

 <b>Eskom</b>	<b>Standard</b>	<b>Technology</b>
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Title: **ESKOM STANDARD FOR  
COUPLING CAPACITORS USED  
FOR POWER LINE CARRIER-  
FREQUENCY (PLC)  
APPLICATIONS**

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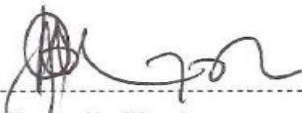
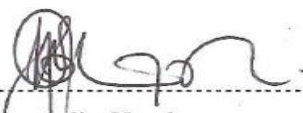
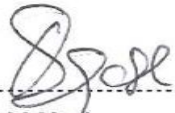

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## **1. Introduction**

This standard stipulates Eskom's requirements for designing, manufacturing, testing and supply of coupling capacitors from 66kV up to 765kV. The requirements stipulated in this document are based on international practices combined with Eskom's experience. The requirements are specified in order to ensure integrity of the product thereby minimising the risk of failure of equipment.

## **2. Supporting clauses**

### **2.1 Scope**

This standard details the requirements applicable to coupling capacitors used in Eskom network for both AC and DC purposes. It applies to coupling capacitors connected line to ground with their low voltage terminal either permanently earthed or connected to a PLC system.

#### **2.1.1 Purpose**

The document is written to capture and standardise Eskom's requirements for coupling capacitors used in Eskom network.

#### **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 60038: IEC standard voltages
- [2] IEC 60060-1: High voltage test techniques – Part 1 – General definitions and test requirements
- [3] IEC 60068-2-17: Basic environmental testing procedures – Part 2-17: Tests – Test Q: sealing
- [4] IEC 60071-1: Insulation co-ordination – Part 1: Definitions, principles and rules
- [5] IEC 600270: High voltage test techniques – Partial discharge Measurement
- [6] IEC 60358-1: Coupling capacitors and capacitor dividers – Part 1 – General rules
- [7] IEC 60358-2: AC or DC single-phase coupling capacitors connected between line and ground for power line carrier-frequency (PLC) application.
- [8] IEC 60721 (all parts): Classification of environmental conditions
- [9] IEC 60815-1: selection and dimensioning of high voltage insulators intended for use in polluted conditions – Part 1: Definitions, information and general principles.
- [10] IEC 61642: Composite Hollow insulators
- [11] IEEE 693 – IEEE recommended practice for seismic design of substations
- [12] CISPR/TR 18-2: Radio Interference Characteristics of overhead power lines and high voltage equipment – Part 2: Methods of measurement and procedure for determining limits
- [13] 240 – 75655504: Corrosion protection standard for new indoor and outdoor Eskom equipment, components, materials and structures manufactured from steel standard

**2.2.2 Informative**

None

**2.3 Definitions****2.3.1 General**

Definition	Description
<b>Capacitance tolerance</b>	permissible difference between the actual capacitance and the rated capacitance under specified conditions
<b>Capacitor element</b>	device consisting essentially of two electrodes separated by a dielectric
<b>Capacitor stack</b>	assembly of capacitor units connected in series
<b>Capacitor unit</b>	assembly of one or more capacitor elements in the same container with terminals brought out
<b>Coupling Capacitor</b>	Capacitor used for transmission of signals in a power system
<b>DC system voltage</b>	highest mean or average operating voltage to earth, excluding harmonics and commutation overshoots
<b>Low voltage terminal of a coupling capacitor</b>	terminal ( $N_{HF}$ ) intended for connection to earth either directly or via a drain coil of negligible value of impedance, at rated frequency, for power line carrier (PLC) application
<b>Maximum DC system voltage</b>	maximum D.C.-system voltage is almost a pure d.c. voltage with a magnitude dependent on voltage control and measuring tolerance excluding harmonics and commutation overshoots.
<b>Power Line Carrier System</b>	A system used mainly for telecommunication, tele-protection and tele-monitoring between substations through high voltage power lines
<b>Rated capacitance of a capacitor</b>	capacitance value for which the capacitor has been designed
<b>Rated frequency of equipment</b>	Frequency for which the coupling capacitor has been designed
<b>Rated insulation level</b>	combination of voltage values which characterises the insulation of the equipment with regard to its capability to withstand dielectric stresses
<b>Rated voltage (VR)</b>	value of the voltage which appears in the designation of the equipment and on which its performance is based
<b>Routine test</b>	A test performed on all individual coupling capacitors after manufacturing process.
<b>Solidly earthed neutral system</b>	System whose neutral point is earthed directly
<b>Special tests</b>	A test other than a type test or routine test, which shall be performed upon agreement between manufacturer and purchaser.
<b>Type test</b>	A test performed on each type of coupling capacitor to demonstrate that all coupling capacitors made according to the same specification comply with requirements not covered by routine tests.

**2.3.2 Disclosure classification**

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

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## **2.4 Abbreviations**

<b>Abbreviation</b>	<b>Description</b>
<b>AC</b>	Alternating Current
<b>CC</b>	Coupling Capacitor
<b>DC</b>	Direct Current
<b>PLC</b>	Power Line Carrier

## **2.5 Roles and responsibilities**

All the Eskom employees and/or appointed bodies involved in the procurement of coupling capacitors used in Eskom's network of nominal voltages up to 765kV shall ensure that the product meets the requirements of this standard. Any deviation from these requirements shall constitute a non-conformance, unless if approved in advance by a delegated Eskom Instrument Transformer specialist in writing and is based on sound engineering judgement.

All the manufacturers supplying coupling capacitors to Eskom must be conversant with the requirements of this specification, and shall comply with the requirements. All the deviations shall be clearly listed in the deviation schedule as part of the tender deliverables. No deviations will be accepted unless approved by Eskom in writing.

The Eskom Instrument Transformer Care Group shall be responsible for ensuring the validity of this document.

## **2.6 Process for monitoring**

This document and its relevance will be evaluated by the instrument transformers Care Group.

## **2.7 Related/supporting documents**

Not applicable.

# **3. Service Conditions**

## **3.1 Normal Service Conditions**

Unless otherwise specified in schedule A, the equipment shall be operated under the following conditions:

- a) Outdoors
- b) Altitude: Up to 1800m above sea level
- c) Ambient temperatures:
  - 1) Minimum: -10°C
  - 2) Maximum: 40°C
  - 3) Maximum diurnal variation: 35°C
  - 4) Yearly average: 20°C
- d) Solar radiation: 2500 kWh/m<sup>2</sup>
- e) Relative humidity: Not exceeding 95%
- f) Wind Pressure: 700 Pa (corresponding to a 34m/s wind speed)
- g) Seismic shock: 0.3g (IEEE 691)
- h) Lightning: Extremely severe

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- i) System Earthing
- j) Solidly earthed neutral system

## **4. Ratings**

### **4.1 Rated Frequency**

Eskom's power system frequency is 50Hz

### **4.2 Rated Voltages**

#### **4.2.1 Rated voltages $U_R$ for AC**

The standard values of rated voltage of an equipment connected between one line of a three-phase system and earth shall be  $1/\sqrt{3}$  times the values of rated system voltage. The values are given in Annexure A (table 1).

#### **4.2.2 Rated voltages $U_R$ for DC**

The values of rated voltage of an equipment connected between one line and earth is the rated value of DC rated line voltage (533kV for Eskom).

### **4.3 Rated voltage factor**

Coupling capacitors are connected between phase and earth in an effectively earthed neutral system with the following rated voltage factors:

- a) 1.2 – Continuous
- b) 1.5 – 30s

### **4.4 Rated Capacitance**

The rated capacitance shall be specified in technical schedule A, however standard capacitance are captured in annexure A (table 2)

- a) The coupling capacitors shall comply with the rated capacitance values specified in schedule A of an enquiry document.
- b) The values of rated capacitance specified in schedule A of an enquiry document will refer to the capacitance at the rated voltage and frequency (50Hz) and at 20 °C.
- c) The coupling capacitors shall be designed to withstand a steady high frequency through current of not less than 1A r.m.s. at any frequency between 40kHz and 500kHz.

## **5. Design requirements**

### **5.1 Coupling Capacitor**

- a) Unless otherwise specified the support structures and plinths required for supporting the coupling capacitors will be provided by Eskom.
- b) Coupling capacitors are required for coupling carrier equipment to the high voltage system.
- c) The carrier auxiliary components, i.e. carrier drain coils, carrier earthing switches and surge arresters shall be fitted as standard equipment on all coupling capacitors. The line matching equipment does not form part of the coupling capacitor and is covered in a separate specification.

- d) If specified coupling capacitors may be used to support line traps. The electrical connection between the trap and the associated capacitor shall be provided by the manufacturer. However, if the line trap supports are independent of the coupling capacitor, the high voltage terminals on the coupling capacitor shall comply with the details given in the technical schedule(s).
- e) When line traps are mounted on coupling capacitors, the manufacturer shall ensure that sufficient clearance exists between the line trap and coupling capacitor so that the effects of induction heating of the coupling capacitor by the line trap and detuning of the line trap by metal components on the coupling capacitor are avoided
- f) The metal base of each coupling capacitor shall be fitted with a threaded earthing terminal of not less than 16 mm in diameter. Earthing terminals shall be suitable for accommodating a 50 mm x 3 mm copper earthing strap.
- g) The low voltage terminal of the coupling capacitor shall be permanently earthed to 50 Hz currents by means of a drain coil. A surge arrester complying with IEC 60099-1 and an earthing switch shall be fitted directly across the drain coil within the base of the coupling capacitor. These carrier auxiliary components shall comply with the details given below. The carrier connection to the line matching equipment shall be brought out on a bushing on the side of the coupling capacitor base. Terminal strips within the coupling capacitor base are not acceptable.

## **5.2 Drain coil**

- a) The drain coil shall be permanently connected between the carrier terminal and the earth terminal of the coupling capacitor.
- b) The drain coil shall have an inductance of 40mH and shall present an impedance of more than 10k $\Omega$  throughout the carrier frequency range of 40kHz to 500kHz.
- c) The drain coil shall, at power frequency, have an impedance of not greater than 20 $\Omega$ .
- d) The drain coil shall be capable of withstanding a power frequency current of 1A r.m.s. continuously and 30A r.m.s. for 0.2 seconds.
- e) The drain coil shall be able to withstand a 1.2/50 $\mu$ s impulse voltage whose peak value is twice the value of the impulse spark voltage of the voltage limiting device but the minimum value should be 10kV peak.
- f) If the maximum fundamental frequency current of the capacitor is higher than 1A, the continuous operation current for the drain coil should be increased accordingly.
- g) For DC application, the grading current of the coupling capacitor shall not saturate the drain coil.

## **5.3 Surge Arrester**

- a) The surge arrester shall be permanently connected across the drain coil between the carrier terminal and the earth terminal of the CC and shall be of the gapped type. (IEC 60099 – 1)
- b) The surge arrester shall not be operated, or remain in operation following transient actuation, by the carrier frequency voltage developed across the unit by the specified carrier frequency peak envelope power (PEP).
- c) The surge arrester shall be capable of sustaining an impulse discharge current of wave shape 8/20 $\mu$ s of 5kA for a period of 0.2s
- d) For AC applications, the protection level voltage  $U_{pL}$  at power frequency shall be greater than 10 times the maximum AC voltage across the drain coil during rated operation.
- e) For AC applications, the protection level voltage  $U_{pL}$  shall be greater or equal to 3.5kV DC.

## **5.4 Earthing Switch**

- a) The earthing switch shall be permanently connected across the drain coil and surge arrester.

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- b) The earthing switch shall be provided with an operating lever which shall be external to the capacitor base enclosure and which shall be insulated to 2kV r.m.s. for 1s. The lever shall clearly indicate the position in which the carrier terminal is earthed and shall, when in the "Open" or "Off" position, be connected to the "earth" side of the switch.

The earthing switch shall have a continuous and short-time current rating as specified for the drain coil (5.2) and shall have a 5kA 8/20  $\mu$ s impulse current capability

#### 5.4.1 Rated insulation and test voltages between terminals (AC)

- a) The equipment shall comply with the appropriate insulation and test voltages specified in schedule A of an enquiry document and are captured in Annexure A (table 1).
- b) The low voltage terminal shall be capable of withstanding an AC. voltage of 10kV r.m.s. to earth for 1 minute.

#### 5.4.2 Rated insulation and test voltages between terminals (DC)

- a) The DC withstand voltage test is defined with a factor  $F_T = 2.6$ . The voltage shall be applied for 10 seconds.
- b)  $DC_{test\ voltage} = F_T * U_R = 2.6 * 533kV = 1386kV$

### 5.5 Partial Discharges

- a) Partial discharges shall be tested using the voltages specified in table 1 and shall not exceed the limits captured in the same table. Partial discharge requirements are applicable to the complete equipment.

**Table 1: Partial discharge test voltages and permissible levels**

Type of system earthing	PD test voltage (r.m.s.)	Permissible PD level (pC) immersed in liquid or gas
Earthed neutral system	$U_m$	10
	$\frac{1.2U_m}{\sqrt{3}}$	5
DC Application	$\frac{1.2U_r}{\sqrt{2}}$	5
Note 1: Permissible PD level is also valid for frequencies different from system frequency Note 2: For dc application PD measurement shall be AC-Voltage (kVr.m.s.) defined above Note 3: For Eskom's DC application purposes $U_R = 533kV$		

### 5.6 High Frequency Characteristics and Equivalent Series Resistance

- a) The high-frequency capacitance and equivalent series resistance, measured over the frequency range of 40 kHz to 500 kHz, with an ambient testing temperature range from 15 °C to 35 °C shall be as follows:
- 1) The measured values of capacitance shall not deviate by more than –5 % or +10 % from the rated capacitance.
  - 2) The measured values of equivalent series resistance shall not exceed 40 $\Omega$  at any frequency or at any temperature.

- b) The self-resonant frequency shall be not less than 1 MHz.
- c) The continuous HF current rating shall be greater than 1A r.m.s.
- d) The capacitance shall be measured at  $0.1 \cdot U_R$  and  $(0.9 - 1.1) \cdot U_R$  for AC applications respectively.
- e) The capacitance shall be measured at  $0.1 \cdot U_R/\sqrt{2}$  and  $(0.9 - 1.1) \cdot U_R/\sqrt{2}$  for DC applications respectively

## **5.7 Capacitor Losses at Power Frequency**

Capacitor losses shall be expressed as  $\tan \delta$  measured at the upper voltages given by 5.3 shall not be more than 0.3% ( $3 \times 10^{-3}$ ).

NB: DC capacitor with parallel grading resistance might have a higher value and this will be discussed and agreed to by the manufacturer and Eskom.

## **5.8 Stray capacitance and stray conductance of the low voltage terminal**

The values of the stray capacitance and stray conductance of the low voltage terminal measured at any frequency between 40kHz and 500kHz shall not exceed 200pF and 20 $\mu$ S respectively.

## **5.9 Creepage Distance**

The equipment shall comply with the specific creepage distances for 3-phase AC systems as specified in IEC 60815. The two levels, heavy (25mm/kV) and extra heavy (31mm/kV) pollution shall apply as specified in schedule A of an enquiry document.

## **5.10 Radio Influence Voltage (RIV)**

- a) This requirement applies to coupling capacitors having  $U_m \geq 123$ kV. The radio interference voltage shall not exceed 2500 $\mu$ V at  $1.1 U_m/\sqrt{3}$ .
- b) For DC applications, the test will be done with 50Hz ac voltage of  $1.1 U_m/\sqrt{2}$  and it shall not exceed 2500 $\mu$ V.

## **5.11 Mechanical Requirements**

- a) All coupling capacitors shall be designed to have a safety factor of 2.5 when subjected to a wind loading of 1.2kPa (1200) on the projected area and a simultaneous static force determined by the highest voltage for equipment captured in table 2. The static force must be in the same direction as the wind pressure, at the top of the equipment, with the static force being due to the pull of the conductor attached to the equipment at this point. The static test loads are captured in annexure A (table 3).
- b) Coupling capacitors which are required to support line traps, as detailed in the schedules, shall comply with the requirements of above (5.8(a)), with the additional force of the wind loading on the projected area of the line trap and the conductor pull on the line trap. The coupling capacitors shall comply with this requirement with the largest line trap specified in Eskom's specification for power line carrier line traps at the corresponding voltage rating. (Refer to Eskom Specification 240-57648739).
- c) The effective area of cylindrical surfaces is 0.6 of the projected area. This factor may be used when calculating the wind loading on capacitors and line traps.

## **5.12 Tightness of Equipment**

The complete coupling capacitor shall be tight in the full temperature range specified in 3.1 for its entire life expectancy of 25 years.

## **5.13 Voltage grading for DC capacitors**

The manufacturer should take into account the DC voltage distribution between the capacitor elements of a unit and between the series connected unit by using grading resistors or equivalent grading systems.

## **6. General information**

### **6.1 Erection / Installation**

- a) The contractor responsible for installing coupling capacitors shall be responsible for connecting the earth terminal of the coupling capacitor to the station earth.
- b) In addition, the low voltage terminal of the coupling capacitor shall be connected to the primary terminal of the line matching equipment by means of a solid 10 mm round copper bar.
- c) NB: The line matching equipment is generally located at a convenient height for adjustment from ground level and can be up to 2 m from the low voltage terminal of the coupling capacitor.

### **6.2 Finish**

- a) All ferrous surfaces shall be protected from corrosion in accordance with Eskom's Specification 240 – 75655504 as a minimum requirement.
- b) The manufacturer shall ensure that the workmanship of all welded seams and joints, the class of weld material used and the gauge of metal to be welded, are suitable for galvanizing.

### **6.3 Welding**

All welded seams and joints shall be welded on both sides. On tubing and thin sheet metal where this is not practical, the "through welding" technique may be employed. Light seal welding may be used on internal joints where no mechanical strength is required.

### **6.4 Mounting Arrangement**

All items of equipment, for which Eskom will provide mounting plinths, shall have the holes for the holding down bolts so arranged that the unit can be rotated through 90° on its plinth, if required. The spacing for the holding down bolts for coupling capacitors (CCs) shall conform to the top cap arrangements specified in Schedule A of an enquiry document.

### **6.5 Mounting Equipment**

Coupling Capacitors at all line voltages up to and including 550kV will be mounted on a "Medium Equipment Supports" as detailed in Eskom drawings 0.54/302 or 0.54/309 with top caps as detailed in drawings 0.54/744 or 0.54/2214 or 0.54/3473.

### **6.6 Marking**

Rating plates shall be engraved, stamped or embossed on stainless steel (any other material is subject to approval by Eskom) with the following information

#### **6.6.1 For individual units (capacitor units):**

- a) Manufacturer
- b) Serial number
- c) Measured capacitance (pF) and temperature (degree Celsius)
- d) Year of manufacturer

### **6.6.2 For the complete capacitor stack on bottom unit**

- a) The inscription "Coupling Capacitor"
- b) Eskom order number
- c) Manufacturer
- d) Type and Number
- e) Serial number
- f) Rated capacitance
- g) Highest voltage
- h) Temperature category e.g. -10°C /+ 40°C
- i) Insulation level, the insulation shall be given by two numbers separated by a forward slash character, the first number giving the r.m.s. value of power frequency withstand test voltage in kV, the second number giving the crest value of impulse test voltage in kV e.g. 630/1425kV for 400kV coupling capacitor.
- j) Serial numbers of capacitor units comprising the whole capacitor stack
- k) Total creepage distance in mm
- l) Insulating oil type

### **6.7 Tests and Test Certificates**

- a) Type test certificates shall be submitted with tender returnable documents during tender stage.
- b) Should the manufacturer be successful but still have outstanding type test report, the manufacturer shall agree with Eskom on the timeframe of the required type test reports.
- c) Routine test certificates in English shall be submitted to the Project Manager / Buyer as soon as possible but not later than the delivery date of the equipment.
- d) A routine test certificate of each unit in addition to the submitted copy suitably protected shall be placed inside the terminal box of each unit.
- e) The manufacturer shall, on completion of the contract, submit a statement confirming that all units have been routine tested and proved to comply with the routine test requirements of this specification. The statement shall list the serial numbers of the units.
- f) The manufacturer shall retain a complete set of routine test certificates for Eskom's reference.

### **6.8 Inspection and Witnessing of tests**

- a) Eskom reserves the right to appoint a representative to inspect the equipment at any stage of manufacture or to be present at any of the specified tests. Such inspection shall not relieve the manufacturer of his responsibility for meeting all the requirements of the specification, and it shall not prevent subsequent rejection, if such material or equipment is later found to be defective.
- b) The manufacturer shall ascertain in writing whether inspection or witnessed tests or both are required. The manufacturer shall then give Eskom no less than 7 weeks' notice of when the equipment will be ready for inspection or witnessing of the requested tests.
- c) Where Eskom has called for type testing of equipment, which Eskom intends to witness, the manufacture shall prepare a detailed programme for Eskom's approval. Eskom will, at its own discretion, select a number of people from Eskom's various departments and offices to witness these tests. All costs incurred for travelling, accommodation, etc. by these people, will be borne by Eskom.

- d) In the event of the approved testing programme not being satisfactorily completed in the period agreed upon, which would require Eskom to undertake a return visit(s), all costs incurred by Eskom shall be to the manufacturer's account.

## **6.9 Numbering of Test Certificates**

Each routine test and type test certificate shall clearly state the type of test being performed and cross referenced to the appropriate test standard.

## **7. Classification of Tests**

The tests specified in standard IEC 60358 shall apply to this Eskom specification and read in conjunction with the requirements below.

### **7.1 Routine Tests**

#### **7.1.1 Coupling Capacitor**

Each fully assembled coupling capacitor shall be subjected to the following routine tests at the manufacturer's factory, to prove compliance to this standard.

- a) Tightness of equipment (IEC 60358-1 par 9.1)
- b) Capacitance and  $\tan \delta$  measurement at 50Hz (before voltage tests) (IEC 60358-1 par 9.2.2)
- c) High voltage dry power frequency or DC withstand test on HV terminal (IEC 60358-1 par 9.2.3)
- d) Measurement of partial discharges (IEC 60358-1 par 9.2.4)
- e) Resistance measurement if resistance(s) are mounted inside the CC (IEC 60358-1 par 9.2.6)
- f) Power-frequency withstand test on low voltage terminal (IEC 60358-1 par 9.2.5)
- g) Capacitance and  $\tan \delta$  measurement at 50Hz (after voltage tests) (IEC 60358-1 par 9.2.2)

#### **7.1.2 Drain coil**

- a) Current carrying capacity test (IEC 60358-2 par 9.2.200.2.1.1)
- b) Measurement of impedance at power frequency (IEC 60358-2 par 9.2.200.2.1.2)
- c) Voltage test between winding and iron core (IEC 60358-2 par 9.2.200.2.1.3)

#### **7.1.3 Surge Arrester**

- a) AC / DC voltage test (IEC 60358-2 par 9.2.200.2.2.1)

## **7.2 Type Tests**

Unless valid and approved type test certificates specified in this standard and in schedule A are available, the manufacturer must carry out tests on one fully assembled coupling capacitor of each type and rating at an IEC approved test facility. The routine type tests shall be performed before and after type tests at 100% test voltages. All type tests must be carried out on the same specimen.

### **7.2.1 Coupling Capacitor**

- a) EMC RIV (IEC 60358-1 paragraph 10.3)
- b) Discharge test for DC coupling capacitor (IEC 60358-1 par 10.1.2)
- c) Chopped Impulse test (IEC 60358-1 par 10.1.2.2)
- d) Lightning Impulse test (IEC 60358-1 par 10.1.3)

- e) Power frequency withstand voltage wet test for outdoor type equipment for AC voltage for voltage range  $U_m < 300\text{kV}$  (IEC 60358-1 par 10.2.1)
- f) DC withstand voltage wet test for outdoor type equipment for DC voltage (IEC 60358-1 par 10.2.1)
- g) Switching impulse test under wet conditions for AC voltage range  $\geq 300\text{kV}$  (IEC 60358-1 par 10.2.2)
- h) Switching impulse test under wet conditions for DC voltage range  $\geq 750\text{kV}$  (IEC 60358-1 par 10.2.2)
- i) Polarity reversal tests for DC equipment (IEC 60358-1 par 10)
- j) High frequency capacitance and equivalent series resistance test (IEC 60358-2 par 10.200.2)
- k) Measurement of stray capacitance and stray conductance measurements of low voltage terminal (IEC 60358-2 par 10.200.2)
- l) Self-resonant frequency (complete capacitor stack)

### **7.2.2 Drain coil**

- a) Impedance measurement (IEC 60358-2 par 10.201.2.1)
- b) Impulse voltage test (IEC 60358-2 par 10.201.2.2)
- c) Current capability test (IEC 60358-2 par 10.201.2.3)
- d) Short time current test (IEC 60358-2 par 10.201.2.4)

### **7.2.3 Surge Arrester**

- a) Impulse voltage test (IEC 60358-2 par 10.201.2.2)

## **7.3 Special tests**

### **7.3.1 Coupling Capacitor**

- a) Mechanical strength test (IEC 60358-1 par 8.4)

## **8. Authorization**

This document has been seen and accepted by:

Name and surname	Designation
Bheki Ntshangase	Senior Manager PDE HV Plant
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	Instrument Transformers Care Group Members

## **9. Revisions**

Date	Rev	Compiler	Remarks
Aug 2019	1	S Maphosa	New document.

## **10. Development team**

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

- S Maphosa
- Tejin Gosai

## **11. Acknowledgements**

The author would like to acknowledge the input from the instrument transformers care group members.

The schedule A of the relevant AB schedules shall form part of this specification and they shall take precedence over this specification in case the two documents are conflicting.

**Annex A – Equipment Ratings****Table A.1: Standard Insulation Levels**

Nominal system voltage $U_n$ (r.m.s.) kV	Highest voltage for equipment $U_m$ (r.m.s.) kV	Rated power-Frequency withstand Voltage (r.m.s.) kV	Rated Lightning Impulse withstand Voltage (peak) kV	Rated switching withstand Voltage (peak) kV
66	72.5	140	325	
88	100	185	450	
132	145	275	650	
220	245	395	950	
275	300	460	1050	850
400	420	630	1425	1050
500	550	680	1550	1175
765	800	975	2100	1550

**Table A.2: Rated capacitances for coupling capacitors**

Rated system voltage (Line -Line) $U_n$ (kV r.m.s.)	Rated capacitance (pF)
72.5	10 000
100	10 000
145	8 000
245	7 000
300	6 000
420	4 400
550	8 000
800	4 400

**Table A.3: Static withstand test loads**

Highest voltage for equipment $U_m$ (r.m.s.) kV	Static Equipment test load $F_R$ Newtons (N) Voltage terminals
72.5 - 100	500
123 - 170	1000
245 - 362	1250
$\geq 420$	1500
DC Voltages	1500

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### Annex B – Technical Schedules

Item	66 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
1	Manufacturer		xxxxxxxxxxxxxx	
2	Manufacturer's type number		xxxxxxxxxxxxxx	
3	Rated Capacitance	pF	10 000	
4	System conditions for which the capacitor shall be suitable			
	a) Rated frequency	Hz	50	
	b) System neutral		Effectively earthed	
	c) Rated r.m.s. line-to-line voltage	kV	66	
	d) Maximum continuous r.m.s. line-to-line Voltage	kV	72	
5	Insulation			
	a) Minimum crest value of full wave lightning impulse type test withstand voltage to earth at sea level on HV terminal	kV	350	
	b) Characteristic of impulse wave	μs	1.2/50	
	e) Minimum 60 s power frequency wet withstand type test voltage to earth at sea level on HV terminal	kV r.m.s.	140	
	f) Minimum 60 s power frequency dry withstand routine test voltage at sea level on HV terminal	kV r.m.s.	140	
	g) Partial discharge measurement in accordance with 9.4 of IEC 60358-1		Complies	
	h) Pollution level			
	1) Extra heavy - creepage distances	mm	Extra heavy	
	arcing distances	mm		
6	Equipment suitable for carrier injection		Yes	
7	High frequency capacitance and equivalent series resistance	% Ωmax	-5 to +10 of rated C 40	
8	Stray capacitance and stray conductance of low voltage terminals	pF max μS max	200 20	

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Item	66 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
9	Radio influence			
	a) Test voltage	kV	N/A	xxxxxxxxxxxxxxxx
	b) Maximum radio influence voltage	µV	N/A	xxxxxxxxxxxxxxxx
10	Self-resonant frequency of complete capacitor stack	MHz	>1	
11	LV terminals			
	Minimum 60 s power frequency dry			
	withstand routine test voltage on low			
	voltage terminal	kV r.m.s.	10	
12	Capacitor suitable for supporting a line trap		Yes	
13	CC equipment with carrier earthing switch		Yes	
14	Temperature category of CC	°C	–10 to +40	
15	Carrier drain coil			
	a) i) Maximum insertion loss	dB	0.5	
	or			
	ii) Minimum impedance at carrier frequency	kΩ	10	
	b) i) Maximum volt drop at rated frequency with			
	associated CC energized at rated voltage	V	30	
	or			
	ii) Maximum 50 Hz impedance	Ω	20	
	c) Minimum 50 Hz current carrying capacity			
	i) Continuous	A r.m.s.	1	
	ii) Short time for 0,2s	A r.m.s.	30	
	d) Minimum impulse withstand voltage	kV	10	
16	Low voltage terminal arrester			
	Non-linear arrester		Yes	
	a) Rated voltage	kV		
	b) Impulse sparkover voltage	kV		
	c) Minimum 8/20 µs impulse discharge current	kA	5	
17	Type of mounting		Upright on pedestal	
18	High-voltage terminal			
	a) Terminal material and finish		Aluminium	

Item	66 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
	b) Dimensions	mm	26 dia x 100 long	
	c) Arrangement of terminals		Vertical	
	d) Number of terminals		1	
	e) Withstand force without failure	kN	3	
	f) Withstand force without distortion	kN	1.5	
19	LV bushing for connection to carrier equipment		Yes	
20	Mass of complete CVT	kg		
21	Outline Drawings showing:			
	a) dimensions, fixing details and mounting arrangements		Yes	
	b) Details of HV connecting terminals		Yes	
	c) Earth terminal		Yes	
	d) LV connection		Yes	
	e) Nameplate		Yes	
22	Type test reports (Coupling Capacitor)			
	a) Chopped Impulse test		Yes	
	b) Lightning Impulse test		Yes	
	c) Power frequency test (wet)		Yes	
	d) High frequency capacitance and equivalent series resistance test		Yes	
	e) measurement of stray capacitance and stray conductance measurement of LV terminal		Yes	
	f) Self resonant frequency		Yes	
	g) Mechanical strength test		Yes	
23	Type test reports (Drain coil)			
	a) Impedance measurement		Yes	
	b) Impulse voltage test		Yes	
	c) Current capability test		Yes	
	d) Short time current test		Yes	
24	Type test reports (Surge Arrester)			
	a) Impulse voltage test		Yes	

Item	88 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
1	Manufacturer		xxxxxxxxxxxxxxx	
2	Manufacturer's type number		xxxxxxxxxxxxxxx	
3	Rated Capacitance	pF	9 000	
4	System conditions for which the capacitor shall be suitable			
	a) Rated frequency	Hz	50	
	b) System neutral		Effectively earthed	
	c) Rated r.m.s. line-to-line voltage	kV	88	
	d) Maximum continuous r.m.s. line-to-line Voltage	kV	100	
5	Insulation			
	a) Minimum crest value of full wave lightning impulse type test withstand voltage to earth at sea level on HV terminal	kV	450	
	b) Characteristic of impulse wave	μs	1.2/50	
	e) Minimum 60 s power frequency wet withstand type test voltage to earth at sea level on HV terminal	kV r.m.s.	185	
	f) Minimum 60 s power frequency dry withstand routine test voltage at sea level on HV terminal	kV r.m.s.	185	
	g) Partial discharge type test in accordance with 9.4 of IEC 60358-1		Complies	
	h) Pollution level			
	1) Extra heavy - creepage distances	mm	Extra heavy	
	arcing distances	mm		
6	Equipment suitable for carrier injection		Yes	
7	High frequency capacitance and equivalent series resistance	% Ωmax	–5 to +10 of rated C 40	
8	Stray capacitance and stray conductance of low voltage terminals	pF max μs max	200 20	

Item	88 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
9	Radio influence			
	a) Test voltage	kV	N/A	xxxxxxxxxxxxxxxx
	b) Maximum radio influence voltage	µV	N/A	xxxxxxxxxxxxxxxx
10	Self-resonant frequency of complete capacitor stack	MHz	>1	
11	LV terminals			
	Minimum 60 s power frequency dry			
	withstand routine test voltage on low			
	voltage terminal	kV r.m.s.	10	
12	Capacitor suitable for supporting a line trap		Yes	
13	CC equipment with carrier earthing switch		Yes	
14	Temperature category of CC	°C	–10 to +40	
15	Carrier drain coil			
	a) i) Maximum insertion loss	dB	0.5	
	or			
	ii) Minimum impedance at carrier frequency	kΩ	10	
	b) i) Maximum volt drop at rated frequency with			
	associated CC energized at rated voltage	V	30	
	or			
	ii) Maximum 50 Hz impedance	Ω	20	
	c) Minimum 50 Hz current carrying capacity			
	i) Continuous	A r.m.s.	1	
	ii) Short time for 0.2s	A r.m.s.	30	
	d) Minimum impulse withstand voltage	kV	10	
16	Low voltage terminal arrester			
	Non-linear arrester		Yes	
	a) Rated voltage	kV		
	b) Impulse sparkover voltage	kV		
	c) Minimum 8/20 µs impulse discharge current	kA	5	
17	Type of mounting		Upright on pedestal	
18	High-voltage terminal			
	a) Terminal material and finish		Aluminium	

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Item	88 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
	b) Dimensions	mm	26 dia x 100 long	
	c) Arrangement of terminals		Vertical	
	d) Number of terminals		1	
	e) Withstand force without failure	kN	3	
	f) Withstand force without distortion	kN	1.5	
19	LV bushing for connection to carrier equipment		Yes	
20	Mass of complete CVT	kg		
21	Outline Drawings showing:			
	a) dimensions, fixing details and mounting arrangements		Yes	
	b) Details of HV connecting terminals		Yes	
	c) Earth terminal		Yes	
	d) LV connection		Yes	
	e) Nameplate		Yes	
22	Type test reports (Coupling Capacitor)			
	a) Chopped Impulse test		Yes	
	b) Lightning Impulse test		Yes	
	c) Power frequency test (wet)		Yes	
	d) High frequency capacitance and equivalent series resistance test		Yes	
	e) measurement of stray capacitance and stray conductance measurement of LV terminal		Yes	
	f) Self resonant frequency		Yes	
	g) Mechanical strength test		Yes	
23	Type test reports (Drain coil)			
	a) Impedance measurement		Yes	
	b) Impulse voltage test		Yes	
	c) Current capability test		Yes	
	d) Short time current test		Yes	
24	Type test reports (Surge Arrester)			
	a) Impulse voltage test		Yes	

Item	132 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
1	Manufacturer		xxxxxxxxxxxxxx	
2	Manufacturer's type number		xxxxxxxxxxxxxx	
3	Rated Capacitance	pF	8 000	
4	System conditions for which the capacitor shall be suitable			
	a) Rated frequency	Hz	50	
	b) System neutral		Effectively earthed	
	c) Rated r.m.s. line-to-line voltage	kV	132	
	d) Maximum continuous r.m.s. line-to-line Voltage	kV	145	
5	Insulation			
	a) Minimum crest value of full wave lightning impulse type test withstand voltage to earth at sea level on HV terminal	kV	650	
	b) Characteristic of impulse wave	µs	1.2/50	
	e) Minimum 60 s power frequency wet withstand type test voltage to earth at sea level on HV terminal	kV r.m.s.	275	
	f) Minimum 60 s power frequency dry withstand routine test voltage at sea level on HV terminal	kV r.m.s.	275	
	g) Partial discharge type test in accordance with 9.4 of IEC 60358-1		Complies	
	h) Pollution level			
	1) Extra heavy - creepage distances	mm	Extra heavy	
	arcing distances	mm		
6	Equipment suitable for carrier injection		Yes	
7	High frequency capacitance and equivalent series resistance	% Ωmax	-5 to +10 of rated C 40	
8	Stray capacitance and stray conductance	pF max	200	

Item	132 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
	of low voltage terminals	$\mu\text{s max}$	20	
9	Radio influence			
	a) Test voltage	kV	92	
	b) Maximum radio influence voltage	$\mu\text{V}$	2500	
10	Self-resonant frequency of complete capacitor stack	MHz	>1	
11	LV terminals			
	Minimum 60 s power frequency dry			
	withstand routine test voltage on low			
	voltage terminal	kV r.m.s.	10	
12	Capacitor suitable for supporting a line trap		Yes	
13	CC equipment with carrier earthing switch		Yes	
14	Temperature category of CC	$^{\circ}\text{C}$	-10 to +40	
15	Carrier drain coil			
	a) i) Maximum insertion loss	dB	0.5	
	or			
	ii) Minimum impedance at carrier frequency	$\text{k}\Omega$	10	
	b) i) Maximum volt drop at rated frequency with			
	associated CC energized at rated voltage	V	30	
	or			
	ii) Maximum 50 Hz impedance	$\Omega$	20	
	c) Minimum 50 Hz current carrying capacity			
	i) Continuous	A r.m.s.	1	
	ii) Short time for 0,2s	A r.m.s.	50	
	d) Minimum impulse withstand voltage	kV	10	
16	Low voltage terminal arrester			
	Non-linear arrester		Yes	
	a) Rated voltage	kV		
	b) Impulse sparkover voltage	kV		
	c) Minimum 8/20 $\mu\text{s}$ impulse discharge current	kA	5	
17	Type of mounting		Upright pedestal on	
18	High-voltage terminal			



Item	132 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
	a) Terminal material and finish			
	b) Dimensions	mm	26 dia x 100 long	
	c) Arrangement of terminals		Vertical	
	d) Number of terminals		1	
	e) Withstand force without failure	kN	3	
	f) Withstand force without distortion	kN	1.5	
19	LV bushing for connection to carrier equipment		Yes	
20	Mass of complete CVT	kg		
21	Outline Drawings showing:			
	a) dimensions, fixing details and mounting arrangements		Yes	
	b) Details of HV connecting terminals		Yes	
	c) Earth terminal		Yes	
	d) LV connection		Yes	
	e) Nameplate		Yes	
22	Type test reports (Coupling Capacitor)			
	a) EMC RIV		Yes	
	b) Chopped Impulse test		Yes	
	c) Lightning Impulse test		Yes	
	d) Power frequency test (wet)		Yes	
	e) High frequency capacitance and equivalent series resistance test		Yes	
	f) measurement of stray capacitance and stray conductance measurement of LV terminal		Yes	
	g) Self resonant frequency		Yes	
	h) Mechanical strength test		Yes	
23	Type test reports (Drain coil)			
	a) Impedance measurement		Yes	
	b) Impulse voltage test		Yes	
	c) Current capability test		Yes	
	d) Short time current test		Yes	
24	Type test reports (Surge Arrester)			
	a) Impulse voltage test		Yes	

Item	132 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
1	Manufacturer		xxxxxxxxxxxxxxxx	
2	Manufacturer's type number		xxxxxxxxxxxxxxxx	
3	Rated Capacitance	pF	7 000	
4	System conditions for which the capacitor shall be suitable			
	a) Rated frequency	Hz	50	
	b) System neutral		Effectively earthed	
	c) Rated r.m.s. line-to-line voltage	kV	220	
	d) Maximum continuous r.m.s. line-to-line Voltage	kV	245	
5	Insulation			
	a) Minimum crest value of full wave lightning impulse type test withstand voltage to earth at sea level on HV terminal	kV	950	
	b) Characteristic of impulse wave	μs	1.2/50	
	e) Minimum 60 s power frequency wet withstand type test voltage to earth at sea level on HV terminal	kV r.m.s.	395	
	f) Minimum 60 s power frequency dry withstand routine test voltage at sea level on HV terminal	kV r.m.s.	395	
	g) Partial discharge type test in accordance with 9.4 of IEC 60358-1		Complies	
	h) Pollution level			
	1) Extra heavy - creepage distances	mm	Extra heavy	
	arcing distances	mm		
	2) Heavy - creepage distances	mm	Heavy	
	arcing distances	mm		
6	Equipment suitable for carrier injection		Yes	
7	High frequency capacitance and equivalent series resistance	%	-5 to +10 of rated C	
		Ωmax	40	

Item	132 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
8	Stray capacitance and stray conductance	pF max	200	
	of low voltage terminals	µs max	20	
9	Radio influence			
	a) Test voltage	kV	155	
	b) Maximum radio influence voltage	µV	2500	
10	Self-resonant frequency of complete capacitor stack	MHz	>1	
11	LV terminals			
	Minimum 60 s power frequency dry			
	withstand routine test voltage on low			
	voltage terminal	kV r.m.s.	10	
12	Capacitor suitable for supporting a line trap		No	
13	CC equipment with carrier earthing switch		Yes	
14	Temperature category of CC	°C	−10 to +40	
15	Carrier drain coil			
	a) i) Maximum insertion loss	dB	0.5	
	or			
	ii) Minimum impedance at carrier frequency	kΩ	10	
	b) i) Maximum volt drop at rated frequency with			
	associated CC energized at rated voltage	V	30	
	or			
	ii) Maximum 50 Hz impedance	Ω	20	
	c) Minimum 50 Hz current carrying capacity			
	i) Continuous	A r.m.s.	1	
	ii) Short time for 0,2s	A r.m.s.	50	
	d) Minimum impulse withstand voltage	kV	10	
16	Low voltage terminal arrester			
	Non-linear arrester		Yes	
	a) Rated voltage	kV		
	b) Impulse sparkover voltage	kV		
	c) Minimum 8/20µs impulse discharge current	kA	5	
17	Type of mounting		Upright pedestal on	

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Item	132 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment offered
18	High-voltage terminal			
	a) Terminal material and finish		Aluminium	
	b) Dimensions	mm	38 dia x 125 long	
	c) Arrangement of terminals		Vertical	
	d) Number of terminals		1	
	e) Spacing between conductors	mm	N/A	
	f) Withstand force without failure	kN	3	
	g) Withstand force without distortion	kN	1.5	
19	LV bushing for connection to carrier equipment		Yes	
20	Mass of complete CVT	kg		
21	Outline Drawings showing:			
	a) dimensions, fixing details and mounting arrangements		Yes	
	b) Details of HV connecting terminals		Yes	
	c) Earth terminal		Yes	
	d) LV connection		Yes	
	e) Nameplate		Yes	
22	Type test reports (Coupling Capacitor)			
	a) EMC RIV		Yes	
	b) Chopped Impulse test		Yes	
	c) Lightning Impulse test		Yes	
	d) Power frequency test (wet)		Yes	
	e) High frequency capacitance and equivalent series resistance test		Yes	
	f) measurement of stray capacitance and stray conductance measurement of LV terminal		Yes	
	g) Self resonant frequency		Yes	
	h) Mechanical strength test		Yes	
23	Type test reports (Drain coil)			
	a) Impedance measurement		Yes	
	b) Impulse voltage test		Yes	
	c) Current capability test		Yes	
	d) Short time current test		Yes	
24	Type test reports (Surge Arrester)			
	a) Impulse voltage test		Yes	

Item	275 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment
1	Manufacturer			
2	Manufacturer's type number			
3	Rated Capacitance	pF	6 000	
4	System conditions for which the capacitor shall be suitable			
	a) Rated frequency	Hz	50	
	b) System neutral		Effectively earthed	
	c) Rated r.m.s. line-to-line voltage	kV	275	
	d) Maximum continuous r.m.s. line-to-line Voltage	kV	300	
5	Insulation			
	a) Minimum crest value of full wave lightning impulse type test withstand voltage to earth at sea level on HV terminal	kV	1050	
	b) Characteristic of impulse wave	µs	1.2/50	
	c) Minimum crest value of full wave switching impulse type test withstand voltage to earth at sea level on HV terminal	kV	850	
	d) Characteristic of impulse wave	µs	250/2 500	
	e) Minimum 60 s power frequency wet withstand type test voltage to earth at sea level on HV terminal	kV r.m.s.	460	
	f) Minimum 60 s power frequency dry withstand routine test voltage at sea level on HV terminal	kV r.m.s.	460	
	g) Partial discharge type test in accordance with 9.4 of IEC 60358-1		Complies	
	h) Pollution level			
	1) Extra heavy - creepage distances	mm	Extra heavy	
	arcing distances	mm		
	2) Heavy - creepage distances	mm	Heavy	
	arcing distances	mm		

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Item	275 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment
6	Equipment suitable for carrier injection		Yes	
7	High frequency capacitance and	%	-5 to +10 of rated C	
	equivalent series resistance	$\Omega_{\max}$	40	
8	Stray capacitance and stray conductance	pF max	200	
	of low voltage terminals	$\mu\text{s}$ max	20	
9	Radio influence			
	a) Test voltage	kV	190	
	b) Maximum radio influence voltage	$\mu\text{V}$	2500	
10	Self-resonant frequency of complete capacitor stack	MHz	>1	
11	LV terminals			
	Minimum 60 s power frequency dry			
	withstand routine test voltage on low			
	voltage terminal	kV r.m.s.	10	
12	Capacitor suitable for supporting a line trap		No	
13	CC equipment with carrier earthing switch		Yes	
14	Temperature category of CC	$^{\circ}\text{C}$	-10 to +40	
15	Carrier drain coil			
	a) i) Maximum insertion loss	dB	0.5	
	or			
	ii) Minimum impedance at carrier frequency	k $\Omega$	10	
	b) i) Maximum volt drop at rated frequency with			
	associated CC energized at rated voltage	V	30	
	or			
	ii) Maximum 50 Hz impedance	$\Omega$	20	
	c) Minimum 50 Hz current carrying capacity			
	i) Continuous	A r.m.s.	1	
	ii) Short time for 0,2s	A r.m.s.	30	
	d) Minimum impulse withstand voltage	kV	10	
16	Low voltage terminal arrester			
	Non-linear arrester		Yes	
	a) Rated voltage	kV		
	b) Impulse sparkover voltage	kV		
	c) Minimum 8/20 $\mu\text{s}$ impulse discharge current	kA	5	
17	Type of mounting		Upright on pedestal	
18	High-voltage terminal			
	a) Terminal material and finish			

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Item	275 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment
	b) Dimensions	mm	38 dia x 125 long	
	c) Arrangement of terminals		Vertical	
	d) Number of terminals		1	
	e) Spacing between conductors	mm		
	f) Withstand force without failure	kN	3	
	g) Withstand force without distortion	kN	1.5	
19	LV bushing for connection to carrier equipment		Yes	
20	Mass of complete CVT	kg		
21	Outline Drawings showing:			
	a) dimensions, fixing details and mounting arrangements		Yes	
	b) Details of HV connecting terminals		Yes	
	c) Earth terminal		Yes	
	d) LV connection		Yes	
	e) Nameplate		Yes	
22	Type test reports (Coupling Capacitor)			
	a) EMC RIV		Yes	
	b) Chopped Impulse test		Yes	
	c) Lightning Impulse test		Yes	
	d) Switching Impulse test (wet)		Yes	
	e) High frequency capacitance and equivalent series resistance test		Yes	
	f) measurement of stray capacitance and stray conductance measurement of LV terminal		Yes	
	g) Self resonant frequency		Yes	
	h) Mechanical strength test		Yes	
23	Type test reports (Drain coil)			
	a) Impedance measurement		Yes	
	b) Impulse voltage test		Yes	
	c) Current capability test		Yes	
	d) Short time current test		Yes	
24	Type test reports (Surge Arrester)			
	a) Impulse voltage test		Yes	

Item	500 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment
1	Manufacturer			
2	Manufacturer's type number			
3	Rated Capacitance	pF	8000	
4	System conditions for which the capacitor shall be suitable			
	a) Rated frequency	Hz	50	
	b) System neutral		Effectively earthed	
	c) Rated r.m.s. line-to-line voltage	kV	500	
	d) Maximum continuous r.m.s. line-to-line Voltage	kV	550	
5	Insulation			
	a) Minimum crest value of full wave lightning impulse type test withstand voltage to earth at sea level on HV terminal	kV	1550	
	b) Characteristic of impulse wave	µs	1.2/50	
	c) Minimum crest value of full wave switching impulse type test withstand voltage to earth at sea level on HV terminal	kV	1175	
	d) Characteristic of impulse wave	µs	250/2 500	
	e) Minimum 60 s power frequency wet withstand type test voltage to earth at sea level on HV terminal	kV r.m.s.	680	
	f) Minimum 60 s power frequency dry withstand routine test voltage at sea level on HV terminal	kV r.m.s.	680	
	g) Partial discharge type test in accordance with 12 of IEC 358		Complies	
	h) Pollution level			
	1) Extra heavy - creepage distances	mm	Extra heavy	
	arcing distances	mm		
	2) Heavy - creepage distances	mm	Heavy	
	arcing distances	mm		
6	Equipment suitable for carrier injection		Yes	
7	High frequency capacitance and equivalent series resistance	%	-5 to +10 of rated C	
		Ωmax	40	

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Item	500 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment
8	Stray capacitance and stray conductance	pF max	200	
	of low voltage terminals	µs max	20	
9	Radio influence			
	a) Test voltage	kV	349	
	b) Maximum radio influence voltage	µV	2500	
10	Self-resonant frequency of complete capacitor stack	MHz	>1	
11	LV terminals			
	Minimum 60 s power frequency dry			
	withstand routine test voltage on low			
	voltage terminal	kV r.m.s.	10	
12	Capacitor suitable for supporting a line trap		No	
13	CC equipment with carrier earthing switch		Yes	
14	Temperature category of CC	°C	–10 to +40	
15	Carrier drain coil			
	a) i) Maximum insertion loss	dB	0.5	
	or			
	ii) Minimum impedance at carrier frequency	kΩ	10	
	b) i) Maximum volt drop at rated frequency with			
	associated CC energized at rated voltage	V	30	
	or			
	ii) Maximum 50 Hz impedance	Ω	20	
	c) Minimum 50 Hz current carrying capacity			
	i) Continuous	A r.m.s.	1	
	ii) Short time for 0,2s	A r.m.s.	30	
	d) Minimum impulse withstand voltage	kV	10	
16	Low voltage terminal arrester			
	Non-linear arrester		Yes	
	a) Rated voltage	kV		
	b) Impulse sparkover voltage	kV		
	c) Minimum 8/20µs impulse discharge current	kA	5	
17	Type of mounting		Upright on pedestal	
18	High-voltage terminal			
	a) Terminal material and finish			
	b) Dimensions	mm	38 dia x 125 long	
	c) Arrangement of terminals		Vertical	

Item	500 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment
	d) Number of terminals		1	
	e) Spacing between conductors	mm	330	
	f) Withstand force without failure	kN	3	
	g) Withstand force without distortion	kN	1.5	
19	LV bushing for connection to carrier equipment		Yes	
20	Mass of complete CVT	kg		
21	Outline Drawings showing:			
	a) dimensions, fixing details and mounting arrangements		Yes	
	b) Details of HV connecting terminals		Yes	
	c) Earth terminal		Yes	
	d) LV connection		Yes	
	e) Nameplate		Yes	
22	Type test reports (Coupling Capacitor)			
	a) EMC RIV		Yes	
	b) Chopped Impulse test		Yes	
	c) Lightning Impulse test		Yes	
	d) Switching Impulse test (wet)		Yes	
	e) High frequency capacitance and equivalent series resistance test		Yes	
	f) measurement of stray capacitance and stray conductance measurement of LV terminal		Yes	
	g) Self resonant frequency		Yes	
	h) Mechanical strength test		Yes	
23	Type test reports (Drain coil)			
	a) Impedance measurement		Yes	
	b) Impulse voltage test		Yes	
	c) Current capability test		Yes	
	d) Short time current test		Yes	
24	Type test reports (Surge Arrester)			
	a) Impulse voltage test		Yes	

Item	533 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment
1	Manufacturer			
2	Manufacturer's type number			
3	Rated Capacitance	pF	8 000	
4	System conditions for which the capacitor shall be suitable			
	a) Rated frequency	Hz	50	
	b) System neutral		Effectively earthed	
	c) Rated r.m.s. line-to-line voltage	kV (DC)	533	
	d) Maximum continuous r.m.s. line-to-line Voltage	kV (DC)	533	
5	Insulation			
	a) Minimum crest value of full wave lightning impulse type test withstand voltage to earth at sea level on HV terminal	kV	1550	
	b) Characteristic of impulse wave	µs	1.2/50	
	c) Minimum crest value of full wave switching impulse type test withstand voltage to earth at sea level on HV terminal	kV	1175	
	d) Characteristic of impulse wave	µs	250/2 500	
	e) Minimum 60 s power frequency wet withstand type test voltage to earth at sea level on HV terminal	kV r.m.s.	N/A	xxxxxxxxxxxxxx
	f) Minimum 60 s power frequency dry withstand routine test voltage at sea level on HV terminal	kV r.m.s.	N/A	xxxxxxxxxxxxxx
	g) Partial discharge type test in accordance with 12 of IEC 358		Complies	
	h) Pollution level			
	1) Extra heavy - creepage distances	mm	Extra heavy	
	arcing distances	mm		
	2) Heavy - creepage distances	mm	Heavy	
	arcing distances	mm		

Item	533 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment
6	Equipment suitable for carrier injection		Yes	
7	High frequency capacitance and	%	–5 to +10 of rated C	
	equivalent series resistance	$\Omega_{\max}$	40	
8	Stray capacitance and stray conductance	pF max	200	
	of low voltage terminals	$\mu\text{s max}$	20	
9	Radio influence			
	a) Test voltage	kV	266	
	b) Maximum radio influence voltage	$\mu\text{V}$	250	
10	Self-resonant frequency of complete capacitor stack	MHz	>1	
11	LV terminals			
	Minimum 60 s power frequency dry			
	withstand routine test voltage on low			
	voltage terminal	kV r.m.s.	10	
12	Capacitor suitable for supporting a line trap		No	
13	CC equipment with carrier earthing switch		Yes	
14	Temperature category of CC	$^{\circ}\text{C}$	–10 to +40	
15	Carrier drain coil			
	a) i) Maximum insertion loss	dB	0.5	
	or			
	ii) Minimum impedance at carrier frequency	k $\Omega$	10	
	b) i) Maximum volt drop at rated frequency with			
	associated CC energized at rated voltage	V	30	
	or			
	ii) Maximum 50 Hz impedance	$\Omega$	20	
	c) Minimum 50 Hz current carrying capacity			
	i) Continuous	A r.m.s.	1	
	ii) Short time for 0,2s	A r.m.s.	50	
	d) Minimum impulse withstand voltage	kV	10	
16	Low voltage terminal arrester			
	Non-linear arrester		Yes	
	a) Rated voltage	kV		

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Item	533 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment
	b) Impulse sparkover voltage	kV		
	c) Minimum 8/20 $\mu$ s impulse discharge current	kA	5	
17	Type of mounting		Upright on pedestal	
18	High-voltage terminal			
	a) Terminal material and finish			
	b) Dimensions	mm	38 dia x 125 long	
	c) Arrangement of terminals		Vertical	
	d) Number of terminals		1	
	e) Spacing between conductors	mm	N/A	xxxxxxxxxxxxxx
	f) Withstand force without failure	kN	3	
	g) Withstand force without distortion	kN	1.5	
19	LV bushing for connection to carrier equipment		Yes	
20	Mass of complete CVT	kg		
21	Outline Drawings showing:			
	a) dimensions, fixing details and mounting arrangements		Yes	
	b) Details of HV connecting terminals		Yes	
	c) Earth terminal		Yes	
	d) LV connection		Yes	
	e) Nameplate		Yes	
22	Type test reports (Coupling Capacitor)			
	a) EMC RIV		Yes	
	b) DC Discharge Test		Yes	
	c) Lightning Impulse test		Yes	
	d) DC withstand test voltage (DC)		Yes	
	e) Switching Impulse test (wet)		Yes	
	f) Polarity reversal test		Yes	
	g) High frequency capacitance and equivalent series resistance test		Yes	
	g) measurement of stray capacitance and stray conductance measurement of LV terminal		Yes	
	h) Self resonant frequency		Yes	
	i) Mechanical strength test		Yes	

Item	533 kV Coupling Capacitor (CC)	Unit	SCHEDULE A	SCHEDULE B
			Eskom requirements	Technical guarantees for equipment
23	Type test reports (Drain coil)			
	a) Impedance measurement		Yes	
	b) Impulse voltage test		Yes	
	c) Current capability test		Yes	
	d) Short time current test		Yes	
24	Type test reports (Surge Arrester)			
	a) Impulse voltage test		Yes	