TRANSNET
freight rail

A Division of Transnet SOC Limited

# TECHNOLOGY MANAGEMENT

# SPECIFICATION

# WAVE FILTER CAPACITORS FOR 3kV DC TRACTION SUBSTATIONS

| | | |
|---|---|---|
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## 1.0 SCOPE

1.1 This specification covers Transnet Freight Rail's requirements for the supply of wave filter capacitors required for DC applications such as harmonic filters.

1.2 The capacitors shall be used with the resonant shunts to reduce the magnitude of the $6^{th}$, $12^{th}$, $18^{th}$ and the $24^{th}$ harmonics at the busbar of the 3 000V DC rectifier traction substation.

## 2.0 STANDARDS AND PUBLICATIONS

Unless otherwise specified all materials used and equipment developed and supplied shall comply with the current edition of the relevant IEC, SANS and Transnet Freight Rail's publications where applicable.

### 2.1 INTERNATIONAL ELECTROTECHNICAL COMMISSION

| | |
|---|---|
| IEC 60871 -1: 2014: | Shunt capacitors for A.C power systems having a rated voltage above 1 000V. |

### 2.2 SOUTH AFRICAN NATIONAL STANDARDS

| | |
|---|---|
| SANS 1019: | Standard voltages, currents and insulation levels for electricity supply. |
| SANS 1091: | National Colour Standards. |
| SANS 60137: | Insulated Bushings for Alternating Voltages above 1000V |

### 2.3 TRANSNET FREIGHT RAIL'S PUBLICATIONS

| | |
|---|---|
| CEE 0224: 2002 | Drawings catalogues instruction manuals and spares list for electrical equipment supplied under contract. |
| CEE 0045: 2014 | Painting of Steel Components of Electrical Equipment. |
| CEE TCK 004: | Wave filter cell layout. |

## 3.0 TENDERING PROCEDURE

3.1 The tenderer shall indicate compliance with the specification. This shall take the form of a separate document listing all the clause numbers of the specification with an individual clause by clause statement of compliance or non-compliance in English.

3.2 The tenderer shall motivate a statement of non-compliance.

3.3 The tenderer shall submit descriptive literature consisting of detailed technical specifications, general construction details and principal dimensions, together with clear illustrations of the equipment offered.

3.4 The tenderer shall complete and submit the technical data sheet in appendix 2.

3.5 Failure to comply with clauses 3.1, 3.2, 3.3 and 3.4 could preclude a tender from consideration

## 4.0 APPENDICES

The following appendices form an integral part of this specification and shall be read in conjunction with it.

4.1 Appendix 1 -"Schedule of Requirements"

This appendix details the specific requirements for this application.

4.2 Appendix 2 -" Information to be provided by tenderer"

This appendix calls for specific technical information to be furnished by tenderer.

## 5.0 SERVICE CONDITIONS

### 5.1 ATMOSPHERIC CONDITIONS

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|---|---|
| Altitude: | 0 to 1800m above sea level. |
| Ambient Temperature: | -10°C to +55°C. |

| | |
|---|---|
| Relative Humidity: | 10% to 90% |
| Lightning Conditions: | 20 ground flashes per square kilometre per annum. |
| Pollution: | Heavily salt laden or polluted with smoke from industrial sources. |

## 5.2 MECHANICAL SERVICE CONDITIONS

5.2.1 The 3kV DC traction substations are situated next to railway lines and the equipment will therefore be subjected to vibration. The design must take appropriate counter measures to ensure reliability of equipment that is sensitive to vibration.

5.2.2 The capacitors are to be installed in the 3kV DC traction substations and shall be floor mounted.

## 5.3 ELECTRICAL SERVICE CONDITIONS

5.3.1 The nominal no-load DC voltage of a traction substation output varies between 3150V and 3900V.

5.3.2 The maximum voltage under no-load conditions can increase up to 4000V depending on the traction transformer tap settings, Eskom's supply voltage and regenerative breaking.

5.3.3 The substation voltage under load conditions may decrease to 2300 V.

# 6.0 POWER FILTER CAPACITORS

## 6.1 GENERAL

6.1.1 The capacitors shall form part of the resonant shunt connected to the positive and negative busbar to reduce the magnitude of the following harmonics:

- $6^{th}$ at 300Hz,
- $12^{th}$ at 600Hz
- $18^{th}$ at 900Hz,
- $24^{th}$ at 1200Hz

6.1.2 Substations with 12-pulse rectification are normally tuned for $12^{th}$ and $24^{th}$ harmonics at 600Hz and 1200Hz, respectively. The 6-pulse type rectifier substations are normally equipped with 300Hz and 900Hz filters to reduce the effect of the $6^{th}$ and $18^{th}$ harmonics.

6.1.3 The design, construction and operation of the capacitors shall be in accordance to specification IEC 60871 -1: 2014.

6.1.4 A dielectric made from Polyester / Polypropylene film (PPR) is preferable.

6.1.5 The capacitor container shall be constructed of steel or stainless steel and shall have adequate mechanical strength to avoid bulging or bursting.

6.1.6 If lifting lugs are required each capacitor container shall be provided with two lugs.

6.1.7 Each capacitor container shall be provided with an earthing lug drilled for a 10mm screw.

6.1.8 The capacitor container shall be hermetically sealed. Moisture and electrical environmental interference shall have no effect on the capacitor

6.1.9 Each capacitor shall be provided with two bushings, one for each pole. The creepage and air clearance of the bushings shall not be less than 200 mm between the live parts of the bushings, the metal base of the container and between the bushing terminals.

6.1.10 The basic insulation level (BIL) for the bushings shall be at least 100kV.

6.1.11 The capacitors shall be immersed in a non-flammable, non-toxic and biodegradable insulating medium and sealed under vacuum.

6.1.12 The positioning of the capacitors in the wave filter cell shall be in accordance to drawing CEE TCK 004.

6.1.13 The capacitor shall have an integral discharge resistor.

6.1.14 The wave filter equipment in the traction substation is connected in series to a 100A fuse.

## 6.2 CAPACITOR RATINGS

6.2.1 The quantities required of the capacitor values are dependent on the substation rectifier arrangement (12-pulse or 6-pulse rectification).The capacitors shall be made up of the following units:

- 10 Microfarad - 80 ampere continuous,
- 20 Microfarad - 80 ampere continuous,
- 50 Microfarad - 80 ampere continuous.

6.2.2 The capacitor shall be rated to handle up to four and one third (13 000 V) of the full load voltage (3kV) for one minute.

6.2.3 The capacitance tolerance of each capacitor shall not vary by more than 5% at 45 °C. Tenderers shall state and guarantee the tolerance of the capacitors offered.

6.2.4 Tenderers are requested to state the following:

- Maximum permissible voltage of the capacitor,
- Maximum permissible current of the capacitor, as per requirement of clauses 19 and 20 of the IEC 60871 -1: 2014 specification.

## 6.3 ADMISSIBLE OVERLOADS

6.3.1 The continuous rated excess voltage shall be at least 20% of the full load voltage (3 kV).

6.3.2 The excess continuous current rating shall be at least 50% of the rated current.

6.3.3 The rated kilo-Volt-Ampere reactive (kVAr) power shall be at least 40% of the rated power.

## 6.4 RATING PLATE

6.4.1 A non-corrosive metal nameplate shall be fixed to each capacitor container giving the following information:

- Manufactures Name,
- Identification Number,
- Continuously Rated AC Current,
- Rated DC Voltage,
- Temperature Category,
- Insulating Medium,
- Insulating Level,
- Measured Capacitance in Microfarad.

6.4.2 The nameplate shall be positioned such that it is visible in the position of normal service and installation.

## 6.5 INSULATION

6.5.1 All capacitors shall be insulated to withstand a pressure of not less than 20 000 volts DC for one minute between the terminals. This must also be applicable between the short-circuited terminals and the container.

6.5.2 Tenderers are requested to state the expected deterioration pattern of the dielectric of the capacitors with time, while in service, and the test voltages that can be applied to the capacitors approximately six months after the manufacturer's tests.

## 6.6 LIFE EXPECTANCY OF THE CAPACITOR

6.6.1 The capacitor shall have a rated life expectancy of not less than 20 years (175 000 working hours).

## 6.7 TESTS

6.7.1 The capacitors shall be subjected to the test requirements as set out in specification IEC 60871 -1: 2014.

6.7.2 All the types of tests shall be done in accordance to specification IEC 60871 -1: 2014 and shall be conducted on each type of capacitor offered.

6.7.3 A Type Test certificate shall be submitted for each type of capacitor offered.

6.7.4 The tenderer shall also submit routine test certificates for each capacitor offered.

## 7.0 QUALITY ASSURANCE

7.1 Transnet Freight Rail reserves the right to carry out inspection and any tests on the equipment at the works of the supplier/manufacturer.

7.2 Arrangements will be made timeously for such inspections to be carried out before the delivery of the equipment.

## 8.0 GUARANTEE AND DEFECTS

8.1 The tenderer shall guarantee the satisfactory operation of the equipment supplied and accept liability for maker's defects, which may appear in design, materials and workmanship.

8.2 The guarantee period for the equipment shall expire after: A period of 12 months commencing on the date of installation and commissioning of the equipment or the date the equipment is handed over to Transnet Freight Rail whichever is the latest.

## 9.0 PACKAGING AND TRANSPORT

9.1 The tenderer shall ensure that the equipment be packed in such a manner that it will be protected during handling and transportation.

9.2 The tenderer shall provide transport for the delivery of the equipment to the site where it is required.

## 10.0 BIBLIOGRAPHY

[1] SANS, "SANS 1019: 2014 Standard voltages, currents and insulation levels for electricity supply," SABS Standards Division, Pretoria, South Africa, 2014.

[2] SANS, "SANS 1091: National Colour Standards," SABS standard division, Pretoria, South Africa.

[3] SANS, "SANS 60137: Insulated Bushings for Alternating Voltages above 1000V," SABS standard division, Pretoria, South Africa.

[4] IEC, "IEC 60871 -1: 2014: Shunt capacitors for A.C power systems having a rated voltage above 1 000V," International Electrotechnical Commission, 2014.

END

## 11.0 APPENDIX 1

**SCHEDULE OF REQUIREMENTS**

(To be filled in by Transnet Freight Rail's Maintenance Depot)

## 1.0 CAPACITORS

1.1 10 MicroFarad

- Quantity Required: _____

1.2 20 MicroFarad

- Quantity Required: _____

1.3 50 MicroFarad

- Quantity Required: _____

## 2.0 MAINTENANCE DEPOT

2.1 Depot Name: _____

2.2 Depot Address: _____

## 12.0 APPENDIX 2

### TECHNICAL DATA SHEET

(To be filled in by Tenderer)

- Capacitance Value ($C_N$):_____
- Capacitance Tolerance:_____
- Detailed Description of Capacitor:_____
- Overall Mass of the Capacitor:_____
- Overall Dimensions of the Capacitor: _____
- Dielectric Insulating Medium:_____
- Container Material:_____
- Rated Current in RMS ($I_N$):_____
- Rated Voltage in RMS ($U_N$):_____
- Rated Output ($Q_N$):_____
- Temperature Category:_____
- Maximum Permissible AC Current:_____
- Maximum Permissible AC Voltage:_____
- Maximum Permissible Temperature:_____
- Capacitor Losses:_____
- Active Power:_____
- Steady State Condition:_____
- Residual Voltage:_____
- BIL (Bushing):_____
- Life Expectancy:_____

**END**