Eskom	Standard	Technology

Title: **SPECIFICATION FOR SURGE CAPACITORS**

Unique Identifier:	**240-131747620**
Alternative Reference Number:	**n/a**
Area of Applicability:	**Engineering**
Documentation Type:	**Standard**
Revision:	**1**
Total Pages:	**11**
Next Review Date:	**February 2023**
Disclosure Classification:	**Controlled Disclosure**

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Date: 07/02/2018	Date: 15/02/2018	Date: 19/02/2018

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Date: 19/02/2018

PCM Reference: **240-44509543**

SCOT Study Committee Number/Name: **High Voltage Plant Engineering**

Content

Figures

1. Introduction

High fault current levels at substations can be reduced with the use of fault current limiting reactors (CLRs). The installation of CLRs may inflict severe recovery voltage stresses on the downstream circuit breakers. In other words, during fault current interruption through the CLRs, Transient Recovery Voltage (TRV) capabilities of the interrupting circuit breakers installed at these stations can be exceeded.

Surge capacitors are then required to reduce TRVs across the fault interrupting circuit breakers. These surge capacitors are to be installed immediately downstream (connected phase-to-ground) of the fault current limiting reactors to lower the natural frequency of the reactor when interrupting fault current. However, if reactors are operated by multiple breakers, surge capacitors are to be connected in parallel across the reactors.

2. Supporting clauses

2.1 Scope

This specification outlines functional requirements for design, manufacture, testing, supply and installation of the surge capacitors.

2.1.1 Purpose

The purpose of this document is to outline Eskom's requirements for the surge capacitors.

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

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] IEC 60358-1, Coupling capacitors and capacitor dividers

[2] IEC 60060-1, High Voltage test techniques – Part 1: General definitions and test requirements.

[3] IEC 60518, Dimensional standardization of terminals for high-voltage switchgear and controlgear

[4] IEC 60815: Guide for the selection of insulators in respect to polluted conditions

[5] IEC 60168, Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000 V

[6] IEC 60273, Characteristic of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V

[7] IEC 60551, Audible sound

[8] IEC 60721-2-6, Classification of environmental conditions. Part 2: Environmental conditions appearing in nature. Earthquake vibration and shock

[9] IEC 60943, Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals

[10] SANS 10103, The measurement and rating of environmental noise with respect to annoyance and to speech communication

[11] 240-56030435, outdoor ceramic station post insulators for systems with nominal voltages up to 765kV specification

[12] 240-79707491, technical evaluation standard for outdoor ceramic station post insulators for systems with nominal voltages up to 765kV

[13] 240-42587021, Specification for air core reactors

[14] ISO 9001, Quality Management Systems

2.2.2 Informative

[15] 32-9, Definition of Eskom documents.

[16] 32-644, Eskom documentation management standard

[17] 474-65, Operating manual of the Steering Committee of Technologies (SCOT)

[18] QM58, Supplier contract quality requirements specification

[19] TPC41-246, Management of Manufacturers/Supplier Equipment Drawings

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
CLR	Current Limiting Reactor
PCB	Polychlorinated Biphenyls
RRRV	Rate of Rise of Recovery Voltage
TRV	Transient Recovery Voltage
TSS	Transient Stability Scheme

2.5 Roles and responsibilities

The Power Electronics Care Group Coordinator must ensure that this document is updated, renewed and current at all times.

2.6 Process for monitoring

Eskom will provide and update this document as required.

2.7 Related/supporting documents

None

3. General requirements

Surge capacitors are required immediately downstream (connected phase-to-ground) of the fault current limiting reactors to lower the natural frequency of the reactor when interrupting fault current, in order to meet the rate of rise of recovery voltage withstand levels of the installed circuit breakers. The surge capacitors are to be installed phase to ground between the circuit breaker and the current limiting reactor.

A complete solution is to be provided, as illustrated in Figure 1. This requirement incorporates all system, environmental and testing requirements outlined in [13].

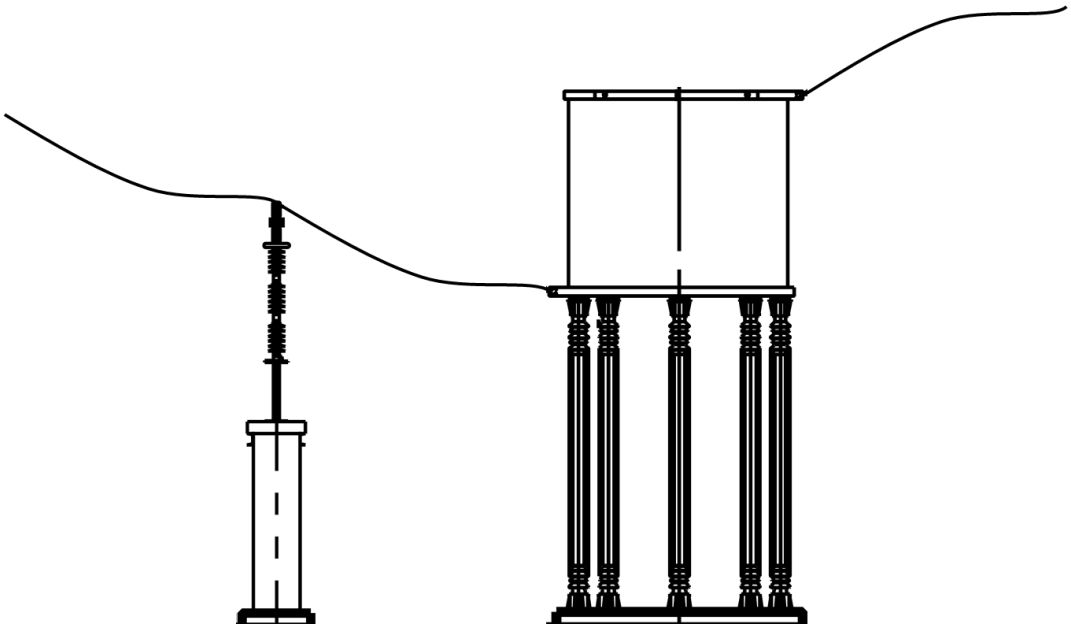

Figure 1: Reactor and surge capacitor combination when the reactor is operated by a single breaker, drawing for information purposes only

However, in a case where the current limiting reactors are operated by multiple breakers, surge capacitors are to be connected in parallel across the reactors, see Figure 2. This requirement incorporates all system, environmental and testing requirements outlined in [13].

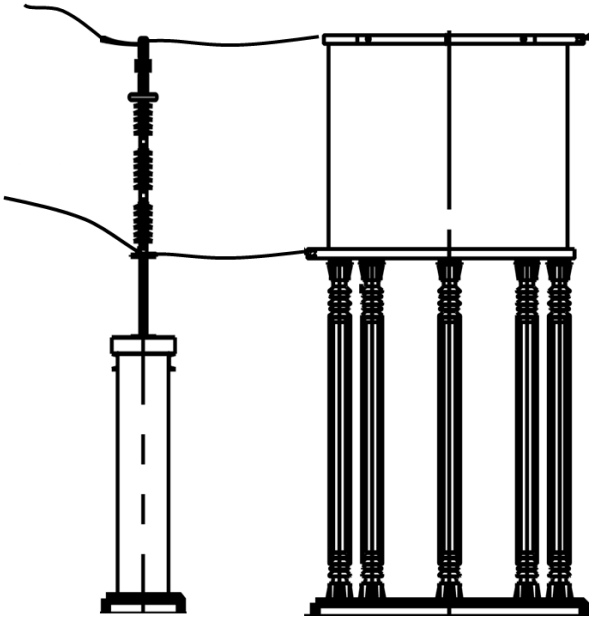

Figure 2 Reactor and surge capacitor combination when the reactor is operated by multiple breakers, drawing for information purposes only

The surge capacitors shall have a steady state and transient voltage ratings that match those of the reactors specified in [13].

Any solution offered shall comply with environmental requirements, for instance, the surge capacitors shall be free of PCB.

The external insulation of the surge capacitor should be conventional silicon rubber with a creepage distance as specified in Annex A and shed profile meeting the minimum requirements of IEC 60815 for pollution class e (very heavy).

The capacitors shall comply with the rated capacitance values specified in Annex A.

A tolerance of +10%, -0% on the capacitor ratings will be accepted.

All outline drawings and type test reports to be supplied.

3.1 Test

Type tests shall be performed in accordance with IEC 60358-1 on one unit of each type and rating. Routine tests shall be performed as on each unit [1].

3.1.1 Routine tests

The following minimum routine tests shall be performed on each unit. For details, reference should be made to the relevant sub-clauses in accordance with IEC 60358-1:

a) Tightness of equipment;

b) Capacitance and tan δ measurement at power-frequency;

c) Power-frequency withstand test;

d) Measurement of partial discharges;

e) Resistance measurement if resistance(s) is (are) mounted inside the equipment;

f) Power-frequency withstand test on low voltage terminal if applicable;

3.1.2 Type tests

The following minimum type tests shall be performed on one unit of each type and rating. The electrical routine tests have to be performed before and after the type test at 100% test voltages. For details, reference should be made to the relevant sub-clauses:

a) Chopped impulse test for a.c. equipment;

b) Power frequency withstand voltage wet test for outdoor type equipment for a.c. voltage for the voltage range Um < 300 kV;

c) Switching impulse test under wet conditions for a.c. voltage range ≥ 300 kV;

d) EMC radio interference voltage (RIV) tests, if applicable;

4. Authorization

This document has been seen and accepted by:

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5. Revisions

Date	Rev	Compiler	Remarks
Feb 2018	1	MM Moabelo	New document

6. Development team

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

- Mashilo Moabelo
- Thavenesen Govender

7. Acknowledgements

- Keri Pickster

Annex A – Schedules A and B

SCHEDULES A AND B FOR XXX kV XXX nF SURGE CAPACITORS FOR XXXX SUBSTATION REVISION 1 DATED XXXXX.

SCHEDULE A: PARTICULARS OF ESKOM'S REQUIREMENTS AND

SCHEDULE B: SUPPLIER'S GUARANTEES OF TECHNICAL PARTICULARS OF EQUIPMENT OFFERED.

THIS SCHEDULE SHALL BE USED IN CONJUNCTION WITH ESKOM SPECIFICATION FOR SURGE CAPACITORS FOR CURRENT LIMITING REACTORS FOR XXXXX SUBSTION PROJECT REF 240-131747620. IN CASE OF CONFLICT, THE TENDERER SHALL REQUEST CLARITY IN A FORM OF AN EMAIL OR LETTER TO ESKOM, AND SHALL COMPLY WITH THE LATEST REVISION OF ALL RELEVANT IEC STANDARDS.

WHERE XXXXX IS INDICATED, THE SUPPLIER MUST COMPLETE IN SCHEDULE B.

Technical specifications				
Item	**Description**	**Units**	**Schedule A**	**Schedule B**
1	**Delivery and off-loading**			
1.1	Delivery to:			
1.1.1	Capacitors	Address		
1.1.2	Spares	Address		
1.2	Delivery effected not before	Date	TBA	
1.3	Off-loaded from transport vehicle by supplier	Yes/No	Yes	
1.4	Transferred to intended operation position	Yes/No	Yes	
1.5	Installation	Indoor/ Outdoor	Outdoor	
2	**Quantity**			
2.1	Capacitors			
2.2	Spares			
3	**Erection**			
3.1	Erected ready for service	Yes/No	Yes	
3.2	Erection complete not later than	Date	TBA	
3.3	Erected for storage	Yes/No	No	
4	**Environmental information**			
4.1	Altitude above sea level	m	1800	
4.2	Ambient temperature			
4.2.1	• Maximum	° C	45	
4.2.2	• Minimum	° C	-10	
4.2.3	• Daily average	° C	35	
4.2.4	• Yearly average	° C	30	
4.2.5	• Maximum average daily temperature variation	° C	20	
4.3	Relative humidity			

4.3.1	• Minimum	%	50	
4.3.2	• Maximum	%	96	
4.3.3	• Average	%	68-83	
4.4	Solar radiation (maximum)	W/m^2	2.6×10^3	
4.5	Wind loading	Pascals/ ms^{-1}	1200/40	
4.6	Pollution			
4.6.1	• Type		Industrial	
4.6.2	• Classification (IEC 60815)	class		
4.6.3	• Climatic conditions		Rain/dry/ hail/high UV radiation	
4.7	Seismic level	g	0.3	
5	**System Details**			
5.1	Maximum system voltage (U_m)	kV		
5.2	Temporary overvoltages			
5.2.1	• For 10 min	kV	1.05 U_m	
5.2.2	• For 1 min	kV	1.25 U_m	
5.2.3	• For 5 s	kV	1.5 U_m	
5.2.4	• For 1 s	kV	1.75 U_m	
5.3	Nominal system frequency	Hz	50	
5.4	Number of phases		3	
5.5	Three-phase system fault levels at the substation	kA		
5.6	Single-phase system fault levels at the substation	kA		
5.7	Interval between fault conditions	hr	N/A	
5.8	Frequency of short circuit application / year		N/A	
5.9	Number of switching operations / day		N/A	
6	**Type**			
6.1	Application		Lower natural resonant frequency of reactor	
6.2	Phases	1Ø/3Ø	1Ø	
6.3	Model		xxxxxx	
6.4	Connection to reactor	Attache d(conne		

		cted across reactor)/ mounte d separat ely ((conne cted phase-to-ground)		
7	**Capacitor Rating**			
7.1	Rated frequency	Hz	50	
7.2	Rated voltage	kV		
7.3	Rated continuous / power frequency current (I_N)	A	xxxxxx	
7.4	Rated capacitance	nF		
7.5	Natural frequency of reactor/capacitor combination	Hz	xxxxxx	
7.6	Losses	W	xxxxxx	
7.7	Dielectric fluid		xxxxxx	
7.8	Insulating foil		xxxxxx	
8	**Capacitor details**			
8.1	Line terminals		xxxxxx	
8.2	Mounting		xxxxxx	
8.3	Minimum clearance between base of insulators and ground level (if mounted separately)	mm	2500	
8.4	Mass of one capacitor	kg	xxxxxx	
8.5	Capacitor dimensions			
8.5.1	• Diameter	mm	xxxxxx	
8.5.2	• Height	mm	xxxxxx	
8.6	Dimensions of unit including pedestals			
8.6.1	• Diameter	mm	xxxxxx	
8.6.2	• Height	mm	xxxxxx	
8.7	Life expectancy	yrs	40	
8.8	Manufacturer		xxxxxx	
8.9	Country of manufacture		xxxxxx	
9	**Capacitor external insulation**			
9.1	Insulation level (BIL)	kV peak		
9.2	60s power frequency withstand voltage	kV rms		
9.3	Minimum Electrical Clearance (Un = XXXkV)	mm		

	(Phase-To-Earth)			
9.4	External Creepage (minimum)	mm/kV	31	
9.5	Material	Porc/Si	Si	
9.6	Shed profile		xxxxxx	
10	**Pedestal insulator (if required)**			
10.1	Material	Porc/Si	Porc	
10.2	Type		xxxxxx	
10.3	Minimum creepage distance	mm		
10.4	60s power frequency withstand voltage	kV rms		
10.5	Insulation level (BIL)	kV peak		
10.6	Steady mechanical load factor		xxxxxx	
10.7	Compliance to 240-56030435 and 240-79707491 [11],[12]	Yes/No	Yes	
11.	**Deviations**			

Clause	Description of deviation	Proposed alternative	Accept/Reject