Eskom Transmission

SPECIFICATION

REFERENCE	REV
TRMSCABS9	**1**

TITLE: **SPECIFICATION FOR POLYMERIC LONGROD INSULATORS FOR TRANSMISSION VOLTAGES OF 220KV AND ABOVE**

DATE: **AUGUST 2005**

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REVISION DATE:

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REVISION INFORMATION

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0	New document	Oct 2004
1	Changes to technical schedule	Aug 2005

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Amendment Status

This specification has been produced to rationalise the application of polymeric insulators in the Transmission Division, and to achieve maximum standardisation at an acceptable quality. It is restricted to silicone rubber material on overhead transmission lines and transmission substation conductor stringing. The Insulation Coordination Equipment Task Team must be consulted on the application and suitability of polymeric insulators.

It is intended to use the insulators specified in this document for the construction of new overhead transmission lines, as well as for the maintenance and refurbishment of existing lines. However, construction and maintenance activities are not only restricted to the use of polymer type insulators. Glass and porcelain insulation has an appropriate application. The connecting lengths and end-fittings specified may be critical and, where necessary, any deviation from these and the tolerances provided will result in a commercial offer being invalidated.

Insulators for maintenance may not have standard connecting lengths or standard end-fittings and provision has been made in the attached schedules for specific requirements.

1. Scope

1.1 Purpose

The purpose of this specification is to ensure that polymeric longrod insulators of 220 kV nominal system voltage and above meet the technical requirements of this standard and as specified in Schedule A.

1.2 Applicability

This specification shall be applicable to all Transmission overhead transmission lines and substations. It is for the construction of all new and refurbished, as well as for the maintenance of existing overhead transmission lines.

2. Normative references

Note: Parties are encouraged to investigate the possibility of applying the latest additions of these documents.

IEC Standards

IEC 60815: Guide for the selection of insulators in respect of polluted conditions.

IEC 60061: High voltage test techniques.

IEC 60120: Dimensions of ball and socket couplings of string insulator units.

IEC 60372: Locking devices for ball and socket couplings of string insulator units.

IEC 61109: Composite insulators for AC overhead lines with nominal voltages greater than 1000V.

ISO Standards

ISO 1461:2000 Hot dipped galvanised coatings on fabricated iron and steel articles – specifications and test methods.

ISO 9001:2000 Code of Practice – Quality Management Systems - Requirements

ISO 14001:1 Code of Practice – Environmental Management Systems Specification with guidance for use.

Eskom Standards

ESKSCAAB8 High Voltage Regulations

3. Definitions and abbreviations

3.1 Definitions

3.1.1 Acid resistant core: A fibre glass reinforced plastic rod produced from corrosion resistant glass fibres.

3.1.2 Alternating shed profile: A construction of the insulator where sheds of small and large diameters are placed in an alternating way.

3.13 Brittle fracture: The fracture is characterised by a razor-cut like surface running perpendicular to the axis of the FRP rod. It is caused by acid induced stress corrosion.

3.1.4 Certified test report: A certificate of successful tests required by the specification and carried out by, or witnessed by, an accredited authority.

3.1.4 Chips, pits or blisters: Surface marks on the insulator shed material usually caused during the manufacturing process.

3.1.5 Connecting zone: Zone where the load is transmitted between the rod and the metal end-fitting.

3.1.6 Core (of a polymeric insulator): The core is the internal insulating part of a polymeric insulator providing the mechanical strength. The core consists of millions of glass fibres in a resin-based matrix.

3.1.7 Coupling: The part of the metal end-fitting that transmits the load to the line hardware external to the insulator.

3.1.8 Crack: A surface fracture greater than 0,1 mm deep.

3.1.9 Creepage distance: The shortest distance or sum of the shortest distances measured along the contours of the external surfaces of the insulating parts between those parts of an insulator that normally have the operating voltage between them.

3.1.10 Delamination: The loss of bonding of fibres to the matrix.

3.1.11 Dry-arcing distance: The shortest distance through the surrounding medium between terminal electrodes, or the sum of the distances between intermediate electrodes, whichever is shorter.

3.1.12 Flashover: A disruptive discharge external to an insulator between those parts of the insulator that normally have the operating voltage between them.

3.1.13 Housing: The external part of an insulator that provides the necessary creepage distance and protects the core from exposure to the elements. An intermediate insulating sheath covering the FRP rod is part of the housing.

3.1.13 Insulator: A device that provides both electrical insulation and mechanical linkage between live conductors and an earth point.

3.1.12 Metal fittings: Devices that form part of an insulator and intended to connect it to a supporting structure or to a conductor. The two fittings referred to in this specification are the earth end and the line or live end.

3.1.13 Routine Test Load (RTL): This is 50% of the SML to which every insulator has to be subjected for 10 seconds.

3.1.14 Shed: A projecting portion of the housing intended to increase the creepage distance.

3.1.15 Shed spacing to projection ratio: The ratio of the distance between two adjacent sheds to the length of the shed overhang. In the case of alternating sheds, two adjacent large-diameter sheds are considered, with the intermediate smaller shed neglected.

3.1.17 Specified Mechanical Load – SML (of long rod insulators): This is the load specified by the manufacturer which is used for mechanical tests.

3.1.18 Strain (tension) insulator: An insulator subject to the tension of the conductors.

3.1.19 Basic Lightning Impulse Insulation Level (BIL): The crest value of the standard lightning impulse for which the insulation exhibits a 90% probability of withstand (10% probability of failure) under specified conditions applicable for self-restoring insulation.

3.1.20 Basic Switching Impulse Insulation Level (SIL): The crest value of the standard switching impulse for which the insulation exhibits a 90% probability of withstand (10% probability of failure) under specified conditions applicable for self-restoring insulation.

3.2 Abbreviations

3.2.1 BIL: Basic Impulse Level

3.2.2 kV: kiloVolts

3.2.3 m: metre

3.2.4 RIV: Radio influence voltage

3.2.5 rms: root mean square

3.2.6 SIL: Switching Impulse Level.

3.2.7 SML: Specified Mechanical Load

3.2.8 U_m: Maximum System Operating Voltage

3.2.9 FRP: Fibreglass Reinforced Plastic

4. Requirements

4.1 General

Nothing in this specification shall lessen the obligations of the supplier as detailed in any other documents forming part of a contract. The insulators shall be designed, manufactured, supplied, installed and tested as specified herein and in Schedule A and B of the Enquiry document.

4.2 Insulator Design

Within the minimum requirements specified in Schedule A and B, the suppliers shall be fully responsible for their designs and their satisfactory performance in service. Acceptance by Eskom shall not relieve the supplier of his responsibility for the adequacy of the design, dimensions and details. Supplier's catalogues shall not refer to any product as "Eskom approved".

Supplier's shall have access to the engineering facilities necessary to provide a technical service and information, advice and after-sales service related to the products under consideration. They may be requested to provide a list of references indicating the country, name of the customer, system voltage, quantity and year of delivery for substantial previous orders.

The insulators shall be designed and manufactured by an accredited ISO 9001: 2000 organisation.

4.3 Insulator approvals and tenders

Approval by Eskom shall not relieve the supplier of his responsibility for the adequacy of the design, dimensions and details. Eskom may only be used as a reference where relevant.

4.4 Tender submissions by suppliers

4.4.1 The Tenderer shall include two copies of the general arrangement and construction drawings of the insulator(s) offered.

4.4.2 The manufacturer's documentation shall include all relevant information and detail drawings shall clearly show the following information:

A. Compliance

The Tenderer shall include in their submission a clause indicating compliance in their schedule as proposed. This shall be included in the attached Technical Schedule A under Item 4.0.

B. Drawings

1. Assembly and arrangements of proposals.
2. Itemised drawings to include;
   a. Materials.
   b. Dimensions.
   c. Tolerances.
   d. Specifications.
   e. Identification of items.
   f. End fittings.

C. Test Documentation.

a. Valid Type Tests of complete product as per referred standards and specifications.
b. Time-load curves illustrating the expectant life of the offered insulator, or insulators of similar dimensions and strengths, shall be submitted with the offer. Time load curves for any other insulator(s) will be considered irrelevant.
c. Documentation of Routine Testing carried out per item during the manufacturing process.

D. Other Submissions

The above technical submissions shall not lessen the tenderers obligations in terms of all the requirements stipulated in the enquiry documentation.

4.5 Supplier ISO Certification Requirements

Compliance to ISO9001 will be applicable throughout the entire process. Proof of certification shall be submitted with the Tender

5. Product/process requirements

5.1 The design parameters of the insulators shall be as specified in Schedule A.

5.2 Design of Insulator Range.

5.2.1 The manufacture's offered product range shall be tested to IEC 61109 including Annexure C.

5.2.2 Transmission may request proof of type tests at any time.

5.2.3 Suppliers shall show proof that all materials and technical requirements are maintained in accordance with the Type Test Records submitted.

5.2.4 Product range approval shall be carried out by Transmission or an Accredited Body.

5.3 The insulator design shall ensure that the core is totally sealed and no part of the core shall become exposed during normal handling and use. Insulating materials shall have a minimum 3mm sheath cover thickness.

5.4 Preference will be given for polymeric insulators that are constructed with alternating shed diameters.

5.5 Where the insulators are not of the flat profile under the shed, the insulator will be deemed to be one IEC pollution class lower than the equivalent flat profile.

5.6 All interfaces between the rod, sheath and sheds shall be chemically bonded together.

5.7 The sheds and sheath shall have high resistance to tearing. It shall not tear when handled normally during storage, transport or installation.

5.8 The metal end fittings and the epoxy resin acid resistant glass rod are to be joined by a compression technique to Eskom's approval. All non-ferrous items to be hot dipped galvanised in accordance with ISO 1461:2000 as specified in schedule A and IEC61109.

5.9 Polymeric weather sheds shall maintain their shape and rigidity under normal operating conditions.

5.10 All epoxy resin acid resistant glass rods are to have a low seed count.

5.11 Depending on the application, only two specific creepage distances will be specified in the Technical Schedules. These shall be 25mm/kV or 31mm/kV.

5.12 The insulation levels of the insulators shall be in accordance with the relevant values in Table 1(a) for phase-to-earth, and Table 1(b) for phase-to-phase applications.

System Voltage kV (rms)		Impulse Withstand Voltage at Sea Level kV (peak)		60 sec. Power frequency Withstand Voltage at Sea Level
Highest	Nominal	BIL	SIL	kV (rms)
245	220	850	-	360
300	275	1 050	850	-
420	400	1 425	1 050	-
800	765	2 100	1 550	-

Table 1(a): Insulation Levels for Phase-to-earth applications

System Voltage kV (rms)		Impulse Withstand Voltage at Sea Level kV (peak)		60 sec. Power frequency Withstand Voltage at Sea Level
Highest	Nominal	BIL	SIL	kV (rms)
245	220	-	-	360
300	275	-	1300	-
420	400	-	1 550	-
800	765	-	2400	-

Table 1(b): Insulation Levels for Phase-to-phase applications

5.13 Unless otherwise specified, the dry arcing distance must be greater than or equal to the relevant safety clearance for phase-to-phase or phase-to-earth depending on the insulator application. These distances shall be in accordance with Table 2.

Highest system r.m.s. voltage (kV)	System nominal r.m.s. voltage (kV)	Safety clearance phase-to-earth (m)	Safety clearance phase-to-phase (m)
245	220	2,1	2,7
300	275	2,5	3,6
420	400	3,2	4,8
800	765	5,5	8,9

Table 2: Minimum dry arcing distances

5.14 Unless other specific configuration are called for, all end fittings should be of the ball and socket type and be in accordance with IEC 60120.

5.15 Epoxy resin acid resistant glass rod diameter must be a minimum of 16mm at a SML of 120kN.

5.16 Corona rings shall be supplied as part of the insulator. They shall be fitted to the live end of all polymeric insulators. In the case of 400kV and above, corona rings shall be supplied for both the live and dead ends of the polymeric insulator. The dimensions of the corona ring shall be such that adequate phase-earth clearances are maintained. Corona rings, both insulator and hardware rings, shall not clash in any way.

5.17 Locking devices shall be in accordance with IEC60372, material and type of device is as per Schedule A. Locking devices shall be of the hump backed split pin (termed split pins in IEC). The preferred material is stainless steel and phosphor bronze as an alternative.

6. Testing requirements

6.1 Type, production and routine testing

Insulators shall be tested in accordance with IEC 61109 including Annexure C: Ageing Test Under Operating Voltage Simulating Weather Conditions. Test certificates indicating compliance with IEC 61109, from a recognised testing authority, must be submitted with the offer.

Test certificates showing results of tests, shall be retained by the supplier and shall be available for Eskom's inspection. At its discretion, Eskom reserves the right to subject randomly selected insulators that have been delivered to site, to tests. The costs of such testing shall be for Eskom's account for insulators that pass the tests. For insulators that fail these tests, the cost shall be for the supplier's account. Failure to pass qualifying design tests will result in rejection of all insulators from the batch, until the problem is satisfactorily resolved.

6.2 Crimping test

All end fittings shall be crimped to the fibre rod by means of a manufacturing method approved by Eskom. Such a manufacturing method must include automatic detection of cracks in all FRP rods during crimping process. In addition to this each and every insulator shall be subject to a routine test load (RTL) equal to 50% of the SML.

6.3 Corona test

In the absence of representative test results, the complete suspension and strain assemblies shall be tested for corona in a simulated tower gap. These assemblies shall be subjected to a 50 Hz single-phase voltage giving a three-phase voltage gradient stress equivalent to that expected at the highest system voltage on the conductor.

An insulator will be considered acceptable if no evidence of visible corona exists at the equivalent phase-to-earth voltage. No corona shall be visible on any part of the insulator and especially at the interface of the metal and the insulating material of the insulator.

The test report submitted by the manufacturer or supplier shall list all pertinent information, including the distance between the assembly and the nearest ground plane.

The test report shall also include photographs of a minimum of two views of all possible sources of corona on yokes and connecting hardware. Photographs shall be taken through a night-viewing device.

It must also be ensured that line hardware and insulators comply with rational limits of RIV. The standing limit used by Eskom is 65dB at 0,5MHz in dry conditions at local high altitudes. The rationale for this limit is that 65dB at 0,5MHz the hardware noise should be at least 6dB below that produced by a full conductor span in wet conditions.

6.4 Impulse test

Test results, indicating compliance with electrical withstand levels for switching, lightning, and 60 sec power frequency where applicable, must be submitted.

Tests to be in accordance with IEC 60061.

7 Identification requirements

7.1 The insulator shall be permanently marked with the following information:

a) manufacturer's name or trademark;

b) SML;

c) type or model or serial number; and

d) batch number or batch date.

7.2 The markings shall be legible and durable. Markings on sheds or housing shall remain legible for the life of the insulator.

8. Packing requirements

8.1 Details of the proposed packaging method shall accompany a tender offer and shall be subject to Eskom approval. The packaging shall protect the insulator from the normal handling that can be expected from the point of dispatch to the point of construction and shall be rodent resistant.

8.2 Any special handling requirements shall be clearly stated.

8.3 The packaging shall be capable of protecting the insulators for sustained periods in storage. The supplier shall notify the purchaser of any special methods recommended for storage.

8.4 The packaging shall not disintegrate due to any wetting and drying that may occur during the line construction. The supplier shall, at his expense, and at

Eskom's discretion, replace insulator units that are damaged due to unsuitable packaging.

8.5 The supplier shall, at his expense, and at Eskom's discretion, replace insulator units that are damaged during transit up to Eskom's delivery point.

8.6 If insulators are packed in boxes or crates on pallets, the gross weight of the pallets shall not exceed 1800 kg.

8.7 Pallets shall be suitable for handling by fork-lift trucks, capable of two-way entry and be reversible.

8.8 All boxes, pallets or containers shall be numbered and marked in accordance with the following example:

Project Name:		Suppliers Name:
Project Number:	Delivery Address:	
	Order Number:	
	Description of Material:	
	Gross Weight:	

9. Storage, transport and handling

The supplier shall supply comprehensive instructions and guidelines as to the storage, transport and handling of all insulators. This will include the handling care procedures during construction.

10. TECHNICAL SCHEDULE A

1	2	3	4
Item No.	**Description**	**Schedule A Eskom's minimum requirements**	**Schedule B Equipment guarantees and particular**
1	Scope The design, manufacture, testing and supply of polymeric insulators for use on Eskom's overhead transmission lines.		
2	General		
2.1	Insulator Type (e.g. Strain, suspension)	Strain & Suspension	
2.2	Drawing Reference		
2.3	Tower type(s)		
2.4	Nominal System Voltage (U_n)	275 kV	
2.5	Maximum System Voltage (U_m)	300 kV	
2.7	Phase Conductor	m	
2.8	Conductor Spacing	m	

1	2	3	4
Item No.	**Description**	**Schedule A Eskom's minimum requirements**	**Schedule B Equipment guarantees and particular**
3	Technical Details		
3.1	Manufacturer		
3.2	Manufacturer's Type Reference		
3.3	Compliance with IEC61109	Test Certificate	
3.4	Core Material Cover Thickness	3mm (minimum)	
3.5	Shed material	Silicone based	
3.6	Shed profile	Alternating pref.	
3.7	Altitude	1 800m	
3.8	Operating Temperature - Minimum - Maximum - Maximum Diurnal Variation	 -10°C 50°C 30°C	
3.9	Required Life Expectancy	30 years	
3.10	Time Load Curves offered	Y/N	
3.11	Strength Requirements (SML) - Suspension - Strain	 120kN 210kN	
3.12	Maximum connecting length of insulator - Suspension - Strain	 2336 mm 2544 mm	
3.13	End Fittings: - Type - Size for Suspension - Size for Strain	 e.g. Ball-Socket 16mm 20mm	

1	2	3	4
Item No.	**Description**	**Schedule A Eskom's minimum requirements**	**Schedule B Equipment guarantees and particular**
3.14	IEC Pollution Classification (according to IEC60815:1986)		
	- Heavy - Very heavy	25mm/kV 31mm/kV	
3.15	Minimum Specific Creepage Distance	25mm	
3.16	Minimum Ratio of Shed Spacing to Shed Projection	=1	
3.17	Insulation Levels		
(a)	Lightning Impulse Withstand (at specified altitude)	1050 kV	
(b)	Switching Impulse Withstand (at specified altitude)	850 kV	
(c)	60 sec Power Frequency Withstand (at specified altitude)	460 kV	
3.18	Corona Rings		
(a)	Corona ring arc rating	50kA @ 100ms	
(b)	Noise levels	See 6.3 Corona Test (page 14)	
(c)	Number of Corona Rings (Live/Dead End)	2 for 400kV and above	
3.19	Fibre Rod Diameter	16mm (minimum)	
3.20	Dry Arc Length	2500 mm	

1	2	3	4
Item No.	**Description**	**Schedule A Eskom's minimum requirements**	**Schedule B Equipment guarantees and particular**
4.0	Comments & Deviations		