

 Eskom	Standard	Technology
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Title: **STANDARD FOR GUY STRAIN
INSULATORS FOR OVERHEAD
DISTRIBUTION SYSTEMS**

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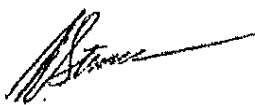
Disclosure Classification: **Controlled
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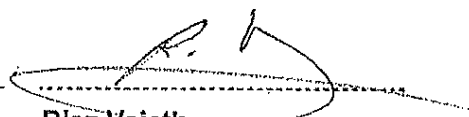
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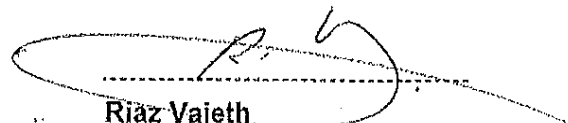
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Date: 24/2/2017

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1. Introduction

This standard has been prepared on behalf of the Steering Committee for Wires Technology (SCOWT). It has been approved by the committee for use by Eskom Distribution as a performance standard when purchasing guy strain insulators for Medium Voltage (MV) overhead power lines.

This is a performance standard for guy strain insulators for MV lines.

2. Supporting clauses

2.1 Scope

2.1.1 Purpose

This standard covers Distribution Group's requirements for the manufacture, testing and supply of guy strain insulators. It is applicable to insulators for use on alternating current (ac) networks with maximum system voltages from 1 kV up to and including 36 kV. The applicable stay wire sizes are up to 7 x 4 mm, 1 100 MPa, and for stay rods up to 20 mm in diameter.

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] SANS 121 Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods
- [2] SANS 60060-1 High voltage test techniques. Part 1: General definitions and test requirements
- [3] SANS 60060-2 High voltage test techniques. Part 2: Measuring systems
- [4] SANS 60591 Sampling rules and acceptance criteria when applying statistical control methods for mechanical and electromechanical tests on insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1 000V

2.2.2 Informative

- [5] 32-9 Definition of Eskom Documents
- [6] 32-644 Eskom Documentation Management Standard
- [7] 474-65 Operating Manual of the Steering Committee of Wires Technologies (SCOWT)

2.3 Definitions

2.3.1 General

Definition	Description
50% Lightning Impulse Flashover Voltage	The value of the lightning impulse voltage which, under the prescribed conditions of test, has a 50% probability of producing flashover of the insulator (Designated U_{50}). Also called the critical flashover voltage (CFO).

Definition	Description
Dry Power Frequency Withstand Voltage	The power frequency voltage that the insulator will withstand without flashover when it is dry.
End Fitting	A metal connection device or cap forming part of the insulator intended to facilitate connection to the stay wire.
Flashover	A disruptive electrical discharge, in the air gap external to the insulator, between the two metal end fittings.
Guy Strain Insulator	An insulator intended to be inserted in-line with a stay wire to electrically isolate the lower part of the stay assembly from the pole top. The insulator is coordinated with and designed such as to provide a high lightning impulse withstand voltage.
Dry Lightning Impulse Withstand Voltage	The maximum lightning impulse voltage, of both positive and negative polarity, that the insulator will withstand with 90% probability when dry. At this voltage there is 10% probability of flashover and therefore may be referred to as the U_{10} .
Mechanical Failing Load	The maximum load reached prior to failure, when the insulator is tested under the prescribed conditions.
Rod	The dielectric component of the composite insulator comprising a solid fiberglass cylinder of sufficient length and diameter to provide the required electrical and mechanical characteristics.
Routine Test Load	The load applied to all assembled insulators during the routine mechanical test prior to dispatch.
Specified Minimum Failing Load	The load as specified by the manufacturer, below which, mechanical failure will not occur.
Wet Power Frequency Withstand Voltage	The power frequency voltage that the insulator will withstand without flashover when wet.

2.3.2 Disclosure classification

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

2.4 Abbreviations

Abbreviation	Description
CAP	Committee for Accepted Products
IARC	Industry Association Resource Centre (formerly 'Distribution Technology')
IEC	International Electrotechnical Commission
LAP	List of Accepted Products
LIWL	Lightning Impulse Withstand Level
LV	Low Voltage
MV	Medium Voltage
n/a	not applicable
SANS	South African National Standards
SC	Study Committee
SCOWT	Steering Committee for Wires Technology

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Abbreviation	Description
SMFL	Specified Minimum Failing Load
UV	Ultraviolet

2.5 Roles and responsibilities

Not applicable.

2.6 Process for monitoring

Not applicable.

2.7 Related/supporting documents

See normative references.

3. Standard for Guy Strain Insulators for Overhead Distribution Systems

3.1 General Requirements

Nothing in this standard shall lessen the obligations of the supplier. The supplier shall be fully responsible for the insulator design, and its satisfactory performance in service. Approval by Eskom shall not relieve the supplier of the responsibility for the adequacy of the design.

3.2 Design Principles

The insulators shall be suitable for use with Eskom's standard components and installation methods used for stays applied to poles.

The insulators shall be designed and manufactured for the purpose of providing a high Lightning Impulse Withstand Level (LIWL) in the stay assembly, whilst accommodating the maximum tensile forces that may be imposed.

The insulators shall comply with the electrical and mechanical requirements of this standard, and retain these properties during the normal lifespan of 30 years in an outdoor environment.

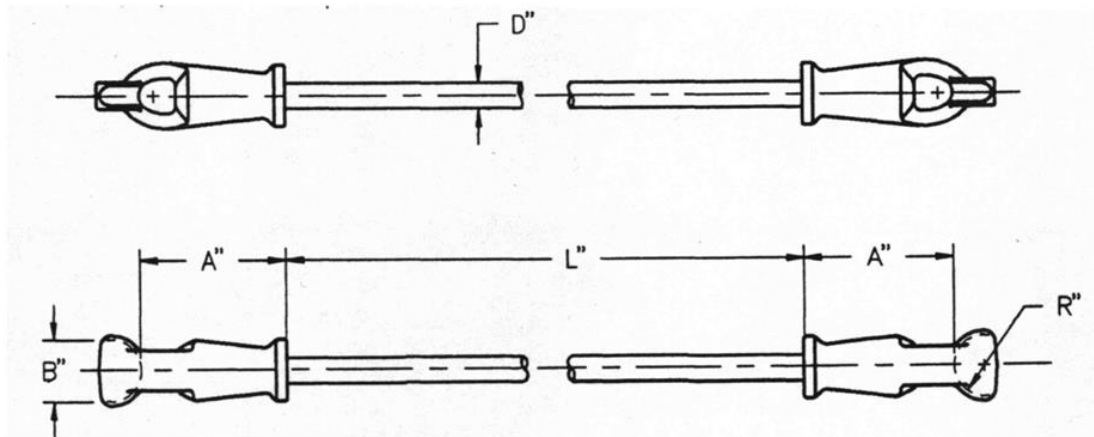
3.3 Physical Characteristics

The insulators shall have the general form and dimensions illustrated in Figure 1.

The dielectric component shall be an acid resistant fibreglass rod with continuous, unidirectional fibres running longitudinally from end to end. The rod shall be coated with a high temperature vulcanised (HTV) silicone rubber sheath with a minimum thickness of 3mm.

The end caps shall either be the thimble, or combination thimble/tongue type, produced from forged steel, or spheroidal graphite (ductile) cast iron material. They shall be hot dip galvanized in accordance with SANS 121 [1]. The thimble groove shall be smooth and have a minimum cross-sectional radius of 7 mm.

The attachment of the caps to the rod shall be affected by multiple point roll crimping and be adequately sealed to prevent moisture ingress. Attachment by other means, such as by the epoxy cementing of internally tapered fittings, shall be subject to Eskom approval.



TYPE No.	ROD LENGTH L (mm)	CAP LENGTH A (typical) (mm)	ROD DIAMETER D (mm)	SEAT DIAMETER		MIN. FAILING LOAD (kN)
				B		
				min. (mm)	max. (mm)	
MV	460 (+10 mm / -5 mm)	125 to 150	Min. 15 mm	35	60	97

Figure 1: Guy Strain Insulator Types and Dimensions

3.4 Electrical Characteristics

The minimum electrical characteristics of the insulators shall be as follows:

- | | | |
|----|--|-------------|
| a) | Power frequency withstand voltage(60sec), dry | 150 kV rms |
| b) | Power frequency withstand voltage (60sec), wet | 60 kV rms |
| c) | Lightning impulse withstand voltage, positive | 300 kV peak |

3.5 Mechanical Characteristics

The minimum mechanical characteristics of the insulators shall be as follows:

- | | | | |
|----|------------------|-------------------------------|-------|
| a) | Type GS 300/100: | Minimum failing load, tensile | 97 kN |
|----|------------------|-------------------------------|-------|

3.6 Workmanship

All insulators shall have a smooth finish, free of defects and shall be of high-quality workmanship.

3.7 Drawings

- Design drawings shall be submitted to Industry Association Resource Centre (IARC) for approval at the time of tendering.
- Drawings shall clearly indicate all relevant dimensions (in millimetres) and tolerances.
- The material grade and the treatment process required for individual items shall be clearly indicated on all drawings.
- Drawings supplied to Eskom at tender stage shall clearly indicate the revision number and details, and date of revision.

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3.8 Marking

All insulators shall be clearly and indelibly marked with the following information:

- a) Manufacturer's identification.
- b) Insulator type number.
- c) Minimum tensile failing load
- d) Batch number or code.

3.9 Tests

3.9.1 General

The tests are divided into the following three groups, which are described in more detail in paragraphs 3.9.2, 3.9.3 and 3.9.4

- a) Type tests:
 - 1) are intended to verify the main electrical and mechanical characteristics of the insulator, which depend mainly on its dimensions and material, but also the manufacturing techniques utilised. are usually carried out on a small number of units, and only once for a new design or manufacturing process;
 - 2) are subsequently only repeated when the design, or manufacturing process is changed;
 - 3) shall be conducted by an independent accredited organization or person approved by Eskom. Eskom reserves the right to witness these tests.
- b) Sample Tests:
 - 1) are conducted to verify the characteristics of an insulator, which can vary with the manufacturing process, and the quality of the component materials;
 - 2) are used as acceptance tests on a sample of insulators taken at random from a lot that has met the requirements of the relevant routine tests.
- c) Routine tests:
 - 1) are intended to eliminate defective units, and are conducted as part of the manufacturing process quality control;
 - 2) shall be carried out on every individual insulator product.

Suppliers are requested to indicate their compliance with this standard at the tendering stage and shall submit all the required type test certificates, design drawings and samples. If the fittings offered have been tested for compliance in accordance with an internationally accepted standard, Eskom may accept those test reports as equivalent tests for the tests covered by this standard. These type test reports and alternative test standards shall be submitted with their tender.

3.9.2 Type Tests

3.9.2.1 Electrical Tests

The following electrical tests shall be performed on a single insulator. The test procedures shall be in accordance with SANS 60060-1 [2].

- a) Dry power frequency withstand test.
- b) Wet power frequency withstand test.
- c) Dry lightning impulse withstand test (positive polarity).

For the power frequency tests, the test voltages to be applied to the insulator are those specified in paragraph 3.4, adjusted for altitude and atmospheric conditions at the time of the test. The voltage shall be maintained at this value for 1 min. The test is successful if no flashover occurs during this period.

For the lightning impulse test, the 50% flashover voltage level is determined by the “up and down method” described in SANS 60060-1 [2]. The insulator passes the test if this voltage is not less than 1.04 times the specified lightning impulse withstand voltage.

3.9.2.2 Mechanical Tests

Five insulators shall be subjected individually to a tensile load applied between their metal end fittings. The tensile load shall be increased from zero, rapidly but smoothly, up to approximately 75% of the specified minimum failing load. Subsequently, the load shall then be gradually increased at a rate of increase between 35% and 100% of the specified minimum failing load per minute, until breakage of the rod or cap, or complete pull out of the rod from the cap, occurs.

The type test is passed if

$$X_t > SMFL + 1.2S$$

Where: X_t = the mean value of the test results

SMFL = Specified Minimum Failing Load

S = the standard deviation of the test results

3.9.3 Sample Tests

3.9.3.1 Sampling rules

The sampling method and quantities of insulators to be tested shall be in accordance with SANS 60591 [4].

3.9.3.2 Verification of dimensions

The dimensions of the insulators shall be checked against the relevant drawings. Unless otherwise agreed, a tolerance of $\pm (0.04d + 1.5)$ mm when $d < 300$ mm or $\pm (0.025d + 6)$ mm when $d > 300$ mm, is allowed on all dimensions (d being the checked dimension in millimetres).

3.9.3.3 Mechanical Test

The insulators shall be subjected to a tensile load applied between the end caps. The load shall be increased rapidly but smoothly from zero to approximately 75% of the SMFL and then be gradually increased to the Specified Minimum Failing Load (SMFL) during the time period from 30 s to 90 s. If 100% of the SMFL is reached in < 90 s, the force shall be sustained for the remainder of the 90 s period.

The test is passed if no failure (breakage or complete pull-out of the rod or fracture of the metal fittings) occurs.

In order to obtain additional information from the test, the load may be increased until the actual failing load is reached, and its value recorded.

3.9.3.4 Galvanising Test

The caps of the sample units shall be subjected to a visual inspection and the measurement of the zinc coating thickness using a suitable gauge instrument. Five measurements shall be made, uniformly and randomly spread over each cap, avoiding edges and sharp points.

The coating shall be continuous, and as uniform as possible. Small uncoated spots are permissible. However, the area of any one spot shall be less than 4 mm^2 and the sum of all the uncoated areas shall be $< 0.5\%$ of the total surface area, with a maximum of 20 mm^2 .

The coating shall have adhered sufficiently to withstand handling consistent with the normal use of the article, without peeling or flaking.

The minimum coating thickness shall be $85 \text{ }\mu\text{m}$.

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3.9.4 Routine Tests

3.9.4.1 Visual Inspection

Each insulator shall be inspected. The mounting of the metal fittings on the insulating rod shall be in accordance with the drawings. The rod shall be covered with a smooth, HTV silicone rubber sheath, free from cracks and other defects prejudicial to satisfactory performance in service. Superficial defects of area $< 25 \text{ mm}^2$ are permitted, provided that the total of such areas does not exceed 0.2% of the total rod surface.

3.9.4.2 Mechanical Test

Every insulator shall withstand a tensile load of at least **80%** of the SMFL for at least 10 s.

3.10 Packing

The insulators shall be packed in cardboard cartons, each carton containing a maximum of 12 units. Insulators should be individually bubble wrapped or carton sleeved to adequately protect the unit from damage during handling and transport from the point of dispatch to the construction site. All packaging shall not disintegrate due to exposure to UV or rain that may occur until when the unit is installed. The exterior of the packaging shall be clearly marked with:

- a) Name of the manufacturer.
- b) Insulator type number.
- c) Quantity of insulators.
- d) Name of the purchaser.
- e) Purchaser's order number
- f) Delivery address.

If the cartons are packed on pallets, the gross weight of each pallet shall not exceed 1 800 kg. Pallets shall be suitable for handling by forklift trucks, have two-way entry and be reversible.

4. Authorization

This document has been seen and accepted by:

Name and surname	Designation
R Asmal	MV LV SC Chairman
R Swinny	Distribution Solutions COE Manager
J Blaau	Distribution Senior Engineer

5. Revisions

This revision cancels and replaces revision number 0 of document number DSP_34-1675.

Date	Rev	Compiler	Remarks
Feb 2020	2	G Strelec	UV stable epoxy coating on fiberglass rod changed to 3mm thick HTV silicone rubber. LV stayrod removed: Type GS 300/70: Minimum failing load, tensile 35 kN (porcelain is used) Document reformatted on to new template, with new document number. No content change. This document supersedes document DSP_34-1675

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Date	Rev	Compiler	Remarks
March 2012	1	G Strelec	Document reformatted no content change. This document supersedes document DSP_34-1675 Added requirement for UV resistant coating fiberglass insulators. Revised packing requirements. Normative references updated.
Nov 2001	0	B Hill	Document issued.

6. Development team

The following people (interested manufacturers) were involved in the development of this document:

- R E Macey Mace Electrical Technologies
- R Martin Eberhardt Martin
- B Hill IARC

In July 2017 the following manufacturers were contacted for their input into the revision of the UV stable epoxy coating on fiberglass rod being changed to 3mm thick HTV silicone rubber. The suppliers support the proposal (R. Martin did not provide any feedback):

- R Theron Aerge Technologies
- S Smith Pfisterer
- J Alves GMC Powerlines

7. Acknowledgements

R Swinny and J Blaau for their input into the revision

Annex A – Impact Assessment

(Normative – for Eskom internal use only)

Impact assessment form to be completed for all documents.

1) Guidelines

- All comments must be completed.
- Motivate why items are not applicable (n/a).
- Indicate actions to be taken, persons or organizations responsible for actions and deadline for action.
- Change control committees to discuss the impact assessment and, if necessary, give feedback to the compiler regarding any omissions or errors.

2) Critical Points

2.1 Importance of this document, e.g. is implementation required due to safety deficiencies, statutory requirements, technology changes, document revisions, improved service quality, improved service performance, optimized costs.

Comment: Improved long-term performance.

2.2 If the document to be released impacts on statutory or legal compliance, this needs to be very clearly stated and so highlighted.

Comment: No impact.

2.3 Impact on stock holding and depletion of existing stock prior to switch over.

Comment: None.

2.4 When will new stock be available?

Comment: Already available.

2.5 Has the interchangeability of the product or item been verified, i.e. when it fails, is a straight swap possible with a competitor's product?

Comment: Yes.

2.6 Identify and provide details of other critical (items required for the successful implementation of this document) points to be considered in the implementation of this document.

Comment: None.

2.7 Provide details of any comments made by the Regions regarding the implementation of this document.

Comment: None.

3) Implementation Time Frame

3.1 Time period for implementation of requirements.

Comment: Immediate.

3.2 Deadline for changeover to new item and personnel to be informed of DX wide changeover.

Comment: n/a

4) Buyer's Guide and Power Office

4.1 Does the Buyer's Guide or Buyer's List need updating?

Comment: Yes.

4.2 What Buyer's Guides or items have been created?

Comment: Existing Buyers Guide.

4.3 List all assembly drawing changes that have been revised in conjunction with this document.

Comment: n/a

4.4 If the implementation of this document requires assessment by CAP, provide details under paragraph 5).

4.5 Which Power Office packages have been created, modified or removed?

Comment: n/a

5) CAP/LAP Pre-qualification Process-related Impacts

5.1 Is an ad hoc re-evaluation of all currently accepted suppliers required as a result of implementation of this document?

Comment: No.

5.2 If NO, provide motivation for issuing this specification before Acceptance Cycle Expiry date.

Comment: revision in preparation for next ENC and to align with present material supplied on ENC.

5.3 Are ALL suppliers (currently accepted per LAP) aware of the nature of changes contained in this document?

Comment: Yes.

5.4 Is implementation of the provisions of this document required during the current supplier qualification period?

Comment: Yes.

5.5 If Yes to paragraph 0, what date has been set for all currently accepted suppliers to comply fully?

Comment: To be decided.

5.6 If Yes to paragraph 0, have all currently accepted suppliers been sent a prior formal notification informing them of Eskom's expectations, including the implementation date deadline?

Comment: Yes.

5.7 Can the changes made, potentially impact upon the purchase price of the material/equipment?

Comment: Minimal.

5.8 Material group(s) affected by specification (refer to Pre-qualification invitation schedule for list of material groups).

Comment: n/a

6) Training or Communication

6.1 Is training required?

Comment: No.

6.2 State the level of training required to implement this document (e.g. awareness training, practical/on job, module).

Comment: n/a

6.3 State designations of personnel that will require training.

Comment: n/a

6.4 Is the training material available? Identify person responsible for the development of training material.

Comment: n/a

6.5 If applicable, provide details of training that will take place (e.g. sponsor, costs, trainer, schedule of training, course material availability, training in erection/use of new equipment, maintenance training).

Comment: n/a

6.6 Was Technical Training Section consulted regarding module development process?

Comment: n/a

6.7 State communications channels to be used to inform target audience.

Comment: n/a

7) Special Tools, Equipment, Software

7.1 What special tools, equipment, software, etc. will need to be purchased by the Region to effectively implement?

Comment: None.

7.2 Are stock numbers available for the new equipment?

Comment: n/a

7.3 What will be the cost of these special tools, equipment, software?

Comment: n/a

8) Finances

8.1 What total costs would the Regions be required to incur in implementing this document? Identify all cost activities associated with implementation, e.g. labour, training, tooling, stock, obsolescence.

Comment: n/a

Impact assessment completed by:

Name: Gavin Strelec

Designation: Convenor Dx Insulator Care Group