

**JOHANNESBURG WATER (SOC) Ltd.**

**BULK WASTEWATER**

**PARTICULAR SPECIFICATION**

**E15 : ELECTRICAL TRANSFORMERS**



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## DOCUMENT CONTROL SHEET

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## **PARTICULAR SPECIFICATION: VOLUME E15: ELECTRICAL TRANSFORMERS**

### **CONTENTS**

<b>E15.1</b>	<b>SCOPE.....</b>	<b>3</b>
<b>E15.2</b>	<b>STATUTORY DOCUMENTS AND STANDARDS .....</b>	<b>3</b>
<b>E15.2.1</b>	<b>Standards.....</b>	<b>3</b>
<b>E15.2.2</b>	<b>Particular Specifications to be read in conjunction with this specification .....</b>	<b>3</b>
<b>E15.3</b>	<b>ENVIRONMENTAL CONDITIONS .....</b>	<b>3</b>
<b>E15.4</b>	<b>CONSTRUCTION REQUIREMENTS .....</b>	<b>4</b>
<b>E15.4.1</b>	<b>General .....</b>	<b>4</b>
<b>E15.4.2</b>	<b>Indoor Transformers.....</b>	<b>4</b>
<b>E15.4.3</b>	<b>Cooling Method .....</b>	<b>4</b>
<b>E15.5</b>	<b>TRANSFORMER OIL .....</b>	<b>4</b>
<b>E15.6</b>	<b>TRANSFORMER LOSSES.....</b>	<b>4</b>
<b>E15.7</b>	<b>WINDINGS .....</b>	<b>5</b>
<b>E15.8</b>	<b>TAP CHANGER SWITCH.....</b>	<b>5</b>
<b>E15.9</b>	<b>FIXTURES.....</b>	<b>5</b>
<b>E15.9.1</b>	<b>Conservator Tank.....</b>	<b>5</b>
<b>E15.9.2</b>	<b>Cable Box MV side .....</b>	<b>5</b>
<b>E15.9.3</b>	<b>Cable Box LV Side .....</b>	<b>5</b>
<b>E15.9.4</b>	<b>Jacking Pads and Lifting Lugs .....</b>	<b>6</b>
<b>E15.9.5</b>	<b>Wheels.....</b>	<b>6</b>
<b>E15.10</b>	<b>AUXILIARY EQUIPMENT .....</b>	<b>6</b>
<b>E15.10.1</b>	<b>Oil Level Gauges .....</b>	<b>6</b>
<b>E15.10.2</b>	<b>Air Breather.....</b>	<b>6</b>
<b>E15.10.3</b>	<b>Buchholz Relays .....</b>	<b>6</b>
<b>E15.10.4</b>	<b>Dual-type Thermometers.....</b>	<b>6</b>
<b>E15.10.5</b>	<b>Pressure Relief Device .....</b>	<b>6</b>
<b>E15.10.6</b>	<b>Oil Filling Point .....</b>	<b>6</b>
<b>E15.10.7</b>	<b>Oil Drain Point .....</b>	<b>6</b>
<b>E15.10.8</b>	<b>Alarm and Trip Contacts .....</b>	<b>6</b>
<b>E15.11</b>	<b>PAINTING .....</b>	<b>7</b>
<b>E15.12</b>	<b>TESTS REQUIREMENTS.....</b>	<b>7</b>
<b>E15.13</b>	<b>DRAWINGS .....</b>	<b>8</b>
<b>E15.14</b>	<b>SOUND LEVEL.....</b>	<b>8</b>
<b>E15.15</b>	<b>IDENTIFICATION TAGS .....</b>	<b>8</b>
<b>E15.16</b>	<b>TESTING AND COMMISSIONING.....</b>	<b>8</b>
<b>E15.17</b>	<b>MEASUREMENT AND PAYMENT.....</b>	<b>9</b>

## **E15.1 SCOPE**

This section covers the design, manufacture, supply and delivery and assembling on site of oil filled distribution transformers.

## **E15.2 STATUTORY DOCUMENTS AND STANDARDS**

### **E15.2.1 Standards**

The transformers offered in terms of this specification shall comply with the requirements as set out in the detailed specification as well as the relevant sections of SANS 780:2004.

The units offered will have the SANS mark of approval.

Any deviation from these conditions will be clearly indicated, and any equipment so offered will only be used with the express permission/concession, in writing, of the Engineer.

The equipment offered and work performed, shall comply with the requirements of the governing occupational Health and Safety act, at time of tender.

Transformer shall be produced in a factory with a SANS ISO 9001 accredited quality system.

- |                 |   |   |
|-----------------|---|---|
| a) SANS 780     | : | Distribution transformers   |
| b) SANS 60078   | : | Power transformers  |
| c) SANS 555     | : | Fluids for electro-technical applications   |
| d) SANS 60529   | : | Degrees of Protection Provided by Enclosures (IP Code)  |
| e) SANS 12944   | : | Paints and varnishes - Corrosion protection of steel structures by protective paint systems   |
| f) SANS 10064   | : | The preparation of steel surfaces for coating   |
| g) SANS 121     | : | Hot dip galvanized coatings on fabricated iron and steel articles   |
| h) SANS 1091    | : | National colour standard  |
| i) SANS 61958   | : | Indicating devices  |
| j) SANS 10142-2 | : | The wiring of premises Part 2: Medium-voltage installations above 1 kV a.c. not exceeding 22 kV a.c. and up to and including 3 MVA installed capacity |

### **E15.2.2 Particular Specifications to be read in conjunction with this specification**

The following particular specifications shall be read in conjunction with the Project Specification:

- |        |   |  |
|--------|---|--|
| a) E06 | : | ELECTRICAL MEDIUM AND LOW VOLTAGE CABLE INSTALLATION |
| b) E05 | : | LOW VOLTAGE POWER AND CONTROL CABLES                 |
| c) E08 | : | WIRING   |
| d) E11 | : | GENERAL EARTHING AND LIGHTNING PROTECTION            |
| e) E26 | : | ELECTRICAL SPECIFICATION FOR COLOUR CODES            |

## **E15.3 ENVIRONMENTAL CONDITIONS**

The transformers shall be suitable for use at full continuous rating, in terms of Paragraph 1.3 of the latest issue of SANS 780.

## **E15.4 CONSTRUCTION REQUIREMENTS**

In addition to the requirements of SANS 780, the following will also be considered:

### **E15.4.1 General**

The transformer vector symbol shall be Dyn11 (step down transformer) of YNd11 (step-up transformers) as per SANS 780 unless otherwise specified in the detailed specification.

Total and component losses shall not exceed 10% of the loss figures as indicated in the tender.

The nominal voltages (primary and secondary) will be as specified in the detailed specification/data sheet.

Transformers will have a removable top lid for maintenance and repair purposes. The lid must be fixed with bolts and nuts, sized to contain integrity of the transformer tank under all circumstances.

All openings on the transformer tank must be sealed with cork gaskets.

The minimum transformer rating will be 500kVA.

The maximum transformer rating will be 1600kVA.

Transformers offered will be painted and finished in accordance with SANS 780.

### **E15.4.2 Indoor Transformers**

Transformers supplied will be free breathing in accordance with SANS 780.

- (a) The contractor will specify the required room size to accommodate the transformer with sufficient free space for maintenance purposes.
- (b) The doors to the transformer room should be sized to allow the installation/removal of the transformer without dismantling the unit.
- (c) A bund wall must be erected around all oil-filled transformers. The bund area must be sized to hold 1.5 times the transformer oil. The bund wall must be sealed to contain the oil, no seepage into cable trenches or surrounding areas will be allowed. The bund area must be supplied with a 50mm stop valve to allow drainage of spilled oil. The stop valve must be kept in the closed position at all times.
- (d) An approved firewall must be erected between the transformer and all adjacent equipment/areas to prevent the spreading of smoke and fire. The firewall should have a fire rating of at least 1 hour.

### **E15.4.3 Cooling Method**

The cooling method used shall be the method represented by the symbol group ONAN in accordance with SANS 780.

## **E15.5 TRANSFORMER OIL**

The transformers will be provided and delivered filled with the required quantity of insulating oil. Should the transformer be delivered with the conservator tank separate from the transformer (dismantled), the supplier will be responsible for assembling the transformer on site and filling it with oil. The oil shall be filtered and tested for break down voltage (BDV) and moisture content before filling. The oil shall be filled under vacuum. All oil shall be new and the use of recycled oil is not acceptable. The oil shall comply with SANS 555.

## **E15.6 TRANSFORMER LOSSES**

Low loss transformers are required for this tender. Accordingly, the Engineer shall retain the right to either not accept the transformers offered or to call for changes to be made to the transformers before acceptance,

Should in the Engineer's opinion, either the no-load losses or the full-load losses of the transformers supplied by the successful tenderer exceed the loss figures specified in the tender, by a quantity exceeding the permissible tolerances in accordance with SANS 780. Any such

changes, called for by the Engineer, will be for the account of the tenderer.

Where any transformer is accepted with reduced performance figures and where tolerances exceed the provisions of paragraph 4.9 of SANS 780, the tender price will be adjusted and reduced by a sum equal to the capitalized value of the excess losses, calculated in accordance with the following capitalization formula:

$$K = 1,46 V + 2,86 N$$

Where

K = capitalized value of the losses in South African Rand (ZAR)

V = full - load losses at normal voltage and frequency, in watts

N = No - load losses at normal voltage and frequency, in watts

In view of adjusting the tender price, the said excess losses shall be taken as the quantity by which the actual losses exceed the loss figure in the tender document, without taking into consideration the permissible tolerances in accordance with SANS 780.

The no - load and full – load losses will be taken into consideration independently when calculating the adjustment of the tender price. Low full-load losses will not be able to compensate for high no-load losses, or vice versa.

Neither will the tender price be increased, should the actual no-load losses and/or full load losses be less than the losses tendered.

The above formula with V and N will be used in adjudicating the tender.

#### **E15.7 WINDINGS**

HV and LV windings shall be wound from aluminium conductor. All internal busbars must be aluminium. The core/coil assembly shall be securely held in position to avoid any movement under short circuit conditions.

#### **E15.8 TAP CHANGER SWITCH**

A off-load tap changer switch shall be installed. The switch shall have 5 tap positions, i.e. - 5%, - 2.5%, Normal, + 2.5%, + 5%.

Tap changing shall be carried out by means of an externally operated self-position switch. Provision shall be made for locking the tapping switch handle in position. The tap setting shall be clearly visible in each step. The displayed tap numbers shall be referenced on the diagram plate.

#### **E15.9 FIXTURES**

##### **E15.9.1 Conservator Tank**

A conservator tank shall be provided on the transformer tank as per SANS 780.

##### **E15.9.2 Cable Box MV side**

The transformer shall be fitted with a suitable cable box on the MV side to terminate one 11kV/ 3 core copper conductor cable up to 240 sq. mm. The cable box must prevent the ingress of moisture into the box (IP54). The cable box shall be of the split type with machined faces and must be fitted with a quality gasket. It must be fitted with a separate split type gland with an earthing clamp (bottom cable entry unless otherwise specified in the detailed specification/datasheet). The bushings of the cable box shall be fitted with nuts and stem to take the cable cores without bending them. The stem shall be of copper with copper nuts. The cross section of the terminal rods shall be adequate for carrying the rated currents and shall have a diameter of not less than 12 mm. Cable support clamp should be provided to avoid tension due to cable weight. Phase windings shall be marked in both the terminal boards inside the tank and on the outside with capital letter 1U, 1V, 1W

##### **E15.9.3 Cable Box LV Side**

The transformer shall be fitted with a suitable LV cable box having non-magnetic material gland plate with appropriate sized single compression glands on LV side to terminate (bottom cable

entry unless otherwise specified in the detailed specification/datasheet) 1 kV/single core XLPE unarmoured cable (size as per detail requirement). Bushings shall be marked by small letter 2u, 2v, 2w. The neutral point terminal shall be indicated by the letter 2n. Neutral terminal is to be brought out and terminated to the tank earthing point.

E15.9.4 Jacking Pads and Lifting Lugs

Sufficient jacking pads shall be fitted to jack the oil-filled transformer into position. The tank plate and the lifting lugs shall be of such strength that the complete transformer filled with oil may be lifted without the use of a sling spreader bar. A lifting procedure must be supplied.

E15.9.5 Wheels

Transformers must stand on skids. No wheels will be allowed. Where wheels are required to position the transformers, the wheels must be removed after positioning.

**E15.10 AUXILIARY EQUIPMENT**

The required auxiliary equipment to be included are specified in the detailed specification.

E15.10.1 Oil Level Gauges

Oil level gauges shall be flush mounted with the gauge glass (of plastic material) securely attached to the tank throughout its length by means of a metal shroud. The oil in the gauge will not be in contact with the air outside the tank.

E15.10.2 Air Breather

Silica gel air breathers shall have a window for inspection of the condition of the silica gel and oil cup or other device to prevent continuous contact of the silica gel with the air outside the transformer.

E15.10.3 Buchholz Relays

Buchholz relays shall be of the double float or bucket type and shall be of approved manufacture.

The gas release cock for the relay shall be placed within easy reach from ground level and connected to the relay by small-bore non-ferrous tubing. The sight window of the relay will be clearly visible from ground level.

The Buchholz relays will be equipped with a set of alarm and trip contacts.

E15.10.4 Dual-type Thermometers

Dual-type thermometers will be graduated in °C for registering "top oil" temperatures. The instrument will be provided with resettable maximum-temperature indicator and a pair of adjustable alarm contacts that can be set to close at a predetermined temperature. An additional set of adjustable contacts will be provided for tripping purposes. All thermistors or other temperature sensors will be installed in oil pockets. Unused thermometer pockets will be fitted with a captive screw cap.

E15.10.5 Pressure Relief Device

A pressure relief device is not required.

E15.10.6 Oil Filling Point

A point must be provided to fill the oil level up. The point must be of the screw type and be sealed to prevent air intake when not in use.

E15.10.7 Oil Drain Point

A drain point must be provided to drain the oil from the transformer tank. A shut-off valve must be installed at the drain point. The drain point must be sealed with a screw type cover when not in use.

E15.10.8 Alarm and Trip Contacts

All alarm contact will be capable of breaking up to 20W DC, inductive, at the specified alarm and

tripping voltages.

All contacts will be capable of making and carrying for 0.5 sec, a current corresponding to 150 watts at the specified alarm and tripping voltage.

All auxiliary relays associated with tripping shall be DC operated and suitable for the specified alarm and tripping currents.

Alarm and tripping contacts will be provided with un-grounded and electrically independent circuits.

#### **E15.11 PAINTING**

The interior and exterior surfaces of a tank, the tank cover and the conservator tank shall be abrasive blast-cleaned or pickled, rinsed and dried (SANS 10064).

##### **(e) Corrosion protection**

A corrosion preventative layer will be applied to the interior surfaces of the transformer. The transformer and cooling radiators will be painted as specified in SANS 780 and SANS 12944.

##### **(f) Final Coat Colour**

The colour of the final paint coat is C12 Avocado Green (6022-G91Y) according to SANS 1091 unless specified otherwise in the detailed specification.

##### **(g) Damaged Paintwork**

Any damage occurring to any part of a painting scheme shall be made good to the same standard of corrosion protection and appearance as that was originally applied.

#### **E15.12 TESTS REQUIREMENTS**

Routine factory acceptance tests (FAT) in accordance with SANS 780 shall be performed at the supplier's facility prior to delivery. Type tests and special tests to SANS 780 shall be performed on one transformer of the size to be delivered in terms of this contract unless the manufacturer can provide certificates of previous tests done on identical transformers. The following routine tests will be carried out on the transformer as a minimum (The tests are described in SANS 780) The Engineer reserves the right to witness the FAT tests.

- (a) Measurement of winding resistance**
- (b) Insulation resistance measurement**
- (c) Measurement of voltage ratio**
- (d) Impedance test**
- (e) Vector group test**
- (f) Measurement of transformer losses**
- (g) Induced over voltage test**
- (h) Separate source voltage withstand test**
- (i) Tank effectiveness of sealing**

The results of these tests will be made available to the Engineer for his evaluation prior to acceptance and delivery of the transformers. Two copies of test results will be provided to the Engineer.

The contractor must arrange for site acceptance tests (SAT) on all transformers. A schedule of all tests to be done must be provided by the contractor for approval prior to commencement of manufacture. The SAT must be witnessed by the Engineer or the client's representative. The results of the SAT will be recorded and issued to the Engineer.

The contractor shall arrange for thermal imaging of the transformer a minimum of 1 week after commissioning and while the transformer is in continuous use. The results of the imaging and



SAT are to form part of the deliverable Operations and Maintenance Manuals.

#### **E15.13 DRAWINGS**

Tenderers shall furnish the following drawings together with their tenders:

- (a) Outline drawings of the transformers, showing:
  - i. All external fittings;
  - ii. Typical mass of the transformer with and without oil;
  - iii. Typical volume of transformer oil;
  - iv. The most important external dimensions.
- (b) Details of MV and LV bushings

The successful tenderer will provide three copies of each of the following drawings, to the Engineer, before manufacturing may commence:

- (a) General Arrangement drawings indicating
  - i. External fittings;
  - ii. Lifting lugs and lifting requirements;
  - iii. The mass of the transformer with and without oil;
  - iv. The volume of the transformer oil;
  - v. Transformer dimensions with free space required;
  - vi. The transformer rating plate (to SANS 780);
- (b) The internal construction of the transformer and the arrangement of the windings, giving full particulars of insulation, as well as the bracing of the cores and windings;
- (c) A diagram of the connections showing the exact manner in which the leads are taken from the tank, as well as the number of windings;
- (d) Schematic drawings of the alarm and trip circuits.

#### **E15.14 SOUND LEVEL**

During design and manufacture of transformers, care should be exercised to limit transformer noise and vibration to within the parameters as recommended in SANS 780.

#### **E15.15 IDENTIFICATION TAGS**

All data on the identification tags shall be in SI units.

#### **E15.16 TESTING AND COMMISSIONING**

During testing and commissioning, the contractor shall:

- (a) Perform an transformer oil test prior to livening of the transformer;
- (b) Perform a visual inspection to ensure that the installation complies to the requirements specified herein as well as in detailed specifications;
- (c) Ensure the rating of all equipment is as specified;
- (d) Test the function of all alarm and trip signals to ensure the transformer circuit breaker trips as required;
- (e) Do a transformer insulation resistance test (as described in SANS 780).
- (f) When the transformer is on load, the correct tap changer setting must be determined. Tap setting changes can only be done off-load.

**E15.17**

**MEASUREMENT AND PAYMENT**

<u>Item</u>	<u>Unit</u>
Supply, delivery and off-loading.....	No

The tendered rate will include full compensation for the supply, delivery and off-loading of the transformers together with all other materials and ancillary equipment required to effect a complete installation.

<u>Item</u>	<u>Unit</u>
Install, test and commission.....	No

The tendered rate will include full compensation for installing the transformers in the designed positions and for the testing and commissioning of the transformers.

The rate shall include for the installation of the control cables between the transformer and the switchgear and all auxiliaries and the connection thereof.

The rate will include for the filling of the transformer with oil to the specified level, as well as the undertaking of any drying out process which may be required to ensure the transformers are ready for operation.