Eskom	Standard	Technology

Title	**STANDARD FOR OPERATING DIAGRAMS FOR ESKOM TRANSMISSION SUBSTATIONS**	Unique Identifier	**240-77297024**
		Alternative Reference Number	**<n/a>**
		Area of Applicability	**Engineering**
		Next Review Date.	**STABILISED**

COE Acceptance	**DBOUS Acceptance**
Bheki Ntshangase	**Amelia Mtshali**
Snr Manager Engineering	**Snr Manager Engineering**
Date:	Date 21/01/2020

This document is **STABILISED.** The technical content in this document is not expected to change because the document covers. *(Tick applicable motivation)*

1	A specific plant, project or solution	
2	A mature and stable technical area/technology	
3	Established and accepted practices	✓

PCM Reference **<xxxxxx>**
SCOT Study Committee Number/Name **<Number or name>**

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Compiled by	Approved by	Authorized by
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Substation Engineering	**Substation Engineering**	**Power Delivery**
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Date: 02/07/2014

PCM Reference: **240-53459042**

SCOT Study Committee Number/Name: **Substation**

Content

Figures

1. Introduction

Operating Diagrams are used as a guide by National Control and Substation Operating Personnel to operate High Voltage (HV) equipment within a Substation. To date, there has been no standardized approach to the structure and content of an Operating Diagram. Currently, each Transmission Grid has different opinions as to what should be included in the Operating Diagram. This document is intended to standardize the structure and content of Operating Diagrams across all the Grids.

***NB**: An Operating Diagram is mandatory as it is a requirement in the ORHVS [EPC 32-846].*

2. Supporting clauses

2.1 Scope

The purpose of this document is to standardize the content and layout of Operating Diagrams throughout the Transmission Network.

***NB**: This document will not cover the draughting aspects of creating an Operating Diagram. Substation Engineering Draughting Personnel shall apply the latest internal Standard for Draughting when creating an Operating Diagram.*

2.1.1 Purpose

The purpose of this document is to standardise the content and layout of Operating Diagrams throughout the Transmission Network.

2.1.2 Applicability

This standard shall be applicable to all Operating Diagrams for Eskom's Transmission Substations.

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

[1] EPC 32-846: Operating Regulations for High-Voltage Systems.

[2] TSP 41-1009: Standard for the Labelling of High Voltage Equipment for Eskom Transmission Substations.

2.2.2 Informative

None.

2.3 Definitions

2.3.1 General

None.

2.3.2 Disclosure classification

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

2.4 Abbreviations

Abbreviation	Description
HV	High Voltage
MV	Medium Voltage
LV	Low Voltage
VAr	Volt Ampere Reactive

2.5 Roles and responsibilities

Substation Designers and Draughting Personnel shall ensure that all new and revised Operating Diagrams conform to the requirements set out in this standard.

2.6 Process for monitoring

None.

2.7 Related/supporting documents

None.

3. Requirements for Operating Diagrams

3.1 Content of the Operating Diagram

***NB**: The Operating Diagram is not intended to duplicate the Station Electric Diagram in terms of content, but rather to identify only commissioned switching and switchable HV equipment within a Substation for ease of operation. It will therefore not contain all the information that appears on the Station Electric Diagram.*

1. The Operating Diagram shall contain the following information, where applicable:
    - o Auxilliary Transformers
    - o Busbars
    - o Circuit Breakers
    - o Earth Switches
    - o Isolators (manual & motorised)
    - o Power Transformers
    - o Series Capacitors
    - o Shunt Capacitors
    - o Shunt Reactors
    - o FACTS Devices (e.g. Static Var Compensators etc.)

***NB:** Only ratings of Capacitor Banks, Power Transformers, Auxilliary Transformers and Reactors shall be shown on the Operating Diagram. The vector group of Transformers should be shown as well.*

2. For the purpose of standardization and consistency, no deviation from the equipment listed in (1) above shall be allowed.

3. The relative position of all HV equipment shown on the Operating Diagram shall be as per the corresponding Station Electric Diagram.

4. The Operating Diagram shall indicate existing bays only. No spare or future bays shall be shown on the Operating Diagram.

5. An operating diagram will be created once for a project prior to commissioning. It is the duty of the control officer to ensure that the state of all the apparatus is shown correctly in the operating diagram as stated in the EPC 32-826.

3.2 Numbering of HV Equipment on the Operating Diagram

1. All HV equipment shown on the Operating Diagram shall be numbered as shown in Figure 1.
2. The numbering of HV equipment shall be sequential per bay as the equipment is shown on the Station Electric Diagram (refer to Figure 2).
3. Each bay shall be allocated a set of 10 numbers (e.g. 10 to 19). If the total number of equipment in a bay exceeds 10, then the numbering will continue with the first number allocated for that bay, suffixed with a sequential alphabetical identifier (e.g. 10A, 11A, etc.).
4. The allocation of numbers shall be independent of the voltage level.
5. For future bays being added to the substation, the numbering shall continue from the last allocated number in the Operating Diagram.
6. All bays shall indicate the phasing, feeder bay number and name/designation.

3.3 Labelling of an Operating Diagram

1. Labelling of all bays and equipment shown on an Operating Diagram shall be in accordance with TSP 41-1009. In the event of the labels on site not conforming to the aforementioned standard, then the Operating Diagram should reflect the labels as they are shown on site.
2. The respective Transmission Grid Manager should then be notified of the out-dated labels in the Substation. The Grid Manager should then initiate a project to update the labels in accordance with TSP 41-1009.
3. This would then trigger an update to the Operating Diagram.

3.4 Compiling a New Operating Diagram

1. The Substation Engineering Department shall be responsible for compiling all new Operating Diagrams for Eskom Transmission Substations.
2. For new Substations, the Operating Diagram for the entire Substation shall be compiled and made available prior to commissioning. The Operating Diagram will indicate all bays to be commissioned for the particular project.
3. For existing Substations where no Operating Diagram exists, the Operating Diagram shall be compiled on receipt of a request from the Grid.
4. The Operating Diagram for an existing Substation shall be based on the latest approved Station Electric Diagram together with the mark-ups obtained from site.

3.5 Updating an Operating Diagram

1. The Substation Engineering Department shall be responsible for updating all existing Operating Diagrams for Eskom Transmission Substations.
2. Where an Operating Diagram exists, there shall be a corresponding update/revision for each particular project taking place at a Substation.
3. Where changes to an existing Operating Diagram are initiated by an Eskom Transmission Grid, the responsible HV Plant Senior Site Supervisor shall submit a request to update the Operating Diagram to the Substation Engineering Department. This request will be accompanied with a marked-up drawing highlighting the required changes.
4. Drawings that are marked up shall be clearly legible, and should provide a description of the changes that have been made.

5. The marked-up drawing that is sent to the Substation Engineering Department for revision needs to bear the signature of the relevant HV Plant Manager. This is to ensure that the mark-ups have been checked.

6. The following colour codes shall be used for marking up Operating Diagrams:

   - Red – Corrections or Additions.
   - Yellow – Deletions.
   - Green – Correct.
   - Blue – Comments.

7. In the event that any of the preceding points are not followed, the request to revise the Operating Diagram will be rejected.

3.6 Approval of an Operating Diagram

1. The Substation Designer shall be responsible for obtaining the relevant signatures for the approval of the Operating Diagram.

2. All new and revised Operating Diagrams shall be approved by the following individuals:

   - Chief Engineer – Substation Engineering Department.
   - National Control Manager – System Operations and Planning.
   - HV Plant Manager – Relevant Transmission Grid.

3. The Substation Designer shall inform the Project Manager/Grid Representative once the Operating Diagram is approved. It is then the duty of the Project Manager/Grid Representative to arrange for collection and distribute the Operating Diagrams to the relevant stakeholders.

3.7 Distribution of an Approved Operating Diagram

1. The Project Manager shall be responsible for distributing approved Operating Diagrams.

2. For revisions initiated by the Grid, the Grid Representative shall be responsible for distributing the updated Operating Diagrams to the relevant stakeholders.

3. One printed copy (A1) of an approved Operating Diagram shall be distributed to each of the following individuals:

   - National Control Manager
   - HV Plant Manager
   - HV Plant Senior Site Supervisor
   - Regional Control Centre Manager

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Phineas Tlhatlhetji	Senior Manager Substation Engineering
Subhas Maharaj	Senior Manager Integration
Eric Shunmagum	Senior Manager Portfolio Management
Harish Mohabir	Senior Manager Portfolio Management
Bob Naraghi	Executive Manager Project Management – PDP Central Grid

Name and surname	Designation
Clint Fisher	Executive Manager Project Management – PDP Northern Grid
Francois Bothma	Executive Manager Project Management – PDP 765 kV Projects
Johan Bornman	Executive Manager Project Management – PDP Cape Grid
Jacob Machinjike	General Manager – Transmission Grid
Al'louise van Deventer	National Control Manager
Thomas Tshikalanga	Grid Manager – Apollo
Martha Lamola	Grid Manager – Central
Mphiliseni Mthimkulu	Grid Manager – East
Lenah Mothata	Grid Manager – Free State
Bheki Ntshangase	Grid Manager – North East
Sibu Mvana	Grid Manager – North West
Victor Shikoana	Grid Manager – Northern
Siyamtanda Maya	Grid Manager – Northern Cape
Danie du Plessis	Grid Manager – Southern
Marius van Rensburg	Grid Manager – Western
Moses Titus	HV Plant Manager – Apollo
Bongani Phewa &	HV Plant Manager – Central
Rudzani Mathomu	HV Plant Manager – Central
Sipho Lushozi	HV Plant Manager – East
Busani Ngacuma	HV Plant Manager – Free State
Kooben Munsamy	HV Plant Manager – North East
Modumaele Nthongoa	HV Plant Manager – North West
Teboho Ramorapeli	HV Plant Manager – Northern
Naresh Ramparshad	HV Plant Manager – Northern Cape
Vuyile Kula	HV Plant Manager – Southern
Lynn Appolis- Laurent	HV Plant Manager – Western

5. Revisions

Date	Rev.	Compiler	Remarks
July 2014	1	MS Nabbie	First issue Comments from reviewers have been incorporated

6. Development team

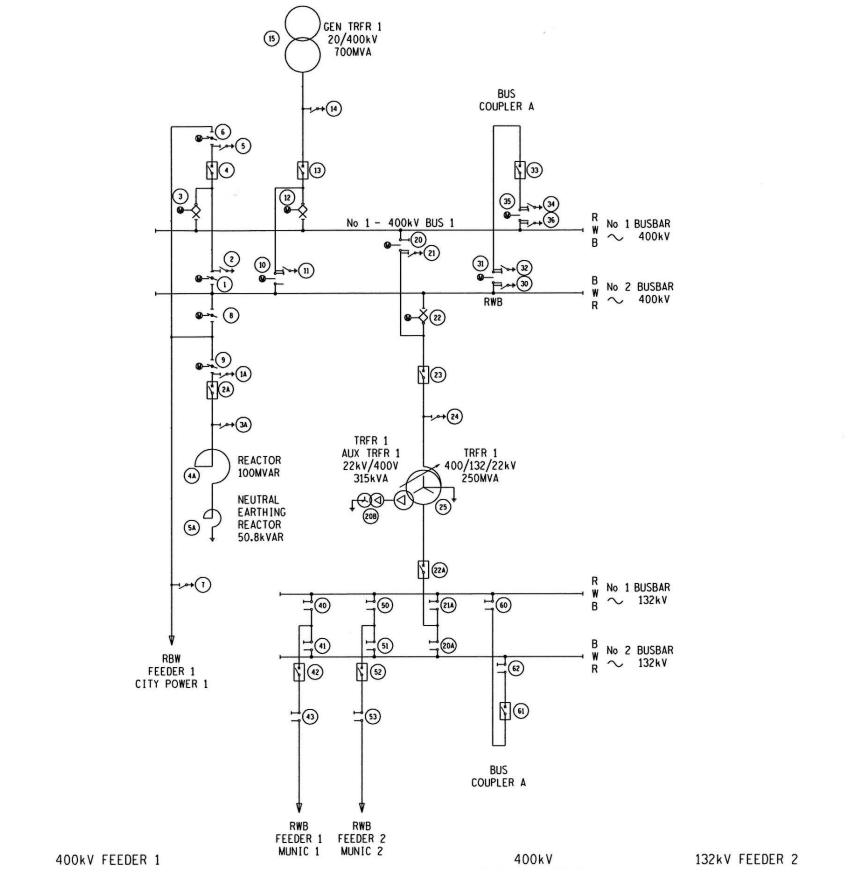
The following people were involved in the development of this document:

- Barry Clayton
- Ian Hill
- Jayandra Haridas
- Mohammad Nabbie
- Phineas Tlhatlhetji

7. Acknowledgements

I would like to express my deep gratitude to all the Substation Engineering personnel, for their patient guidance, enthusiastic encouragement and useful critiques of this standard. Finally, I wish to extend a special thanks to all those who provided valuable input into the standard over the years.

Annex A – Drawing Examples



400kV FEEDER 1 CITY POWER 1

1	CITY POWER 1 400kV BUSBAR 2 ISOLATOR
2	CITY POWER 1 400kV BKR EARTH SWITCH BUSBAR SIDE
3	CITY POWER 1 400kV BUSBAR 1 ISOLATOR
4	CITY POWER 1 400kV BREAKER
5	CITY POWER 1 400kV BKR EARTH SWITCH LINE SIDE
6	CITY POWER 1 400kV LINE ISOLATOR
7	CITY POWER 1 400kV LINE EARTH SWITCH
8	CITY POWER 1 400kV BYPASS ISOLATOR
9	CITY POWER 1 400kV REACTOR ISOLATOR
1A	CITY POWER 1 400kV REACTOR BKR E/SW LINE SIDE
2A	CITY POWER 1 400kV REACTOR BREAKER
3A	CITY POWER 1 400kV REACTOR BKR E/SW REACTOR SIDE
4A	CITY POWER 1 400kV REACTOR
5A	CITY POWER 1 NEUTRAL REACTOR

GEN TRFR 1

10	GENERATOR 1 NO.2 400kV BUS LINKS
11	GENERATOR 1 400kV BKR EARTH LINKS BUS SIDE
12	GENERATOR 1 NO.1 400kV BUS LINKS
13	GENERATOR 1 400kV BKR
14	GENERATOR 1 400kV BKR EARTH LINKS TRFR SIDE
15	GENERATOR TRFR 1

400kV TRFR 1

20	TRFR 1 NO.1 400kV BUS LINKS
21	TRFR 1 400kV BKR EARTH LINKS BUS SIDE
22	TRFR 1 NO.2 400kV BUS LINKS
23	TRFR 1 400kV BKR
24	TRFR 1 400kV BKR EARTH LINKS TRFR SIDE
25	TRFR 1 400/132/22kV

400kV BUS COUPLER A

30	NO.2 400kV BUS 1 EARTH LINKS
31	400kV BUS CPLR A NO.2 400kV BUS LINKS
32	400kV BUS CPLR A EARTH LINKS NO.2 BUS SIDE
33	400kV BUS COUPLER A BREAKER
34	400kV BUS CPLR A EARTH LINKS NO.1 BUS SIDE
35	400kV BUS CPLR A NO.1 400kV BUS LINKS
36	NO.1 400kV BUS 1 EARTH LINKS

132kV FEEDER 1 MUNIC 1

40	MUNIC 1 132kV BUSBAR 1 ISOLATOR
41	MUNIC 1 132kV BUSBAR 2 ISOLATOR
42	MUNIC 1 132kV BREAKER
43	MUNIC 1 132kV LINE ISOLATOR

132kV FEEDER 2 MUNIC 2

50	MUNIC 2 132kV BUSBAR 1 ISOLATOR
51	MUNIC 2 132kV BUSBAR 2 ISOLATOR
52	MUNIC 2 132kV BREAKER
53	MUNIC 2 132kV LINE ISOLATOR

132kV TRFR 1

20A	TRFR 1 132kV BKR
21A	TRFR 1 NO.1 132kV BUS LINKS
22A	TRFR 1 NO.2 132kV BUS LINKS

132kV BUS COUPLER A

60	132kV BUS COUPLER A BUSBAR 1 ISOLATOR
61	132kV BUS COUPLER A BREAKER
62	132kV BUS COUPLER A BUSBAR 2 ISOLATOR

TRFR 1 AUX TRFR 1

20B	TRFR 1 AUX TRFR 1 22kV/400V

Figure 1 - Example of an Operating Diagram

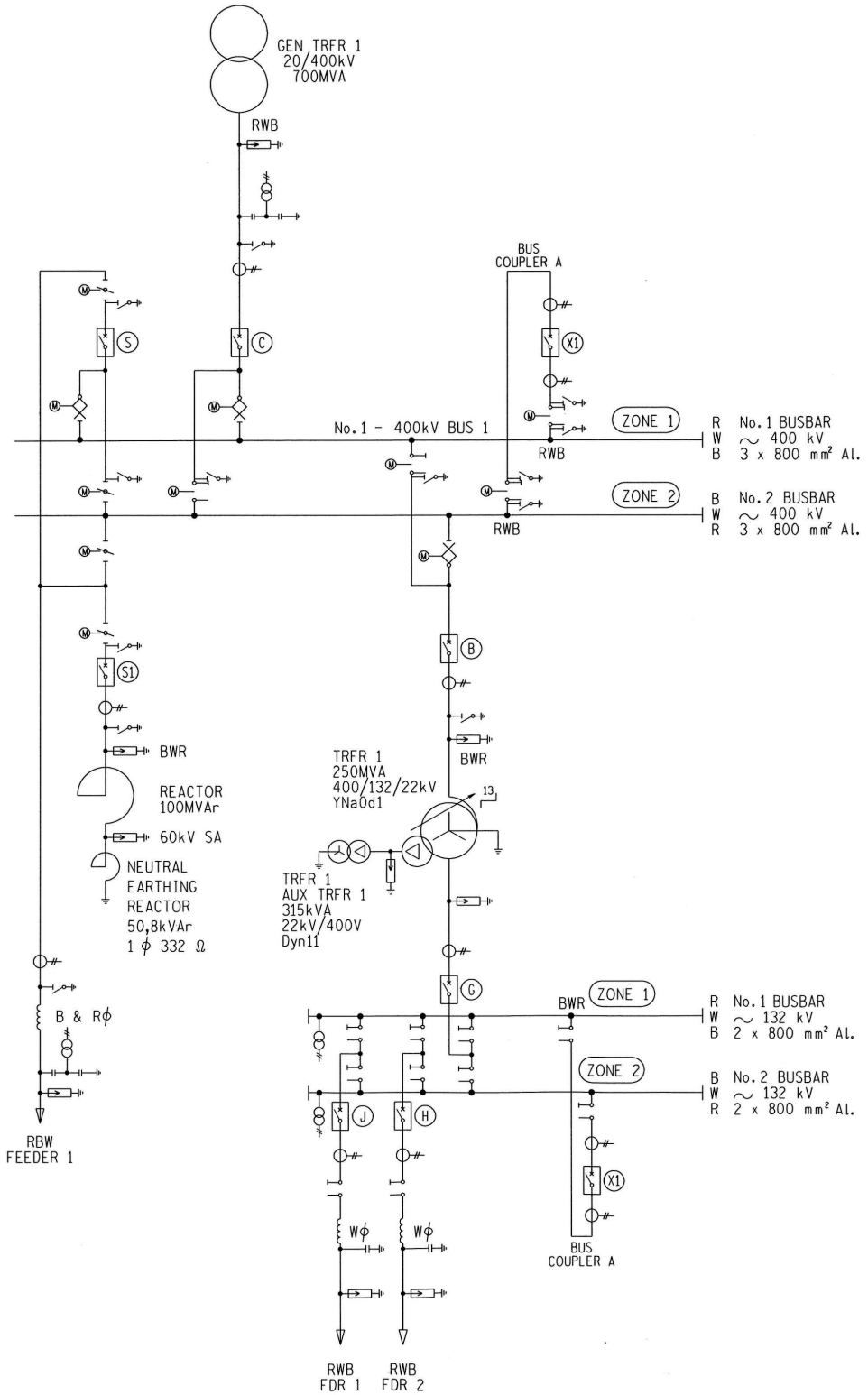


Figure 2 - Example of a Corresponding Station Electric Diagram