the BMK incl height) 1 x Fixed Frame Panel (800 x 600 x 2400) Cables
5.2.1.2 Control	Fibre Patch Panels (1U) Fibre Patch Boxes Bay Ethernet Switches (RSG2100) Multi-mode Fibre Patch Leads Multi-mode HDD Fibre Optic cables
5.2.1.3 Measurements	Incorporated in the Protection Scheme (IEC61850)
5.2.1.4 Teleprotection	Existing ADSS Fibre. Line Length ≈ 3.15km 1 x 8 core S/M GCO Fibre cable (unarmoured cable), Complete Fibre Patch Panel (1U) with accessories & Fibre Patch Leads.

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5.2.2 132 kV Feeder 4 – Gugulethu 2

Discipline	Requirements
5.2.2.1 Protection	HV Single Panel Feeder Protection Scheme without Transfer – 6FZD-2910 (M & BU) including 3 rd Party Relay (ABB RED670, COCT version). 6IJB-#300 with PIUs – Next to BMK (The IJB aesthetics to be similar to the BMK incl height) 1 x Fixed Frame Panel (800 x 600 x 2400) Cables
5.2.2.2 Control	Fibre Patch Panels (1U) Fibre Patch Boxes Bay Ethernet Switches (RSG2100) Multi-mode Fibre Patch Leads Multi-mode HDD Fibre Optic cables
5.2.2.3 Measurements	Incorporated in the Protection Scheme (IEC61850)
5.2.2.4 Teleprotection	Existing ADSS Fibre. Line Length ≈ 3.15km 1 x 8 core S/M GCO Fibre cable (unarmoured cable), Complete Fibre Patch Panel (1U) with accessories & Fibre Patch Leads.

5.2.3 132 kV Feeder 5 – Mitchells Plain 1

Discipline	Requirements
5.2.3.1 Protection	HV Single Panel Feeder Protection Scheme without Transfer – 6FZD-2910 (M & BU) including 3 rd Party Relay (ABB RED670, COCT version). 6IJB-#300 with PIUs – Next to BMK (The IJB aesthetics to be similar to the BMK incl height) 1 x VTJB (included in the BMK & construction/design layout to be in line with the 1JB-0602) 1 x Fixed Frame Panel (800 x 600 x 2400) Cables
5.2.3.2 Control	Fibre Patch Panels (1U) Fibre Patch Boxes Bay Ethernet Switches (RSG2100) Multi-mode Fibre Patch Leads Multi-mode HDD Fibre Optic cables
5.2.3.3 Measurements	Incorporated in the Protection Scheme (IEC61850)
5.2.3.4 Teleprotection	Existing ADSS Fibre. Cable Length ≈ 0.7km 1 x 8 core S/M GCO Fibre cable (unarmoured cable), Complete Fibre Patch Panel (1U) with accessories & Fibre Patch Leads.

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5.2.4 132 kV Feeder 6 – Mitchells Plain 2

Discipline	Requirements
5.2.4.1 Protection	HV Single Panel Feeder Protection Scheme without Transfer – 6FZD-2910 (M & BU) including 3 rd Party Relay (ABB RED670, COCT version). 6IJB-#300 with PIUs – Next to BMK (The IJB aesthetics to be similar to the BMK incl height) 1 x VTJB (included in the BMK & construction/design layout to be in line with the 1JB-0602) 1 x Fixed Frame Panel (800 x 600 x 2400) Cables
5.2.4.2 Control	Fibre Patch Panels (1U) Fibre Patch Boxes Bay Ethernet Switches (RSG2100) Multi-mode Fibre Patch Leads Multi-mode HDD Fibre Optic cables
5.2.4.3 Measurements	Incorporated in the Protection Scheme (IEC61850)
5.2.4.4 Teleprotection	Existing ADSS Fibre. Cable Length ≈ 0.7km 1 x 8 core S/M GCO Fibre cable (unarmoured cable), Complete Fibre Patch Panel (1U) with accessories & Fibre Patch Leads.

5.2.5 132 kV Bus Coupler ‘A’

Discipline	Requirements
5.2.5.1 Protection	HV Single Panel Bus Coupler Protection Scheme without Transfer – 6BC-2910 (M & BU) 6IJB-#300 with PIUs – Next to BMK (The IJB aesthetics to be similar to the BMK incl height) 1 x Fixed Frame Panel (800 x 600 x 2400) Cables
5.2.5.2 Control	Fibre Patch Panels (1U) Fibre Patch Boxes Bay Ethernet Switches (RSG2100) Multi-mode Fibre Patch Leads Multi-mode HDD Fibre Optic cables
5.2.5.3 Measurements	Incorporated in the Protection Scheme (IEC61850)
5.2.5.4 Teleprotection	N/A

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5.2.6 132 kV Bus Coupler 'B'

Discipline	Requirements
5.2.6.1 Protection	HV Single Panel Bus Coupler Protection Scheme without Transfer – 6BC-2910 (M & BU) 6IJB-#300 with PIUs – Next to BMK (The IJB aesthetics to be similar to the BMK incl height) 1 x Fixed Frame Panel (800 x 600 x 2400) Cables
5.2.6.2 Control	Fibre Patch Panels (1U) Fibre Patch Boxes Bay Ethernet Switches (RSG2100) Multi-mode Fibre Patch Leads Multi-mode HDD Fibre Optic cables
5.2.6.3 Measurements	Incorporated in the Protection Scheme (IEC61850)
5.2.6.4 Teleprotection	N/A

5.2.7 132 kV Busbar 1 Bus section 1

Discipline	Requirements
5.2.7.1 Protection	HV Single Panel Bus Section Protection Scheme without Transfer – 6BC-2910 (M & BU) 6IJB-#300 with PIUs – Next to BMK (The IJB aesthetics to be similar to the BMK incl height) 1 x Fixed Frame Panel (800 x 600 x 2400) Cables
5.2.7.2 Control	Fibre Patch Panels (1U) Fibre Patch Boxes Bay Ethernet Switches (RSG2100) Multi-mode Fibre Patch Leads Multi-mode HDD Fibre Optic cables
5.2.7.3 Measurements	Incorporated in the Protection Scheme (IEC61850)
5.2.7.4 Teleprotection	N/A

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5.2.8 132 kV Busbar 1A, 1B & 2

Discipline	Requirements
5.2.8.1 Protection	3 x VTJB (included in the BMK & construction/design layout to be in line with the 1JB-0902) Cables
5.2.8.2 Control	N/A
5.2.8.3 Measurements	N/A
5.2.8.4 Teleprotection	N/A

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5.3 COMMON YARD REQUIREMENTS

5.3.1 Auxiliary/Construction Supply	Required
5.3.2 AC Reticulation	SDB Type 2/AC Board Type 1 AC Board Type 4 3 x Plug box (400kV Diameter GA, GB & GC) – Foundation required Power cables
5.3.3 Eskom Telecoms	Circuits to be requested: Scada, Teleprotection, DFR & TWS, EADS, QOS, Security & Metering Two Direct lines (National & Stabnac), Hotlines, Pax MSAP ADM/OTN Cisco router Fibre Optic Terminal Equipment 3 x 600 x 600 x 2200 Cabinets (OTN, MSAP & IT) 2 x 48 Core S/M OPGW between Philippi & Erica Refer to Service Application form. Detail design with BOM to be provided by Eskom Telecomms
5.3.4 Operating Floodlighting/ Security Lighting	Refer to Substation Engineering Design Report
5.3.5 Safety and Security	Security systems for the entire station (Non-Lethal Fence, Energizers, Integrated Access Control Systems, CCTVs etc.)
5.3.6 Control Room (NB: A new control room with HMI room will be built)	
5.3.6.1 Protection	400 kV B&H Low Impedance Bus zone (8 Bay) – 6BZB-2810 400 kV B&H Disturbance Recorder & TWS – 6DRB-7100 132 kV Low Impedance Bus zone (24 Bay) – 6BZ-2410 4 x Swing Frame Panel (2400 x 800 x 600)
5.3.6.2 Tele-Control (SCADA)	Gateway Panels (6AGW-2101) with interlocking, create interlocking rules and Implement interlocking on the station, HMIs (6AHMI-2100), EADS (6ADC-7100), Backbone switches with integrated GPS, Switches/Router, Fibre Switching Panels (6AFS-2100), Common Equipment Panel (6ACE-2100), Fibre Patch Panels, Fibre Patch Boxes, Fibre Patch Leads, Media Converters (Copper to Fibre), Cable Trays, M/M Fibre Optic Cable and X.21 cable Vertical IDF, IDF Equipment & cables 1 x Fixed Frame Panel (2400 x 800 x 600) 4 x Type A Automation Panel (2400 x 600 x 600) 1 x Internal Swing Frame (2400 x 800 x 600) NB: GIS Alarms to be included in the Common Equipment Panel

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5.3.6.3 Teleprotection	1 x 600 x 600 x 2200 Fibre Optic Panel, Complete 12 way Fibre Patch Panel (1U), Fibre Patch Leads, S/M Fibre Optic cable & Fibre Accessories.
5.3.6.4 Metering	ITM with 2 x Meter point scheme (Main & Check) QOS to be integrated in the ITM panel Tariff Metering Panels with 4 x Meter point scheme (Main & Check)
5.3.6.5 DC Systems (50V)	Dual 50V 200A Battery Chargers & DC Boards Cables
5.3.6.6 DC Systems (220V)	Dual 220V 100A Battery Chargers & DC Boards Cables
5.3.6.7 Battery Room (50V)	Dual 50V 830Ah Batteries Battery Stands Inter row connectors Terminating Devices Cables
5.3.6.8 Battery Room (220V)	Dual 220V 340Ah Batteries Battery Stands Inter row connectors Terminating Devices Battery Room Accessories Cables
5.3.6.9 Under-frequency load shedding	N/A
5.3.7 Office Furniture	Required, including HMI & EADS furniture

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5.4 REMOTE END

5.4.1 Philippi s/s: 400kV Feeder 3 – Erica 1

Discipline	Requirements
5.4.1.1 Protection	Refer to WPHI12P01-P-87
5.4.1.2 Control	Refer to WPHI12P01-P-87
5.4.1.3 Measurements	Refer to WPHI12P01-P-87
5.4.1.4 Teleprotection	Refer to WPHI12P01-P-87

5.4.2 Pinotage s/s: 400kV Feeder 2 – Erica 1

Discipline	Requirements
5.4.2.1 Protection	To be done on the COCT Phase 3 Project
5.4.2.2 Control	To be done on the COCT Phase 3 Project
5.4.2.3 Measurements	To be done on the COCT Phase 3 Project
5.4.2.4 Teleprotection	To be done on the COCT Phase 3 Project

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5.4.3 Stikland s/s: 400kV Feeder 3 – Erica 1

Discipline	Requirements
5.4.3.1 Protection	To be done on the COCT Phase 3 Project
5.4.3.2 Control	To be done on the COCT Phase 3 Project
5.4.3.3 Measurements	To be done on the COCT Phase 3 Project
5.4.3.4 Teleprotection	To be done on the COCT Phase 3 Project

5.5 RELATED PROJECTS

- City of Cape Town Strengthening Phase 1 (Philippi Substation Extension)
- City of Cape Town Strengthening Phase 3 (Looping in the Stikland-Pinotage 400 kV Line)

5.6 SPECIAL PROJECTS

- None.

5.7 REVISION CONTROL

Date	Rev	Compiler	Remarks
01 Jun 2022	1	Lungie Nogela	Detail Initial Scope

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6. DESIGN PHILOSOPHY

EHV system (220kV and above) shall be protected by two equivalent protection systems (i.e. Main 1 and Main 2). The Main 1 & Main 2 protection systems shall be fully segregated in secondary circuits. The EHV measurements and telecontrol systems are incorporated in the protection scheme (IEC61850 compliant). HV system (132kV & below) shall be protected by a single or dual main protection system, incorporating either distance or differential protection. The single main protection system shall have a separate backup protection system. The applicable document is SAGC Network code v10.1 (**Ref: Pg. 30 – 34 of 65, Section 5.1**). The purpose of protection is to detect faults that the equipment can be exposed to timeously and to initiate appropriate tripping action. The main performance requirements of the protection are the following:

- Sensitivity; Reliability (Security, Dependability & Directionality); Speed and Longevity

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

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

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

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

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- Perform Telecommunications Pre-engineering

7. MAINTENANCE PHILOSOPHY

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

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

Approved maintenance plans shall include the following:

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

Transmission is responsible for ensuring that the appropriate maintenance tasks are carried out to ensure the required plant performance. To this end it is important to ensure that a consistent process is followed in the planning, scheduling and control of maintenance tasks. The applicable documents are Maintenance Planning, Scheduling and Control **TST41-475**, Secondary Plant Templates/Manuals for Planned Maintenance **41-976** & can also be found using the follow link: http://tx1.eskom.co.za/docManagement/part_b.htm and Eskom Maintenance Policy **32-1205**.

8. OPERATING PHILOSOPHY

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

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

Operational philosophy ref: SPL46-101

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

9. COMMISSIONING PHILOSOPHY

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

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The objective is that:

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

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

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

The applicable commissioning document is Standard for Commissioning Protection Assets **240-54615413 (Ref: Pg 11 – 22, Section 4)**.

10. EXPECTED LIFE CYCLE

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

11. TECHNOLOGY

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

In the case of a once-off turnkey type project, the contractor proceeds with the installation and commissioning of the system at site. This is followed by Site Acceptance Testing (SAT). After successful completion of the SAT, the system is formally handed over to Eskom. The applicable documents for technology development are PTM&C Technology Development Procedure **240-83684419** and Process for Secondary Plant Technology Management **TPC41-714**. Protection schemes, Telecontrol and other equipment are available from the Eskom National Contracts listed below:

- Phase VI P&C Contract
- Phase VI Disturbance Recorder Contract
- Phase VI EADS Contract

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- Phase VI Junction Box Contract
- PMU Contract
- DC Chargers contract
- VLA Batteries contract
- Patch Panel Contract
- Panel Contract
- Metering Contract
- Modem Contract
- Transducer Contract
- QOS Contract

12. PROCESSES

PTM&C (Protection, Teleprotection, Measurement and Control) is accountable for technology management, Engineering Planning, Project Support and Engineering Applications within Eskom Group Technology and Commercial Division.

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

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

12.1 FUNCTIONAL SCOPE

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

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

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

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Further Telecommunications sites are analysed and selected based on availability and usability. Telecommunications pre-engineering work is determined including geotechnical, structural, environmental requirements and the need for applications for permits and approvals.

12.2 SETTINGS REQUEST PROCEDURE

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

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

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

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

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

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

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

13. PROTECTION SCHEME DESIGN CRITERIA

The protection system shall be based on the principle of dual main and/or main & back-up protection for system security and redundancy.

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

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

The main requirements of this protection are following:

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

14. DESIGN AND MATERIAL ALTERNATIVES CONSIDERED/REJECTED

The selected schemes are based on the standardized protection schemes, available on the ENC documentation and cater for AIS systems. The design and testing of the relays shall comply with the Standard for Electronic Protection and Fault Monitoring Equipment for Power Systems document **TST41-1062 (Ref: Pg. 10 of 79, Section 2.2)** and Generic Specification for Protective Intelligent Electronic Devices (IEDs) **240-64685228 (Ref: Pg. 17 – 18 of 40, Section 4.18 & 5)**.

The substation capacity is determined by the capacity of the transformer/s installed as well as the substation layout design (SED) according to the Electrical Area Classification – Class IV and/or the load flow studies indicated in the Grid Planning Report.

15. SPECIFICATIONS

All protection equipment used is selected such that:

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

16. EQUIPMENT LIST

Refer to Secondary Plant Requirements (Section 5) for a list of all PTM&C Equipment to be installed.

17. EQUIPMENT SELECTION CRITERIA

Equipment selection is based on the following criteria:

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

18. CONTROL PHILOSOPHY

The Transmission Substation Control System (SCS) is based both on legacy architecture as well as a more modern arrangement. The legacy SCS architecture is based on functionally distributed RTUs that are serially connected to ERTUs (via the Estel protocol), which provides the central points of data and communication coordination. The newer modern architecture also has limited distributed RTUs. These RTUs communicate via IEC61850 over an IP connection to the Gateway which also provides the central points of data and communication coordination.

In the legacy architecture, the Estel protocol forms the communications link between the ERTUs and BLCs/Station RTU/IEDs as well as the link to the external HMIs, whereas in the modern arrangement, this is achieved via IEC61850. Between remote master stations and the substation ERTUs/Gateways, the protocols supported are Estel and IEC 60870-5-101.

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

19. TRAINING

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

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20. EQUIPMENT AND UTILITY REQUIREMENTS

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

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

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

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

21. ELECTRICAL SPECIFICATIONS

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

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

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

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

22. SOFTWARE (CADD/MODEL) REQUIREMENTS

Drawings are cadded using MicroStation software. The draughtsperson register the drawings on the ProjectWise™ system once checked and signed off as per the Drawing office standard **TST41-634 (240-96632721)** and according to Eskom's Standard for Electronic Protection and fault monitoring equipment **TST41-1062** (Section 2.3.3). The applicable configurations or software for protection relay/s

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is provided by the OEM service provider, used in conjunction with test equipment software for secondary and primary injection.

23. TRANSPORTATION AND STORAGE REQUIREMENTS

The scheme shall be packed in a high specification impact resistance, corrugated cardboard box or wooden crate. The packaging shall be waterproof and shall protect the contents from reasonable transport related wear and tear. It shall be clearly marked and where cabinet door locks, front panel switches etc. may cause damage to the packaging, these shall be removed and placed in a suitable plastic bag and securely tied to the interior of the cabinet for fitment on site. The location in which equipment may be stored / installed will be specified by the supplier (Temperature and Humidity).

24. PRE-COMMISSIONING AND HANDOVER SEQUENCE REQUIREMENTS

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

25. FUTURE EXPANSION REQUIREMENTS AND CONSTRUCTABILITY

A new 400kV control room is required for planned & future panels.

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

Design, Construct and Refurbish process guide 41-1022

PCM for Perform Design Analysis 240-44509564 (Section 9.1.4).

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

26. MAINTENANCE AND OPERATING REQUIREMENTS

The Grids, as owners of the Plant prepares and implements the plant maintenance execution strategies and procedures as influenced by the maintenance strategy set during the design phase. Responsibilities include development, planning, controlling and execution of the outage scope. Management and maintenance of spares and the strategic planning and holding thereof are critical to the function.

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Procedures for both operating and emergency purposes including the development, optimization, implementation and maintenance thereof are managed within the O&M domain (i.e. The Grids).

All Grids will have their own maintenance plan specific to the Grid. Secondary plant maintenance of equipment is specified / covered by the documents on Hyperwave under Transmission Group, Part B – Secondary Plant Maintenance Manual. The Grid will create the site specific operating procedure based on **240-674449796**, once the plant has been handed over to the Grid.

27. DECOMMISSION

The purpose is to overcome any negative impact to the system from decommissioned secondary plant equipment and its presents at the station. The applicable document is Decommissioning and Removal of Protection Panels **TPC41-148**. Decommissioning of panels is not applicable for this project.

28. REFERENCE DOCUMENTS

- PTM&C Operating Procedure 240-53249157
- PMC Application Work Instruction 240-56362378
- PTM&C Technology Development 240-83684419
- Design Review Procedure 240-53113685
- Standard for Transmission and Distribution Protection Schemes: Common Requirements 240-65336348
- Process Control Manual for Perform PTM&C Systems Engineering 240-53458797
- South African Grid Code (network code ver 10)
- Protection Settings Philosophy for Transmission and Sub-Transmission Grids SPL46-101
- Generic Specification for Protective Intelligent Electronic Devices (IEDs) 240-64685228
- Specification for Transmission and Distribution Protection Schemes: Transformers and Reactors 240-67712833
- Standard for Electronic Protection and Fault Monitoring Equipment for Power Systems TST41-1062
- Power Line Carrier Frequency Planning Design Guide 240-56362025
- Sizing of DC Systems for Substation Application Standard 240-57649110
- Design Standard for DC & Auxiliary Supplies 34-999
- Substation Gateway and Station RTU/IED Standard Specification for EHV Substations 240-68234842
- AC Reticulation Philosophy for Substations 240-55151946

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- AC Reticulation Application Design Guideline for Substations 240-55151908
- Specification for Non-Lethal Energized Perimeter Detection System (NLEPDS) for protection of Eskom Installations and its Subsidiaries 240-78980848
- Robust Energizer Specification TSP41-766
- Secondary Plant Templates for Planned Maintenance 41-976
- Transmission Maintenance Planning, Scheduling and Control TST41-475
- Standard for Commissioning Protection Assets 240-54615413
- Secondary Plant Security Systems Commissioning Procedure TPC41-244
- Substation Fibre Optic Design Standard – Part 2: Substations 240-46264031
- Fibre Optic Cable System Acceptance Testing TPC41-5
- PCM for Perform Design Analysis 240-44509564
- Design, Construct and Refurbish process guide 41-1022
- Eskom Maintenance Policy 32-1205
- Decommissioning and Removal of Protection Panels TPC41-148

29. DEVELOPMENT TEAM

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

- PTM&C Project Engineering Team

30. ACKNOWLEDGEMENTS

- None.

31. APPENDIX

31.1 APPENDIX A – PDE DRT PRESENTATION SLIDES

31.2 APPENDIX B – CONTROL ROOM SIZING

- Reference Doc: Control Room Panel Dimensions

31.3 APPENDIX C – DC BATTERY ROOM SIZING

- Reference Doc: Battery Room Dimensions

31.4 APPENDIX D – SECONDARY PLANT SOW DOCUMENT

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31.5 APPENDIX E – CABLE DOCUMENT

31.6 APPENDIX F – FIBRE NETWORK DIAGRAM

APPENDIX B: CONTROL ROOM SIZING

No	Panel Size	Description
1	800x600	400kV CB&½ Bus Zone Panel 1
2	800x600	400kV CB&½ Disturbance Recorder & TWS
3	800x600	400kV CB&½ Disturbance Recorder & TWS
4	800x600	Tap Change Panel 1
5	800x600	Tap Change Panel 2 (Future)
6	800x600	400kV Feeder 1 – Philippi 1 Main 1
7	800x600	400kV Feeder 1 – Philippi 1 Main 2
8	800x600	400kV Diameter GA Interface Panel Main 1
9	800x600	400kV Diameter GA Interface Panel Main 2
10	800x600	400/132/22kV Transformer 11 Main 1
11	800x600	400/132/22kV Transformer 11 Main 2
12	800x600	400kV Feeder 2 – Pinotage 1 Main 1
13	800x600	400kV Feeder 2 – Pinotage 1 Main 2
14	800x600	400kV Diameter GB Interface Panel Main 1
15	800x600	400kV Diameter GB Interface Panel Main 2
16	800x600	400/132/22kV Transformer 12 Main 1
17	800x600	400/132/22kV Transformer 12 Main 2
18	800x600	400kV Feeder 3 – Stikland 1 Main 1
19	800x600	400kV Feeder 3 – Stikland 1 Main 2
20	800x600	400kV Diameter GC Interface Panel Main 1
21	800x600	400kV Diameter GC Interface Panel Main 2
22	800x600	400/132/22kV Transformer 13 Main 1
23	800x600	400/132/22kV Transformer 13 Main 2
24	800x600	400kV Spare
25	800x600	400kV Spare
26	800x600	400kV Diameter GD Interface Panel Main 1 (Future)
27	800x600	400kV Diameter GD Interface Panel Main 2 (Future)
28	800x600	400/132/22kV Transformer 14 Main 1 (Future)
29	800x600	400/132/22kV Transformer 14 Main 2 (Future)
30	600x600	Gateway Panel Main 1
31	600x600	Gateway Panel Main 2
32	600x600	Fibre Switching Panel 1 Main 1
33	600x600	Fibre Switching Panel 1 Main 2
34	600x600	Fibre Switching Panel 2 Main 1 (Future)
35	600x600	Fibre Switching Panel 2 Main 2 (Future)
36	800x600	132kV Bus Zone Panel 1
37	800x600	132kV Bus Zone Panel 2
38	800x600	132kV Bus Zone Panel 3
39	800x600	132kV Feeder 1 (Future)
40	800x600	132kV Feeder 2 (Future)
41	800x600	132kV Bus Coupler 'A'
42	800x600	132kV Feeder 3
43	800x600	132kV Feeder 4
44	800x600	132kV Busbar 1 Bussection 1
45	800x600	132kV Feeder 5
46	800x600	132kV Feeder 6
47	800x600	132kV Bus Coupler 'B'

48	800x600	132kV Feeder 7	(Future)			
50	800x600	132kV Feeder 8	(Future)			
51	800x600	132kV Feeder 9	(Future)			
52	800x600	132kV Feeder 10	(Future)			
53	800x600	230V AC Distribution Board Type 4				
54	800x600	230V AC Distribution Board Type 4	(Future)			
55	600x600	220V 100A DC Charger	Main 2			
56	600x600	220V 100A DC Board	Main 2			
57	600x600	220V 100A DC Board	Main 1			
58	600x600	220V 100A DC Charger	Main 1			
59	600x600	50V 200A DC Charger	Main 2			
60	600x600	50V 200A DC Board	Main 2			
61	600x600	50V 200A DC Board	Main 1			
62	600x600	50V 200A DC Charger	Main 1			
63	800x600	ITM Panel	(Future)			
64	800x600	ITM Panel				
65	800x600	Stats Metering Panel				
66	800x600	Stats Metering Panel	(Future)			
67	800x600	Common Equipment Panel				
68	800x600	Common Equipment Panel	(Future)			
69	800x600	Engineering and Data Server (EADS)				
70	600x600	Telecomms MSAP				
71	600x600	Telecomms OTN				
72	600x600	Fibre Optic Cabinet				
73	600x600	IT				
74	600x600	PLC/Teleprotection (Pinotage 1)				
75	600x600	PLC/Teleprotection (Stikland 1)				
76	600x600	PLC/Teleprotection	(Future)			
77	2000x430	Room 400V AC Distribution Board				
78		IDF Rack				
79	(1500x800) x 3	HMI Workstation & EADS				
APPENDIX C: BATTERY ROOM SIZING						
Voltage	Cell Type	Capacity	No. of Cells	Battery Stand	Length (mm)	Width (mm)
220V DC	2-330D	340Ah	208	2 x FRCT	4082	1000
50V DC	2-810D	830Ah	48	2 x DRST	2639	600

