

 Eskom	Report	Technology
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Title:	Detail Design Report For Rouxville Substation 20MVA 66/33kV Transformer Bay With 2 x 33kV Feeder Bays	Unique Identifier:	NW-STM-1606-2731
		Alternative Reference Number:	N/A
		Area of Applicability:	Engineering
		Documentation Type:	Report
		Revision:	0
		Total Pages:	24
		Next Review Date:	N/A
		Disclosure Classification:	CONTROLLED DISCLOSURE

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EXECUTIVE SUMMARY

The objective of the design phase is to finalise the detailed phase of the Rouxville substation 66/22kV transformer bay project.

Rouxville substation has 1 x 10MVA 66/22kV transformer installed and the transformer feeds Zastron Munic, Smithfield Munic and Rouxville Munic. The transformer load peaks above 10MVA during winter due to the overloading of the transformers at Smithfield and Zastron Munic 22/11kV substations. The Zastron and Smithfield 22kV feeders experience low voltages due to the overloading.

The intent of the project is to ensure reliability of supply at Rouxville substation by installing the second 10MVA 66/22kV transformer and 2 x 22kV feeder bays for the new Smithfield and Zastron Munic 22kV feeders.

The installation of the second transformer triggers the extension of the existing 66kV busbar, the upgrading of the 22kV busbar conductors, the installation of Trfr 1 66kV busbar isolator, the extension of the existing control room and upgrading of the existing access road to the substation.

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1. INTRODUCTION

This document provides design status information on the completed detail design phase for Rouxville 66/22 kV transformer by project. This document is a major input to the formal design review process at the end of the design phase and describes the design process and technical output for the phase. The document contents provide an overview to the technical reviewers who will then, where required, use the actual design documents for performing their review.

The purpose of the detail design phase is to:

1. Establish a complete design, i.e. to produce all the component specifications, engineering drawings and other design documentation for procurement, fabrication, installation, construction and commissioning
2. Ensure integration of sub-system detail designs
3. Integrate operating and maintenance designs
4. Consolidate and standardise bulk items for procurement
5. Formalise the acceptance test procedures for product validation; and
6. Develop construction, installation and commissioning procedures.

System Identification

- Rouxville Substation 66/22 kV Substion

System Overview

Rouxville substation will have 2 x 66/22kV 10MVA transformer installed and 5 x 22kV feeder bays. The existing 10MVA transformer will supply the existing Rouxville Munic, Zastronc and Smithfield 22kV feeders. Normally open points will be created on the Zastron and Smithfield 22 kV feeders outside the respective substations. This is to ensure the separation of municipality loads and rural loads (Eskom clients)

The new 10MVA transformer will supply the new Zastron Munic and Smithfield Munic 22kV feeders. The new 22 kV feeders will be constructed along the existing 22kv feeders and will terminate at the respective substations.

The substation will remain radially fed by the Melkspruit 66 kV feeder.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document provides an overview of the engineering processes followed and the system design status at the end of the detail phase. The document includes the results of technical assessments to determine compliance with stakeholder requirements, technical risks identified, lessons learned during the design process and outstanding issues for this design phase. This document further provides references to the design output documentation.

This document does not provide design cost, schedule or other project management type information.

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2.1.1 Purpose

This document summarises the status and outcome of the detail phase design related activities and describes the achievement of the design goals, in terms of meeting stakeholder requirements. This document, together with the design output documentation of this phase, is submitted for review.

2.1.2 Applicability

The document is applicable to the Central East Cluster Operating Unit Design Review Team (DRT) committee for the review and the Central East Cluster Operating Unit Project Management Team for the execution of the project.

2.2 NORMATIVE / INFORMATIVE REFERENCES

2.2.1 Normative

- [1] 240-71062174 - Generic Substation Design
- [2] 240-68972408 - Standard For Flexible And Tubular Conductor Heights And Phase Spacing
- [3] 240-85524376 - Standard For Determining Dropper Conductor Short-Circuit Forces On Equipment In Outdoor Substations
- [4] 240-109589380 - Direct Lightning Stroke Protection Of Substations
- [5] 240-101940513 - Substation Earth Electrode Resistance Measurement
- [6] 240-109589380 - Standard For HV Yard Stone In Substations
- [7] 240-120804300 - Standard For Labelling Of Equipment In Wires Business
- [8] 240-84854974 - Continuity Measurement Of Substation Earth Grid
- [9] 240-134369472 - Substation Earth Grid Design Standard
- [10] 240-83563472 - Quality Checklist For Distribution Substation Primary Plant Prior To Handing over For Commercial Operation
- [11] 240-153000199 - Substation Drainage Specification
- [12] 240-102393009 - Standard For Substation Flood Analysis Design

2.2.2 Informative

- [13] TRH 20: - The Structural Design, Construction and Maintenance of Unpaved Roads
- [14] UTG7: - Geometric Design of Urban Local and Residential Streets
- [15] D-FS-887 - Substation Civil work details
- [16] ISBN 978-0-620-55428-2 – Drainage Manual, sixth edition, as published by, The South African National Roads Agency SOC Ltd, 2013
- [17] 240-64100247 – Standard for Earthing of secondary plant equipment in substations
- [18] 240-54615413 – Standard for commissioning protection assets
- [19] 240-85224724 – standard for distribution protection schemes : common requirements
- [20] 240-73735443 – D20 Commissioning Procedure

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- [21] 240-68234842 – Substation Gateway and Station RTU/IED Standard Specification for EVH Substations
- [22] 240-77589987 – Maintenance Standard for Substation Automation and Telecontrol Equipment
- [23] 240-89388001 – Commissioning and Implementation of Serial IED – RTU Diagnostics
- [24] 240-64813568 - Standard indoor and outdoor telephone cable
- [25] 240-95399670 - Telecommunications Network Interface Converter Standard
- [26] 240-71086056 - DNP3 Class Allocation Standard

2.3 DEFINITIONS

2.3.1 Disclosure Classification

Controlled Disclosure: Controlled Disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
AC/DC	Alternating Current / Direct Current
CT	Current Transformer
DC	Direct Current
HV	High Voltage
JB	Junction Box
kV	kilovolt
MV	Medium Voltage
MVA	Mega Volt Amp
NEC	Neutral Earth Compensator
PLCM	Project life cycle model
RTU	Remote Terminal Unit
SCADA	Supervisory, Control and Data Acquisition
TRFR	Transformer
V	Volt
VT	Voltage Transformer

In the preceding table, list and describe all abbreviations used in the document, in alphabetical order.

3. DETAIL DESIGN INFORMATION

Through various meetings with stakeholders, the design team was able to produce the detail design herein and for which the detail is provided below.

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3.1 OBJECTIVE OF THE DETAIL DESIGN PHASE

The objective of the detail design phase is to produce a constructable design that meets the initial requirements of the project.

3.2 SYSTEM DETAIL DESIGN OVERVIEW

3.2.1 Site and Building Layout Design

The substation is located approximately 1.7 km south of the Rouxville Town centre, via an unsurfaced road and a short gravel / farm track towards the substation. The substation is located on a hill side outside of the town.



Figure 1: Substation Site Overview

The gravel / farm track towards the substation shall be improved to accommodate transformer delivery vehicles with a portion of the road extending to the access gate on the north-western boundary of the substation.

The substation site layout will be changed with the addition of the new 66/22kV transformer bay and 22kV feeder bays. The substation boundary will remain the same and all changes will be done inside the existing substation extents.

The control room shall be extended to allow for the additional Control Plant panels which are to be installed. The control room extension will be constructed towards the south west. The building extension shall keep the same appearance of the existing building.

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3.2.2 Site Infrastructure Design

The majority of the site remains unchanged with the exception of the new 66/22kV transformer bay and 22kV feeder bays., the building extension and the required changes on the MV side of the substation.

3.2.3 Civil Building and Structural Design

The existing control room shall need to be extended to accommodate the new control plant panels to be installed inside the building. The building extensions shall be 4.747m long x 5.191m wide in a southern direction. The new building façade is to match that of the existing building. The existing foundation shall be extended, utilizing the same dimensions, for the extent of the building extension.

Brick walls shall be of the same design and type as that of the existing building. No extensions shall be made to the existing cable trenches in the building and new cable ladders shall be installed in the extension and continue vertically into the existing cable trenches to facilitate cable installation in the building extension. The new control plant panels to be installed shall be top entry panels. The existing windows and ventilation ducts shall be built-up and shut using the same brick wall construction as that of the existing building to prevent unauthorised access and lessen dust contamination in the building. The power and lighting installation shall be extended to include the new building extension. Sufficient lights shall be installed to ensure ample task lighting is provided in the building extension, as per the requirements of the detailed drawings.

The walls shall be plastered inside and outside and then primed and painted with a durable paint finish. The roof shall be extended using the same roof structure design. The roof structure design shall be provided to a reputable roofing designer or supplier which shall confirm the design as suitable for the new extension prior to the construction of the roof. The roof sheeting shall match that of the existing building. A new roof gutters shall be installed on the lower side of the roof slope to drain run-off from the roof. The existing ceiling shall be completely removed and a new ceiling shall be installed to cover the entire building. The ceiling shall be insulated as detailed.

To note is that an existing column foundation will need to be demolished and disposed of and earthworks reinstated prior to the construction of the building extension. This foundation shall obstruct the building extension and thus the demolition of the concrete.

A new boundary fence gate shall be installed at the start of the gravel Access Road no 1 Refer to the Project drawings for an exact position. This position may, however be changed after consultations with the property owner. This gate shall be installed complete with a concrete gate ramp. Refer to the detailed drawings for more information. The existing substation security fence diamond mesh shall be completely removed and replaced with a new diamond mesh fence as per the detailed drawings and specifications. All the existing gates shall be replaced as scheduled and a new 5.0m double leaf gate shall be installed on the south western fence to allow access to the substation stone transformer runway.

The existing internal substation fence shall be completely replaced with the new diamond mesh fence as per the detailed drawings.

All the substation yard stone shall be replaced with new yard stone to the required depth as detailed. Herbicide shall be applied to the substation terrace prior to the placement of the imported yard stone.

The existing substation cable trench covers are asbestos type covers. These shall be removed in accordance with the relevant OHS required standard for working with existing asbestos containing materials and disposed of accordingly. New concrete type trench covers shall be installed on the existing cable trenches.

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The existing stone verge kerbing shall be completely removed and disposed of. The kerb line shall be relocated to the require 1.2m from the fence line. Minor earthworks shall be required to fill and the adjacent natural ground to the same level as the substation terrace using G5 material. New pre-cast concrete kerbs shall be installed in the correct position, prior to the spreading and levelling of new yard stone.

New cable trenches shall be constructed on the MV side of the substation, as per the detailed drawings. Refer to the substation General Arrangement drawings for detailed positions of the new cable trenches.

The access road shall be “formalized” in order to ensure a transformer delivery vehicle which should encounter less obstructions. Due to the load design speed and operating speed of the anticipated road users the design criteria from the Draft UTG 7: Geometric Design of Urban and Local Residential Streets. The road way with for the road shall be 4m.

The horizontal curves have been designed such as to avoid visual “kinks” in the alignment. Due to the low design speed, minimum curve length criteria are not followed due to the visual aspect of the horizontal curve instead of a minimum length such as in rural high speed surfaced roads.

The vertical alignment has been designed with a minimum design speed of 30km/h. This design speed is used as the criteria for the minimum k-value and curve length for vertical crest and sag curves. For sag curves the “headlight” criteria has been followed to ensure sufficient sight distance is provided by the vehicle lights which need to illuminate the road ahead at the current design speed in low light conditions, similar to which Field Staff need to operate in at night. The increase in k-value for this provides a “smoother” vertical alignment.

TABLE 7.3

Minimum lengths of vertical curves

Design speed (km/h)	Length of curve (m)
20	20
30	20
40	30
50	30
60	40

TABLE 7.2

Minimum values of K for vertical curves

Speed (km/h)	Stopping sight distance (m)	K		
		Crest	Sag	Comfort
20	18	1	2	2
30	30	1	2	2
40	45	2	6	4
50	65	6	11	6
60	85	10	17	8

The minimum and maximum vertical grades stated in the UTG 7 are as per the following table:

TABLE 7.4

Maximum gradients

Road class	Recommended maximum gradient (%)	Maximum gradient over short sections	
		Gradient (%)	Maximum length (m)
a) Major residential access link	10	12,5	70
b) Access loop	12	16	50
c) Access cul-de-sac	12	16*	50
d) Access way	12	16	30
e) Access court	4	N/A	N/A
f) Access strip	12	16	30
* The last 20m towards the turning area of the cul-de-sac should have a gradient not exceeding 5%.			

The maximum grade along the route is 4.6%, at the start of the access road, there after the gradients vary between 1.1% and 3.8%, all below any of the stated criteria. This has been done to assist with the passage of the transformer delivery vehicle.

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Minimum gradients are not of a concern on this access road since the site topography is in rolling terrain and not flat terrain, therefore the natural ground gradient is more than 0.25%. The road cross slope is to be constructed at 3%, sloping towards the higher natural ground side in order to prevent excessive storm water run-off following over the road surface.

Kerb returns or “bell mouths” at intersections have been design to accommodate the anticipated daily traffic and thus have a 7m radius.

Since the design traffic for the road will not be high over the design life of the road a modified approach to the catalogue design has been performed and the following pavement layers have been selected:

- 150mm Gravel Wearing Course – G5
- 150mm Selected Subgrade – G5
- 150mm Insitu Road bed preparation
- 150mm Fill Layers as is required – G9

The road shall have a trapezoidal shaped grass lined drain on the upstream side of the road in order to intercept storm water and direct the storm water away from the road. A pipe culvert, complete with inlet and outlet structures, shall be installed at Chainage 0+202 to drain water away from the substation. Another pipe culvert shall be constructed adjacent to the access road where the new substation access gate shall be installed in order to drain the storm water collected in the trapezoidal drain.

The pipe culverts and drains have been sized to accommodate a 1:5 return period storm event. The pipes have also been sized to ensure sufficient size in order to facilitate cleaning of the culverts during periodic maintenance and thus a minimum pipe diameter of 250mm. These pipe culverts will also have sufficient capacity to accommodate the 1:20 return period storm event.

Due to the outlet velocity at the culverts stone pitching shall be required to provide protection against erosion at the culvert outlet. The erosion protection and culvert inlet and outlet structures shall be as indicated in the detailed drawings for the project.

Further, a storm water diversion berm, as per the detailed drawings, shall be constructed upstream of the substation in order to re-direct storm water away from the substation.

“Mitre banks” shall also be constructed along the left-hand bottom of fill of Access Road 1 to direct water away from the fill “toeline”. The positions of the “Mitre banks” shall be placed at positions finalized on site in consultation with the Project Engineer.

3.2.4 Primary Plant Design

The design entails

- The extension of the 66kV busbar using column and beams
- The installation of a second 66/22kV 10MVA transformer bay
- The installation of a 66kV busbar isolator on the existing 66/22kV transformer bay
- The restringing of the 22kV busbar
- The installation of 2 x 22kV feeder bays

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3.2.4.1 Equipment schedule

Eskom shall procure and deliver the following equipment on site. The contractor shall install the equipment as per design drawings D-FS-1357 Sheets 4-7 and manufacturer specifications.

66 kV Busbar Bay

DESCRIPTION	SAP - / D-DT-No	UNIT	QTY
INSUL,L/ROD 66kV 120kN C/L=+-880 31C D7029	0167609	EA	12

New Transformer 66/22kV Bay

DESCRIPTION	SAP - / D-DT-No	UNIT	QTY
ISO,EL:66 KV ;2500 A ;25 KA ;HAND ;0ES	0642555	EA	1
TRFR 10MVA 66/22kV OLTC YNd1 31 D6283	0185767	EA	1
BKR 66kV 1600A 20kA 110VDC 31 D6251	0170220	EA	1
CT 66kV 1600A 31.5kA 2P2M2B1600 31 D6198	0180037	EA	3
S/ARR S/CL 66kV MCOV 48kV 31 D6212	0401595	EA	4
S/ARR S/CL 22kV MCOV 24kV 31 D6215	0400391	EA	3
NEC/NER/AUX TFR 22kV 360A 31 D6141	0182732	EA	1
BKR:KSK;33 KV;1600 A;25 KA;3;110 VDC	0633119	EA	1
ISO,EL:33 KV ;1600 A ;25 KA ;HAND ;0ES	0642551	EA	1
INSUL,L/ROD 33kV 120kN 570C/L LM D3190	0167598	EA	12

Existing 66/22kV Transformer Bay

DESCRIPTION	SAP - / D-DT-No	UNIT	QTY
ISO,EL:66 KV ;2500 A ;25 KA ;HAND ;0ES	0642555	EA	1

22kV Busbar

DESCRIPTION	SAP - / D-DT-No	UNIT	QTY
ISO,EL:33 KV ;1600 A ;25 KA ;HAND ;0ES	0642551	EA	1
INSUL,L/ROD 33kV 120kN 570C/L LM D3190	0167598	EA	18
VT 1PH 22kV/110V 100/50VA 31 D6173	0402179	EA	3

New 22kV Feeder Bays

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DESCRIPTION	SAP No	UNIT	QTY
ISO,EL:33 KV ;1600 A ;25 KA ;HAND ;0ES	0642551	EA	4
BKR:KSK;33 KV;1600 A;25 KA;3;110 VDC	0633119	EA	2
S/ARR S/CL 33kV&44kV MCOV 36kV 31 D6214	0400398	EA	6

Existing 22kV Feeder Bays

DESCRIPTION	SAP No	UNIT	QTY
ISO:22 KV;1600 A;25 KA;H/O;0ES;110 VDC	0642548	EA	3

3.2.4.2 Material Schedule

Eskom shall procure and deliver the following equipment on site. The contractor shall install the equipment as per design drawings D-FS-1357 Sheets 4-7 and manufacturer specifications.

66 kV Busbar Bay

DESCRIPTION	SAP No	UNIT	QTY
BOLT, U GALV M16 x 89 x 102mm D6098	0163763	EA	12
CLEVIS-BALL 16mm 16L 80CL 120kN D6059	0167508	EA	12
SOCKET-TONGUE 16mm 120kN D6061	0010270	EA	12
CLAMP, PISTOL 4B 20mm-30mm D6042	0400580	EA	12
CLAMP:ETC-A;T/COMP; 23.5 MM; 26.5 MM	0401758	EA	6
COND, ACC CENTIPEDE 26.45D UNGRS	0014447	M	100

New 66/22kV Transformer Bay

DESCRIPTION	SAP No	UNIT	QTY
CLAMP:ETC-C;T/COMP; 26.5 MM; 26.5 MM	0401758	EA	21
CLAMP:EPC-B;COMP/PALM 45DG;26.5 MM	0400420	EA	12
CLAMP:EPC-A;COMP/PALM ODG;26.5 MM	0401580	EA	12
CLAMP:EXC-B;BOLT/COMP; STEM 38 COND26.5	0401766	EA	9
CLAMP:EX-B;BOLT/BOLT; STEM 26 COND 26.5	0401584	EA	8
CLAMP:EXC-A;BOLT/COMP; STEM 26 COND26.5	0401752	EA	3
CLAMP:ETC-N;T/COMP; 26.5 MM; 18.1 MM	0401576	EA	3
LUG,AL HORNET 1B M12 0 DEG I/C D3074	0554064	EA	3
BOLT, U GALV M16 x 89 x 102mm D6098	0163763	EA	6
CLEVIS-BALL 16mm 16L 80CL 120kN D6059	0167508	EA	6
SOCKET-TONGUE 16mm 120kN D6061	0010270	EA	6
CLAMP, PISTOL 4B 20mm-30mm D6042	0400580	EA	6
COND, ACC CENTIPEDE 26.45D UNGRS	0014447	M	300

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Existing 66/22kV Transformer Bay

DESCRIPTION	SAP No	UNIT	QTY
CLAMP:ETC-C;T/COMP; 26.5 MM; 26.5 MM	0401758	EA	3
CLAMP:EPC-B;COMP/PALM 45DG;26.5 MM	0400420	EA	6
CLAMP:EPC-A;COMP/PALM ODG;26.5 MM	0401580	EA	6
CLAMP:EXC-A;BOLT/COMP; STEM 26 COND26.5	0401752	EA	3
CLAMP:EXC-B;BOLT/COMP; STEM 38 COND26.5	0401766	EA	6
CLAMP:EX-B;BOLT/BOLT; STEM 26 COND 26.5	0401584	EA	6
CLAMP:EXC-A;BOLT/COMP; STEM 26 COND26.5	0401752	EA	3
COND, ACC CENTIPEDE 26.45D UNGRS	0014447	M	100

22 kV Busbar

DESCRIPTION	SAP No	UNIT	QTY
BOLT, U GALV M16 x 89 x 102mm D6098	0163763	EA	15
CLEVIS-BALL 16mm 16L 80CL 120kN D6059	0167508	EA	15
SOCKET-TONGUE 16mm 120kN D6061	0010270	EA	15
CLAMP, PISTOL 4B 20mm-30mm D6042	0400580	EA	15
CLAMP:EX-B;BOLT/BOLT; STEM 26 COND 26.5	0401584	EA	12
CLAMP:EPC-B;COMP/PALM 45DG;26.5 MM	0400420	EA	6
COND, ACC CENTIPEDE 26.45D UNGRS	0014447	M	150

New 22 kV Feeder Bays

DESCRIPTION	SAP No	UNIT	QTY
CLAMP:ETC-C;T/COMP; 26.5 MM; 26.5 MM	0401758	EA	6
CLAMP:EPC-B;COMP/PALM 45DG;26.5 MM	0400420	EA	18
CLAMP:EPC-A;COMP/PALM ODG;26.5 MM	0401580	EA	18
CLAMP:ETC-N;T/COMP; 26.5 MM; 18.1 MM	0401576	EA	6
LUG,AL HORNET 1B M12 0 DEG I/C D3074	0554064	EA	6
CLAMP:ETC-L;T/COMP; 18.1 MM; 26.5 MM	0401790	EA	6
COND, ACC CENTIPEDE 26.45D UNGRS	0014447	M	100

Existing 22 kV Feeder Bays

DESCRIPTION	SAP No	UNIT	QTY
CLAMP:ETC-C;T/COMP; 26.5 MM; 26.5 MM	0401758	EA	9
CLAMP:EPC-B;COMP/PALM 45DG;26.5 MM	0400420	EA	9
CLAMP:EPC-A;COMP/PALM ODG;26.5 MM	0401580	EA	9
CLAMP:EXC-B;BOLT/COMP; STEM 38 COND26.5	0401766	EA	9

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COND, ACC CENTIPEDE 26.45D UNGRS	0014447	M	100
COND, ACC CENTIPEDE 26.45D UNGRS	0014447	M	100

Existing 66 kV Feeder Bay

DESCRIPTION	SAP No	UNIT	QTY
CLAMP:ETC-C;T/COMP; 26.5 MM; 26.5 MM	0401758	EA	3
CLAMP:EXC-A;BOLT/COMP; STEM 26 COND26.5	0401752	EA	3
COND, ACC CENTIPEDE 26.45D UNGRS	0014447	M	100

Substation Earthing

DESCRIPTION	SAP No	UNIT	QTY
BAR, CU RD 10.0mm ANNEALED D6044	0400769	KG	300

3.2.4.3 Labelling Schedule

The contractor shall supply and install the following labels

	EQUIPMENT LABEL ORDERING SCHEDULE						
	Rev.					0	
	PROJECT NAME:		ROUXVILLE 66/22 KV 10MVA TRANSFORMER				
	PROJECT No:		NW-STM-1606-2731				
Label manufacturing specifications:							
All labels to be manufactured in accordance to Eskom standard 240-75660336 (Latest Revision)							
LEGEND	LABEL No.	D-DT-	MATERIAL			“J” Bracket	QTY
			VE	CD	FG		
MELKSPRUIT	4	5047s2		X		Y	1
66 kV LINE ISOL							
66 kV B/B	4	5047s2		X		Y	2
TRFR 1	4	5047s2		X		Y	1
66 kV B/B ISOL							
TRFR 1	4	5047s2		X		Y	1
66 kV BKR							

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TRFR 1	4	5047s2		X	Y	1
66 kV CT						
TRFR 1	4	5047s2		X	Y	2
66/22 kV						
TRFR 1	4	5047s2		X	Y	1
22 kV NECRT						
TRFR 1	4	5047s2		X	Y	1
22 KV BKR						
TRFR 1	4	5047s2		X	Y	1
22 kV B/B 1A ISOL						
TRFR 2	4	5047s2		X	Y	1
66 kV B/B ISOL						
TRFR 2	4	5047s2		X	Y	1
66 kV BKR						
TRFR 2	4	5047s2		X	Y	1
66 kV CT						
TRFR 2	4	5047s2		X	Y	1
66/22 kV						
TRFR 2	4	5047s2		X	Y	1
22 kV NECRT						
TRFR 2	4	5047s2		X	Y	1
22 KV BKR						
TRFR 2	4	5047s2		X	Y	1
22 kV B/B 1B ISOL						
22 kV B/B 1A	4	5047s2		X	Y	2

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B/B	4	5047s2		X		Y	1
22kV BUS-SECT ISOL							
22 kV B/B 1B	4	5047s2		X		Y	2
B/B 1A	4	5047s2		X		Y	1
22 kV VT							
B/B 1B	4	5047s2		X		Y	1
22 kV VT							
SMITHFIELD	4	5047s2		X		Y	1
22 kV B/B 1A ISOL							
SMITHFIELD	4	5047s2		X		Y	1
22 kV BKR							
SMITHFIELD	4	5047s2		X		Y	1
22kV LINE ISOL							
ROUXVILLE MUNIC	4	5047s2		X		Y	1
22 kV B/B 1A ISOL							
ROUXVILLE MUNIC	4	5047s2		X		Y	1
22 kV BKR							
ROUXVILLE MUNIC	4	5047s2		X		Y	1
22kV LINE ISOL							
ZASTRON	4	5047s2		X		Y	1
22 kV B/B 1A ISOL							
ZASTRON	4	5047s2		X		Y	1
22 kV BKR							
ZASTRON	4	5047s2		X		Y	1
22kV LINE ISOL							

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SMITHFIELD MUNIC	4	5047s2		X		Y	1
22 kV B/B 1B ISOL							
SMITHFIELD MUNIC	4	5047s2		X		Y	1
22 kV BKR							
SMITHFIELD MUNIC	4	5047s2		X		Y	1
22kV LINE ISOL							
ZASTRON MUNIC	4	5047s2		X		Y	1
22 kV B/B 1B ISOL							
ZASTRON MUNIC	4	5047s2		X		Y	1
22 kV BKR							
ZASTRON MUNIC	4	5047s2		X		Y	1
22kV LINE ISOL							
R	5	5047s2 &s5		X		Y	4
W	5	5047s2 &s5		X		Y	4
B	5	5047s2 &s5		X		Y	4

3.2.5 Secondary Plant Design

3.2.5.1 Protection Scope:

- Install transformer protection scheme on the new 66/22kV 20MVA transformer.
- Install a Tap change control scheme and incorporate it into the transformer panel.
- Install 2 x rural feeder protection schemes on the new 22kV feeder bay.
- Install a communication processor for remote access.
- All protection installations to use serial communication.
- Install 1 x CT JB's on the new 66kV transformer CT.
- Install 1 x VT JB's on the 66kV and 22kV busbar VTs.
- Replace the existing 22kV VT JB on 22kV busbar.
- Pre-commission and commission the new installation.

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- Provide control and supervisory cabling accordingly to new and the existing equipment.
- All new installations to be done in a new and old control room.

3.2.5.2 SCADA Scope:

- RTU will be replaced with the Bloemfontein Bulk ACE Replacement.
- Expand D20 RTU with a serial interface.
- Pre commission and Final-commission all the equipment according to the IDF records.
- Provide control and supervisory cabling accordingly.

3.2.5.3 Metering Scope:

- Install stats metering on the new transformer and feeder bays.
- Install a standard 19" metering panel.
- Install a Quality of Supply module
- Pre-commission and commission

3.2.5.4 DC Scope:

- Install a new 110V battery charger on the AC/DC panel as specified according to section 5 on the document.
- Install new 110V DC batteries in the Battery Cabinet in the control room as specified according to section 5 on the document.
- Commission the new DC installations (Battery Charger and Batteries) in the new control room.
- Pre-commission and Commission new DC units.
- Provide DC cabling accordingly.

3.2.5.5 Telecoms Scope:

- OPGW on the new Melkspruit – Rouxville line is covered in a different document.

3.2.6 Lines Design

The scope for the new Rouxville-Zastron Munic and Rouxville Smithfield Munic 22kV lines is addressed in a separate detailed design report

3.3 SYSTEM MAINTENANCE AND OPERATING DESIGN

3.3.1 Maintenance Design

The maintenance of all the primary plant and control plant equipment will be as outlined in the Eskom specifications and manufacturer manuals.

3.3.2 Operating Design

Under normal conditions the 22kV busbar bus-section isolator will be open and the new transformer will feed the 22kV Smithfield Munic and Zastron Munic feeders and the existing transformer to feed the existing Smithfield, Zastron and Rouxville Munic 22kV feeders.

The 22kV bus-section isolator will be closed when there is a planned outage on any of the transformer bays.

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3.4 WASTE MANAGEMENT

3.4.1 Waste Storage and Transportation

All waste shall be collected and disposed of as required by the Eskom Representative and Environmental Officer.

3.5 SYSTEM SAFETY ANALYSIS

The primary plant design takes into account electrical and working clearances, vehicle clearances and safety clearances as stipulated in the standard Generic Substation Design (240-71062174).

3.6 SYSTEM TECHNICAL INTEGRATION REVIEWS

3.6.1 Site Integration

3.6.2 System Layout Integration

The orientation of the new 22kV feeder bays was done in conjunction with the MV line designers. The objective was to bring in the new 22kV lines in the substation with minimal line crossings or deviation of the existing 22kV lines.

3.6.3 Civil and Structural Design Integration

The civil design was performed in conjunction with the requirements for the Primary plant requirements. Meetings were held on site to ensure integration. Design reviews have also been performed to ensure compliance.

3.6.4 Primary Plant Integration

The primary plant design was performed in conjunction with the requirements for Secondary Plant requirements. Meetings were held on site to ensure integration.

3.6.5 Secondary Plant Integration

The secondary plant design was performed in conjunction with the requirements for Primary Plant requirements. Meetings were held on site to ensure integration.

3.6.6 Lines Integration

The orientation of the new 22kV feeder bays was done in conjunction with the MV line designers. The objective was to bring in the new 22kV lines in the substation with minimal line crossings or deviation of the existing 22kV lines.

3.7 SYSTEM DESIGN ASSESSMENT

3.7.1 Operability

The substation will be operated with the 22kV bus-section isolator open under normal conditions. The 22kV bus-section isolator will be closed if there is a planned outage on any of the transformer bays.

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3.7.2 Constructability

The project construction sequence of events are proposed as follows.

Activity	Outage Requirement
Restraining of the 22Kv Busbar	An outage will be required for reinstallation of the existing 22kV suspension beam as a strainer beam, restraining the busbar with Centipede conductor and connect the droppers from the busbar to existing 22kV busbar isolators. A report from Network Optimisation has confirmed that the existing 22kV loads cannot be back-fed from other 22kV lines. A 22kV cable will be installed from the transformer 22kV busbar isolator to the 22kV coupling bar on the retic lines to by pass the existing busbar.
Extension of the 66kV busbar and construction of the 66/22kV transformer bay	The works can be done without any outage. An outage will be required for stringing the 66kV busbar using Centipede, and to connect the droppers form the 22kV busbar conductors to the 22kV bus-section isolator and new 22kV feeder bays busbar isolators
22kV feeder bays	The works can be done without an outage
Installation of 66kV busbar isolator for existing transformer bay	An outage will be required to connect the dropper from the busbar conductors to the isolator
Substation Control Room Extension	No outage required
Substation access road	No outage required

3.8 SYSTEM SAFETY ASSESSMENT

3.8.1 Environmental Assessment

The project environmental management plan addresses the impact of all the construction activities on the environment and the mitigation measures that need to be in place.

The plan calls for the appointment of a registered Asbestos Removal contractor in order to be remove the asbestos trench covers in the substation.

The plan calls for the appointment of a bee removal contract to remove the bees in the existing control room prior to the construction work to extend the control room.

.Test and Commissioning Strategy

The testing and commissioning shall be done as per Eskom and manufacturer' specifications.

3.9 RISK REGISTER

The project construction should take place in the summer months when the load on the transformer is low. The load on the transformer exceeds 10MVA during winter due to Smithfield and Zastron Munics exceeding their NMD.

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4. AUTHORISATION

This document has been seen and accepted by:

Name	Designation
Emmanuel Mokalanyane	Sub Transmission, Distribution and Electrification Design manager
Andre Damons	HV Lines, Civil and Control Plant Manager

5. REVISIONS

Date	Rev.	Compiler	Remarks
March 20222	0	M. Seate	First Issue

6. DEVELOPMENT TEAM

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

- Modiri Seate Primary plant design
- Pieter Weideman Control plant design
- Michael Lombard Control plant design
- Miguel Da Côte Carreira Civil design

7. ACKNOWLEDGEMENTS

The authors of the report acknowledge the various stakeholders involved in the preparation and planning that has gone into this detailed design.

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APPENDIX A: DESIGN OUTPUT DOCUMENTS

Document Number	Rev.	Document Title	Remarks
	0	Substation Grid Continuity Test Report	First Issue
	0	Substation Grid Resistance Measurement Report	First Issue
	0	Rouxville Substation Backfeeding 15 March 2022	First Issue
	0	Control Plant Final Design Report	First Issue
	0	Environmental Management Plan	First Issue
	0	Bill Of Quantities: Rouxville 66/22kV New Transformer Bay: Primary Plant	First Issue
-	0	Detailed Specifications: Rouxville 66/22 kV Substation New Transformer Bay: Civil works	First Issue
-	0	Bill of Quantities: Rouxville 66/22 kV Substation New Transformer Bay: Civil works	First Issue

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APPENDIX B: SUBSTATION PRIMARY PLANT MAJOR DRAWINGS

Drawing	Rev.	Drawing Title	Remarks
D-FS-13574 SHT 4		Rouxville Substation 66/22 kV Substation Earthmat Layout	
D-FS-13574 SHT 5		Rouxville Substation 66/22 kV Substation Foundation Layout	
D-FS-13574 SHT 6		Rouxville Substation 66/22 kV Substation Steelwork Layout	
D-FS-13574 SHT 7		Rouxville Substation 66/22 kV Substation General Arrangement	
D-FS-13574 SHT 8		Rouxville Substation 66/22 kV Substation Sections	
-		Bloemfontein Control Operating Diagram Rouxville 66/22 kV S/S	

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