

Title: **TRANSMISSION SUBSTATION
INSULATION COVERS TO
PREVENT WILDLIFE CONTACT**

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Executive Summary

Transmission Substation insulation covers are products that are used to cover equipment (primarily clamps, bushings and conductors) in a substation yard to prevent phase bridging by wildlife that could result in unplanned outages and/or injury/death for the wildlife concerned. It is to be used at sites where there is an identified risk of wildlife interaction or where there is a history of wildlife interactions resulting in disruptions to the power supply. This document describes the product that is to be supplied and installed at Eskom Transmission sites with regards to dimensions, colour etc. It furthermore outlines the tests that the product should be compliant with, to be considered acceptable for use within Eskom Transmission.

1. Introduction

A number of incidents have been observed where wildlife have come into contact with live substation equipment and been electrocuted. As a result this necessitated the covering of the substation equipment at certain sites that posed an increased risk of such wildlife interaction. This is done especially on the MV equipment where the clearance between phases is small enough for wildlife to bridge and cause electrical faults.

2. Supporting clauses

2.1 Scope

The document addresses equipment, clamp and conductor covers at substations where there is perceived to be a high risk of animal contact on the electrical network.

2.1.1 Purpose

This standard specifies the Eskom Transmission requirement for conductor and equipment clamp insulation covers installed at substations. This is to protect animals from electrocution when climbing/ perching on live equipment and bridging the air insulation gap.

2.1.2 Applicability

This document shall apply throughout Eskom Transmission Holdings Limited Divisions, applicable to 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] ISO 9001, Quality Management Systems.
- [2] IEC 62631-3-1:2016, Dielectric and resistive properties of solid insulating materials
- [3] IEEE Std 1656 – 2010, IEEE Guide for Testing the Electrical, Mechanical, and Durability Performance of Wildlife Protective Devices on Overhead Power Distribution Systems Rated up to 38 kV
- [4] SANS 1091:2012 (National colour standard) Table B.1 — List of standard colours.
- [5] 240-132406362 - Technical evaluation standard for substation Insulation Covers to prevent Wildlife Contact

2.2.2 Informative

- [6] D-DT-6055 COVER: CLAMP
- [7] D-DT-6370 COVER: CLAMP
- [8] 0.54-412 Sheets 19 – 22 CLAMP COVERS

2.3 Definitions

2.3.1 General

Definition	Description
Accelerated aging test	The covers are subjected to stress which is meant to mimic the aging process. This can include mechanical stress, temperature extremes, humidity changes, physical trauma, etc.
Creepage distance	Shortest distance along the insulator surface between the metal parts at each end of the insulator
Dielectric strength	Maximum voltage required to produce a dielectric breakdown through the material
Ultraviolet aging	A test meant to simulate the effects of extended exposure to natural UV radiation
Volume resistivity	Electrical resistance through a cube of insulating material

2.3.2 Disclosure classification

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

2.4 Abbreviations

Abbreviation	Description
ACC	Acrylic cover
FAS	Fall Arrest System
ID	Internal Diameter
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
ISO	International Organisation for Standardisation
kPa	kilo Pascal
LG	Length
MV	Medium Voltage
MVLC	Medium Voltage Line Cover
OEM	Original Equipment Manufacturer
OU	Operating Unit
SANS	South African National Standards
UV	Ultraviolet

2.5 Roles and responsibilities

This standard is to be complied with by all manufacturers and suppliers of insulation covers to be used in Eskom Transmission. Applicable Eskom Transmission staff to ensure compliance on all equipment installed at Eskom Transmission sites.

2.6 Process for monitoring

Compliance will be confirmed during the supporting documents provided during tender submissions.

2.7 Related/supporting documents

Not applicable.

3. Insulating Substations

Sites have been identified in Eskom Transmission where wildlife has made contact with live substation equipment and this could result in a loss of supply to customers or damage to equipment. The impact is both on the affected wildlife and on the Eskom Transmission performance indices.

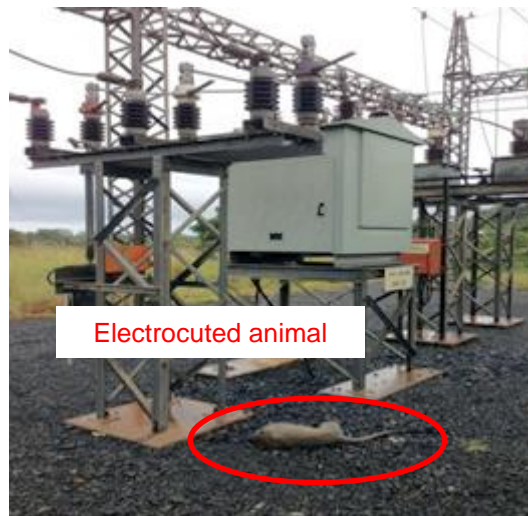


Figure 1: Shows animal electrocuted after climbing onto the breaker



Figure 2: Bushing damaged following monkey making contact with live ends

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3.1 Substation conductor and equipment clamp insulation covers

3.1.1 Service conditions

The wildlife insulation covers shall be suitable for use in outdoor substations under the following service conditions:

- Altitude (max) 1800 m
- Ambient temperature:
 - minimum -10°C
 - maximum 45°C
 - daily average 30°C
- Maximum solar radiation 2300 Watts/m²
- Pollution level Very heavy in accordance with IEC 60071-2
- Seismic requirement 0.3g

3.1.2 Types of Insulation Covers

Table 1: Insulation covers

Name	SAP Number	Material	Dimensions (ID x LG)	Drawing
ACC1	0402647	UV Stable Plastic or Composite	ID 125 X LG 220 mm	0.54/1872 & 0.54/1871
ACC2	0011495	UV Stable Plastic or Composite	ID 135 X LG 257 mm	0.54/1873 & 0.54/1871
ACC3	0402649	UV Stable Plastic or Composite	ID 110 X LG 350 mm	0.54/1874 & 0.54/1871
ACC4	0402651	UV Stable Plastic or Composite	ID 160 X LG 480 mm	0.54/1875 & 0.54/1871
ACC5	0011498	UV Stable Plastic or Composite	ID 135 X LG 400 mm	0.54/1876 & 0.54/1871
ACC6	0011499	UV Stable Plastic or Composite	ID 220 X LG 485 mm	0.54/1877 & 0.54/1871
ACC7	0402665	UV Stable Plastic or Composite	ID 220 X LG 320 mm	0.54/2784 & 0.54/1871
ACC8	0011551	UV Stable Plastic or Composite	ID 240 X LG 815 mm	0.54/2969 & 0.54/1871
ACC9	0011008	UV Stable Plastic or Composite	ID 280 X LG 430 mm	0.54/3737 & 0.54/1871
Large Insulation Cover	0698394	Tracking Resistant Polymer - Maroon	330mm x 290mm	D-DT-6370
Medium Insulation Cover	0698395	Tracking Resistant Polymer - Maroon	220mm x 270mm	D-DT-6370
Small Insulation Cover	0698396	Tracking Resistant Polymer - Maroon	140mm x 250mm	D-DT-6370

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Name	SAP Number	Material	Dimensions (ID x LG)	Drawing
Bull Line Cover	0698397	Tracking Resistant Polymer - Maroon	38.3mm x 50m	D-DT-6370
Centipede Line Cover	0698398	Tracking Resistant Polymer - Maroon	26.5mm x 50m	D-DT-6370
Hornet Line Cover	0698399	Tracking Resistant Polymer - Maroon	16.3mm x 50m	D-DT-6370

3.1.3 Material and colour

The covers shall be manufactured from clear UV stabilised plastic or tracking-resistant polymer and the colour shall be maroon (Colour No. A01 as per SANS 1091:2012 (National colour standard) Table B.1 — List of standard colours).

3.1.4 Requirements for Substation Installation

- It is recommended that the supplier or approved contractors undertake the installation.
- If the installation is to be done by Eskom Transmission, staff shall be trained and certified by the OEM to undertake the task.
- The installer needs to have a valid FAS training certificate.
- The equipment shall be isolated during installation
- The correct sizes of the covers shall be selected based on the size of the bushings and clamps to be covered
- The actual installation requires clipping on the cover on top of the bushing while still maintaining the bushing creepage distance.



Figure 3: Substation with wildlife protective covers installed

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3.1.5 Tests

Manufacturers/ Suppliers are required to provide evidence confirming that the products supplied are in conformance with the tests listed below. The equivalence of alternate tests will be determined by the relevant subject matter expert at Eskom Transmission or the technical evaluation team. Tests from the same manufacturer of similar design, similar application and same material may be acceptable and transferrable at the discretion of the relevant subject matter expert or the technical evaluation team.

- a) Volume resistivity test as per IEC 62631-3-1:2016, or equivalent

The Volume resistivity of the material must be greater than $1 \times 10^{14} \Omega \text{ cm}$.

- b) Wet withstand test as per IEEE Std 1656- 2010, or equivalent

The test is performed on three samples of the design under consideration. The test duration should be 1 minute, and the voltage applied should be 26 kV (Phase to Ground) for both the fixed electrode or moving electrode method. Either method may be employed and the pass criteria is the total absence of a flashover during the testing of any of the samples in the stipulated time.

- c) Wet power frequency flashover test as per IEEE Std 1656- 2010, or equivalent

The test is performed on three samples of the design under consideration. The device passes this test if the average flashover value on all three samples is not less than 90 % of the value obtained on the test fixture alone.

- d) Lightning impulse withstand as per IEEE Std 1656- 2010, or equivalent

The test is performed on three samples of the design under consideration. This test should be performed with a peak voltage equal to 200 kV and should be tested with both positive and negative polarity impulses. The product passes this test if all three samples are tested and show no evidence of puncture.

- e) Cold temperature test as per IEEE Std 1656- 2010, or equivalent

The test is performed on three samples of the design under consideration. This test should be performed at a temperature of $-25 \text{ }^\circ\text{C}$ for a minimum of 4 hours. Thereafter, remove and reinstall the sample a minimum of 5 times consecutively within 1 minute. The product fails this test if there is the presence of a crack or split on any of the samples viewed by the naked eye under normal lighting conditions.

- f) Ultraviolet aging as per IEEE Std 1656- 2010, or equivalent

The test is performed on three samples of the design under consideration. The samples are aged for a period of 1000 Hours using UV-A lamps having a peak emission at 340 nm. The sample is subject to a repeating cycle of 8 hours of UV exposure at $60 \text{ }^\circ\text{C}$ followed by 4 hours of condensation exposure at $50 \text{ }^\circ\text{C}$. At the conclusion of the test, the sample is visually inspected with the naked eye under normal lighting conditions. Evidence of cracking, erosion and discoloration are to be documented. The test report must contain information on the UV lamp used and pictures of the samples, before and after the test.

- g) Salt fog aging as per IEEE Std 1656- 2010, or equivalent

The test is performed on three samples of the design under consideration. The following are the test parameters

- Continuous application of 26 kV AC Voltage with a tolerance of 3%
- Total ageing period - 1000 Hours
- Salt spray conductivity – $370 \Omega \text{ cm}$ to $400 \Omega \text{ cm}$
- Application of salt fog for 4 hours, followed by a 4 hour period with no salt fog.

In the event of a flashover during the ageing process, the sample will be deemed to have failed if 3 flashovers occur during the stipulated time. If, after a flashover, the voltage cannot be restored, the sample is deemed to have failed. Premature removal from the ageing process constitutes a failure.

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- h) Retention testing as per IEEE Std 1656- 2010, or equivalent
- The test is performed on three samples of the design under consideration. The aim of this test is to verify the ability of the device to stay in position when exposed to external environmental factors. The sample should remain properly installed when subjected to a minimum wind speed of 97 km/h. The tests report must include pictures of the positioning before and after the test.
- Alternative methods e.g. high pressure water exposure may also be considered. The product is considered to have passed the test if all three samples remain properly installed at the conclusion of the test.
- i) Flammability testing as per IEEE Std 1656- 2010, or equivalent
- It is recommended that the high current test (power arc) be conducted on a minimum of three samples to verify that the material used is not flammable. Initiate an arc on the surface of the sample for a minimum of ten cycles at 10 kA using a nominal phase to ground voltage of 26 kV. The sample is considered to have passed the test if all the samples self-extinguish without signs of melting.
- Alternatively, one could submit either the 50 W Vertical Flame Test or the 50 W Horizontal Flame tests as per IEC60695-11-10:1999. A material will be considered to have passed if the sample is rated (V-0 or V-1) or (HB or HB40) respectively.
- j) Radio-influence voltage test as per IEEE Std 1656- 2010, or equivalent
- The test is performed on three samples of the design under consideration. Compare the Radio Influence Voltage (RIV) obtained before and after the installation of the wildlife cover. The product passes if the average RIV value of all three samples is not greater than 100 μ V.

Should alternative tests be submitted/ not required, the supplier must provide Eskom Transmission with a detailed explanation from the manufacturer detailing the reasons why equivalent tests are valid or not required (if applicable). Regardless, all deviations from this standard must be stated in the supplied deviation schedule.

3.1.6 Marking, labelling and packaging

The manufacturer shall mark each substation insulation cover with the following information:

- Manufacturer name and/or logo
- Product code
- Batch identification

All identification markings shall be indelible and marked in such a manner that all finished markings are distinct and legible. The markings shall not be made illegible by normal exposure to the outdoor environment.

3.1.7 Returnables to be submitted as part of a tender

All returnables shall be in English. The following shall be submitted as returnables during a tender enquiry:

- Completed Technical Schedule B, refer to Annex A.
- Deviations and Declarations report, refer to Annex B.
- Type Test Schedule, refer to Annex C.
- Test certificates and reports in accordance with the requirements stipulated in Section 3.1.5 verifying the listed requirements.
- Storage/ maintenance and installation manual (in English)

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
Subhas Maharaj	Senior Manager – Transmission Division, Substation Engineering
Christy Thomas	Senior Engineer – Transmission Division, Substation Engineering
Derrick Delly	Chief Engineer – Transmission Division, Substation Engineering
Percy Seboco	Chief Engineer – Transmission Division, Substation Engineering
Enderani Naicker	Chief Engineer – Transmission Division, Substation Engineering
Shivern Singh	Chief Engineer – Transmission Division, Substation Engineering
Mark Peffer	Chief Engineer – Transmission Division, Substation Engineering
Nkululeko Mazibuko	Chief Engineer – Transmission Division, Substation Engineering
Rukesh Ramnarain	Chief Engineer – Transmission Division, Substation Engineering
Sipho Zulu	Chief Engineer – Transmission Division, Substation Engineering

5. Revisions

Date	Rev	Compiler	Remarks
Oct 2023	1	Rukesh Ramnarain	First Issue

6. Development team

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

- Rukesh Ramnarain
- Christy Thomas

7. Acknowledgements

Members of the Substation Products Care Group for the development and review of this document and the corresponding Technical Evaluation Criteria Document

Annex A – Technical Schedules A and B

INSULATION COVERS

NB. UNIQUE SCHEDULES ARE TO BE COMPLETED PER SAP NUMBER LISTED BELOW

NB. SUPPLIERS TO CONFIRM ADHERENCE TO THE LATEST PUBLISHED REVISION OF ALL APPLICABLE ESKOM TRANSMISSION DRAWINGS

SAP Number	Technical Description	SELECT ITEM
0698394	Large Insulation Cover	
0698395	Medium Insulation Cover	
0698396	Small Insulation Cover	
0698397	Bull Line Cover	
0698398	Centipede Line Cover	
0698399	Hornet Line Cover	
0402647	ACC1 - UV Stable Plastic or Composite	
0011495	ACC2 - UV Stable Plastic or Composite	
0402649	ACC3 - UV Stable Plastic or Composite	
0402651	ACC4 - UV Stable Plastic or Composite	
0011498	ACC5 - UV Stable Plastic or Composite	
0011499	ACC6 - UV Stable Plastic or Composite	
0402665	ACC7 - UV Stable Plastic or Composite	
0011551	ACC8 - UV Stable Plastic or Composite	
0011008	ACC9 - UV Stable Plastic or Composite	

1	2		3	4
Item	Description		Schedule A	Schedule B
1	Product Information			
1.1	Purchasing details			
1.1.1	Manufacturer	Manufacturer name	xxxxxxxxxx	
1.1.2	Manufacturer's Product Code	Specify Code	xxxxxxxxxx	
1.1.3	Manufacturer's Drawing number & Revision number	Specify No and Rev	xxxxxxxxxx	
1.1.4	Manufacturer's physical unique identifier indelibly marked.	240-170001063, clause 3.1.5	YES	

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1	2		3	4
Item	Description		Schedule A	Schedule B
1.1.5	Is the product suitable for use in the service conditions as stipulated in Clause 3.1.1?		YES	
1.2	Mechanical Properties			
1.2.1	Internal Diameter	mm	XXXXXXXXXX	
1.2.2	Length of Insulation Cover	mm	XXXXXXXXXX	
1.2.3	State what material the insulation cover is manufactured from?	240-170001063, clause 3.1.3	XXXXXXXXXX	
1.2.4	State the colour of the supplied insulation cover?	240-170001063, clause 3.1.3	Maroon (AO1)	
2	Documentation (to be submitted with tender) Note: All documentation to also be provided in electronic format.			
2.1	General		Required	
2.1.1	Approved Manufacturer Drawings showing markings and dimensions	1 Set submitted	YES	
2.1.2	Has a signed and completed deviation sheet (Annexure B) been submitted?	Signed Deviation Schedule Submitted	YES	
2.2	Test Reports			
2.2.1	Has the relevant signed mandatory test schedule been submitted. (annexure C)?	Signed Test Schedule Submitted	YES	
2.2.2	Has the relevant storage, installation and maintenance manual been submitted	Have the manuals been submitted	YES	
3	Packaging			
3.1	Packaging as per 240-170001063 clause 3.1.6		YES	
3.2	Installation instructions provided in packaging		YES	

Deviations to any of the stated requirements are to be captured on the Deviation Schedule

SUPPLIER SIGNATURES

_____ Name (Print)	_____ Company name
_____ Sign	_____ Date

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Annex C – Test Reports

The test reports are required for the stated SAP number listed on this sheet

SAP No: _____ (To be specified)

1	2	3	4
Item	Description	Standard 240-170001063	Report No.
1	Volume resistivity test	Clause 3.1.5	
2	Wet withstand test	Clause 3.1.5	
3	Wet power frequency flashover test	Clause 3.1.5	
4	Lightning impulse withstand test	Clause 3.1.5	
5	Cold temperature test	Clause 3.1.5	
6	Ultraviolet aging	Clause 3.1.5	
7	Salt fog aging	Clause 3.1.5	
8	Retention testing	Clause 3.1.5	
9	Flammability testing	Clause 3.1.5	
10	Radio-influence voltage test	Clause 3.1.5	

SUPPLIER SIGNATURES

Name (Print)

Company name

Sign

Date

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