

**OMAN WASTEWATER
SERVICES COMPANY S.A.O.C**



**الشركة العمانية
لخدمات الصرف الصحي ش.م.ع.م**

OMAN WASTEWATER SERVICE COMPANY

ELECTRICAL STANDARD SPECIFICATION

SECTION 02

POWER TRANSFORMERS

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1-0 SCOPE

This specification covers the design, manufacture and testing of Oil filled and cast resin insulated power transformers to be installed within Oman Wastewater Services Company plants.

2-0 STANDARDS SPECIFICATIONS

Power transformers shall conform in design, materials and performance (except where otherwise specified) with all relevant Statutory Regulations and the latest editions (at time of order) of all relevant British and Harmonized European standards and international standards including:

- IEC 76 Power transformers
- IEC 85 Recommendations for the classification of materials for the insulation of electrical machinery and apparatus in relation to their thermal stability in service,
- IEC 214 On-Load tap changers,
- IEC 529 classification of degree of protection provided by enclosures
- IEC 551 Measurement of transformers and reactors sound levels
- IEC 726 Dry type power transformers
- Omani Electrical Standards

3-0 SERVICE AND ENVIRONMENTAL CONDITIONS

Power transformers shall, in all respects, be suitable for operation under service conditions stated on Electrical Standard Specification – Section 01.

4-0 ELECTRICAL SYSTEM

- 4-1 The electrical systems rating (voltage, frequency, etc.) shall be as stated on the transformers data sheets.
- 4-2 Power transformers shall be suitable for operation, without deleterious effect, with the variations of voltage and frequency as stated on the transformers data sheets as follows.
- 4-3 The voltage levels are as follows:
- 33 kV, 11kV and 6.6 kV - nominal regulated on – load voltage.
 - 6.6 kV or 3.3 kV - nominal regulated secondary voltage.
 - 0.433 kV - nominal open circuit secondary voltage

5-0 CONSTRUCTION

- 5-1 The transformer cores shall be manufactured from non-ageing, low loss and high permeability cold reduced grain oriented steel to BS 6404. Preference shall be given to transformers constructed with mitred cores in which no core bolts are used. Lifting eyes or lugs shall be provided for removal of the core assembly.
- 5-2 The core shall be earthed at one point only with a readily accessible removable connection which may be conveniently opened to check the core insulation.
- 5-3 Transformers shall be of the oil immersed type for outdoor service and cast resin dry type for indoor service.
- 5-4 Enclosures for cast resin transformers shall be of sheet steel with either lockable doors, or access panels fixed by unique fixings requiring a special tool for removal. Where lockable doors are fitted, the locks shall be interlocked with the feeder HT Switchgear, to prevent access unless the circuit is earthed through the switchgear.
- 5-5 Adequate ventilation shall be provided into the enclosure, which shall have a minimum protection rating of IP 31 to BS EN 60529. Shrouds shall also be provided within the enclosure to prevent an object being pushed through vents onto live parts. Lifting facilities shall be provided.

- 5-6 Transformers shall be manufactured and tested to the relevant British or Harmonised European standard.
- 5-7 Transformer oil shall be of the mineral oil type and conform to BS 148.
- 5-8 Where Non flammable fluid filled transformers are specified they shall have the same fittings and location features as those for oil filled transformers.
- 5-9 If the transformer is to be filled with oil at site, the Contractor shall provide oil and filtration equipment of suitable capacity.
- 5-10 The Contractor shall supply a schedule of insulating oils and greases, with the Contractor recommends for use with the transformer.
- 5-11 For outdoor service transformers shall be either of hermetically sealed type or breathing type with conservator tank, as stated on the transformers data sheets.
- 5-12 When oil filled transformers are used indoors, they shall only be installed at a ground level.
- 5-13 The primary windings of all transformers shall be closed delta connected. Unless specified otherwise, the winding configuration shall be Dyn11.
- 5-14 The secondary windings of all transformers, except for special applications such as 12 pulse inverters, shall be star connected with the star/neutral point brought out to the low voltage terminal box.
- 5-15 The transformer star/neutral terminal shall be capable of accepting cabling as specified in the Particular Specification.
- 5-16 The star/neutral point of the secondary windings shall be solidly earthed.
- 5-17 The following fittings and auxiliary equipment shall be fitted, where applicable, to oil filled transformers:
- Conservator (transformers of 2 MVA and above)
 - Buchholz relay (transformers of 2 MVA and above) with alarm and trip contacts, 2 sets N/C (i.e. open for alarm and trip conditions, and to be confirmed) contacts for both alarm and trip settings,
 - Silica Gel breather, weatherproof, complete with first filling of silica gel,

- Two drain valves (in series), each fitted with a padlock facility. Two padlocks shall be provided,
- Auxiliary terminal/marshalling box housing all terminals for the alarm and trip contacts from Buchholz and winding temperature units,
- The terminal box shall have a degree of protection IP 55 W minimum. The Contractor shall provide all cabling between trip and alarm contacts and the terminal/marshalling box,
- Oil level gauge on conservator tank with markings indicating cold and hot oil levels with drain cock,
- Tank oil thermometer pocket complete with dial type indicating thermometer, fitted with alarm and trip contacts, 2 sets N/C, (to be confirmed) for both alarm and trip settings,
- Lifting and jacking lugs,
- Skid under base,
- Explosion vent.

5-18 The following fittings and auxiliary equipment shall be fitted, where applicable, to cast resin transformers:

- Winding temperature indicator fitted with alarm and trip contacts, 2 sets N/C,
- (to be confirmed) for both alarm and trip settings,

- Auxiliary terminal/marshalling box housing all terminals for the alarm and trip contacts from winding temperature units,
- The terminal box shall have a degree of protection IP 54 W minimum. The Contractor shall provide all cabling between trip and alarm contacts and the terminal/marshalling box.

- 5-19 Hermetically sealed transformers shall be permanently sealed and rendered tamper proof. The tank cover shall be welded to the tank with a continuous bead. The tank cover and cooling system shall have the mechanical strength to withstand, from on-load to full-load, without distortion, the internal pressures caused by expansion or contraction of the oil under the service conditions.

The following accessories shall be fitted:

- A pressure relief device,
- A sudden pressure relay (with trip contact),
- An oil level indicator, with a minimum level marking. Oil sampling facilities shall be provided.

- 5-20 Breathing type transformers shall be provided with:

5-20.1 Separate lifting lugs for the tank cover

5-20.2 Filling/filter connection valve located at the top of the conservator

5-20.3 Drain/filter connection valve located at the lowest part of the tank.

5-20.4 An oil level indicator, with a minimum level marking.

5-20.5 Silica gel breather, weatherproof, complete with first filling of silica gel.

5-20.6 A Buchholz relay with alarm (gassing) contacts and trip (oil surge) contacts.

5-20.7 Conservator tank with oil fill point, provision for collection of water and sludge and a drain valve in the lowest part of the conservator.

5-20.8 Thermometer pocket.

- 5-21 Dry type transformers shall be equipped with IP30 metallic protection housing and fitted with thermal protection devices for each phase..
- 5-22 Transformers shall be skid mounted suitable for erection on concrete foundations. The skid shall be arranged such that cables may rise directly up to the terminations.
- 5-23 For cooling purposes either the tank walls shall be corrugated or cooling radiators shall be fitted. Cooling shall be ONAN or ONAF, as stated on the transformers data sheets. Transformers shall be equipped with all necessary fans, controls and wiring suitable for a 415V, 50Hz, 3 wire power supply. The motor control circuit voltage shall be 240V, 50Hz, single phase 2 wire one line grounded. All fan, motor starters and controls shall be housed in a separate cabinet mounted on the transformer. Design of tank and cooling radiators shall permit easy cleaning and painting.
- 5-24 Transformer tanks shall be shot blasted internally and externally to remove mill and welding scale. Immediately after shot blasting, a primer coat of paint shall be applied to external surfaces.
- 5-25 Tanks shall be oil pressure tested to at least 34 kN/m² plus the dead weight of oil contained under the operating conditions.
- 5-26 Tanks shall be provided with a suitably sized earthing connection.
- 5-27 Externally operated off-circuit tap changing facilities shall be provided. The tapping range shall be as stated on the data sheets.
- 5-28 Tapping range shall be $\pm 2\%$, $\pm 5\%$ of the principal tapping.
- 5-29 A padlock facility shall be provided for locking the tap change selector in any chosen position. A padlock and one key only, shall be provided.
- 5-30 On-load tap changers shall be in accordance with IEC Standard and the data sheets.
- 5-31 Termination facilities shall be provided as follows:
- 5-31.1 High voltage connection will be by cable, size and type as specified on the data sheets. Terminal box shall be air insulated.

- 5-31.2 Unless specified otherwise, HT cable boxes shall be designed for dry type terminations, and shall have adequate space to permit cores of cables to cross over if required.
- 5-31.3 It shall be possible to remove the cable boxes without breaking the cable seals or oil seals or if oil filled, draining off the oil.
- 5-31.4 The primary and secondary terminal boxes shall be provided with gland plates, to suit the H.V. and L.V. cables. Non-magnetic gland plates shall be provided where single core cables are specified. All cable entries shall be on the bottom of the terminal boxes.
- 5-31.5 Low voltage connections will be by busduct or by cable as stated on the transformers data sheets. Terminal box shall be air insulated. The transformer terminations shall be drilled and supplied with all necessary nuts, bolts and washers required to make the busduct/or cable connections.
- 5-31.6 The primary and secondary terminal boxes shall be provided with gland plates, to suit the H.V. and L.V. cables. Non-magnetic gland plates shall be provided where single core cables are specified. All cable entries shall be on the bottom of the terminal boxes.
- 5-31.7 Where the secondary system is three phases, three wires, the winding star-point shall be brought out to a bushing mounted on a separate terminal box. Provision shall be made within the box to mount and clamp current transformer(s) on the neutral between the star point and the cable termination point. The neutral will be connected to earth by a single core insulated cable the connection shall be either solid or via a neutral earthing resistor as stated on the transformers data sheets.
- 5-31.8 Where the secondary system is three phase, four wire, terminals shall be located in one terminal box.
- 5-31.9 All auxiliary devices shall be pre-wired to an auxiliary terminal box.
- 5-31.10 Permanent terminal markings are to be mounted on primary and secondary terminal boxes.
- 5-32 Transformers shall have two separate windings with connection and vector group as stated on the transformers data sheets.

- 5-33 The windings shall have uniform class A insulation.
- 5-34 The Vendor shall state the manufacture, type and grade of insulating oil used for the transformers.
- 5-35 An oil temperature gauge, with alarm and trip switches, shall be fitted to measure oil temperature at the hottest spot. Each switch shall be provided with one normally open and one normally closed contact.
- 5-36 A winding temperature device shall be fitted complete with high temperature alarm and trip switches. Each switch shall be provided with one normally open and one normally closed contact.
- 5-37 Transformers shall be provided with sun shields when specified on the transformers data sheets.
- 5-38 Transformer locations:
- 5-38.1 Transformers shall be housed in Transformer rooms or transformers pens.
- 5-38.2 Transformer rooms shall be designed and constructed to withstand fire, and shall have doors designed to burst open in the event of explosion. All doors into the Transformer room shall be external doors, and shall open outwards, no doors or windows shall link into another building, or room, other than one used for housing transformers. Transformer room shall be vented to outdoors; it shall not vent into another room or building.
- 5-38.3 Oil filled transformers shall sit on a concrete pad. A bunded soak-away shall be provided. This shall be designed to rapidly absorb any spillage oil and to prevent a fire being sustained in the event of the tank exploding. There shall be a facility built within the soak-away to enable a portable submersible pump to pump any liquid out the bunded soak-away.
- 5-38.4 Cast resin transformers for use with inverters, or rectifier equipment, which have both primary and secondary windings operating at low voltage, may be housed within control panel assemblies. Access to the transformer shall be by means of hinged and lockable doors, which are interlocked with the incoming isolator, fuse switch or circuit breaker.

5-38.5 Cast resin transformers with either primary or secondary HV windings shall be housed in Transformer rooms. Transformer rooms shall be designed and constructed to withstand fire, and shall have doors designed to burst open in the event of explosion. Doors into the Transformer room may open into other rooms, but shall be at least ½ hour fire rated and open outwards. Transformer room shall be vented to outdoors; it shall not vent into another room or building. The Transformer shall sit on a concrete pad.

5-38.6 Steel Rollers shall be provided for positioning the transformer and left in-situ for future use.

6-0 PERFORMANCE REQUIREMENTS

- 6-1 Transformers shall be sized for continuous operation at the maximum rating under the ambient conditions. Allowance shall be made for harmonics where non linear loads (i.e. inverters) are connected.
- 6-2 Transformers short circuit withstand ability shall be in accordance with the standards specified.
- 6-3 Transformers shall be designed to withstand the relevant impulse test voltage and power frequency test voltage as specified in the standards.
- 6-4 Transformers shall be suitable for parallel operation where indicated on the transformer data sheets.
- 6-5 The design and manufacture of the transformer shall be such as to reduce noise and vibration. The maximum noise level shall not exceed the value indicated on the transformers data sheets.
- 6-6 For sealed type transformers the Vendor shall state the test pressures and maximum expected internal pressure in the tank.

7-0 RATING PLATE

7-1 In addition to the requirements stated in the standards specification, the following shall be given on the rating plate:

- 7-1.1 Purchase order number,

7-1.2 Equipment number (as stated on the transformer data sheet),

7-1.3 Connection diagram with terminal markings,

7-1.4 Tapping range and extreme voltages,

7-1.5 Rated temperature rise in degrees centigrade,

7-1.6 Identification of insulation.

7-2 Terminal Markings:

7-2.1 Permanent terminal markings are to be mounted on primary and secondary terminal boxes.

7-3 Identification Labels:

7-3.1 All transformers shall be provided with a white/black/white traffolyte identification label mechanically fixed to the front of the transformer. Minimum letter size 15mm.

8-0 FINISH

8.1 The Vendor shall submit his proposed painting specification for review and approval by the buyer.

8.2 The paint specification shall be suitable for the environment in which the transformer is to be located. The finish colour shall be the manufacturer's standard.

8.3 For oil filled transformers the finish of the internal and external walls of the tank cover, terminal boxes and cooling system shall be protected against the effects of corrosion and the influence of the insulating oil.

8.4 The finish shall be suitable for the service conditions stated in section 3.0.

9-0 SPECIAL TOOLS

A complete set of any special tools required for operation, commissioning and maintenance.

10-0 SPARES

The Vendor shall provide a list of recommended commissioning and operating spares.

11-0 INSPECTION AND TESTING

11-1 Tests shall be carried out by the manufactures at his works in accordance with the relevant standards.

11-2 The Vendor shall submit Type test Certificates, from a recognized testing authority, proving the ability of the transformers to withstand a short circuit and impulse levels specified.

11-3 The following tests, additional to those above, shall be carried out:

11-3.1 Heat run test,

11-3.2 Noise level test,

11-3.3 Insulating oil dielectric test for oil filled transformers.

11-4 The buyer reserves the right to witness all transformer tests.

11-5 The Vendor shall provide test certificates for each type and rating of transformer, for all tests carried out.

11-6 The Vendor shall give two weeks notice of tests prior to commencement.

11-7 Site tests of transformers after erection and prior to the connection of site cables and commissioning shall consist of the following tests (where relevant to the type and size of transformer):

- Insulation tests of Primary and Secondary windings,
- Buchholz relay calibration and functional tests (to auxiliary terminal box),
- Winding Temperature indication calibration and functional tests (to auxiliary terminal box),
- Oil Temperature indication calibration test,
- Dielectric tests,
- High Voltage tests on Primary and Secondary Windings with cable links disconnected.

The Contractor shall provide power required for testing purposes. This may involve provision of a portable generating set.

11-8 Works Tests:

- 11-8.1 The works tests, as detailed in the following, shall be witnessed by the Contractor.
- 11-8.2 'Routine Tests' as set out in the relevant British or Harmonised European Standard.
- 11-8.3 Calibration and functional checks on Buchholz, WTI and indicating thermometer.
- 11-8.4 In addition to the above routine tests the transformers shall have been subjected to a temperature rise 'Type Test' as set out in the relevant British or Harmonised European Standard.

12-0 SHIPPING, HANDLING AND STORAGE

12-1 Preparation for shipment shall protect power transformers and auxiliary devices, against corrosion, high humidity, dampness, breakage or vibration injury during transportation and handling.

12-2 The location of lifting points shall be clearly marked on the containers.

13-0 DRAWINGS AND DATA

The Vendor shall provide drawings and data in accordance with international standards.

14-0 DEVIATIONS

Deviations from this specification are only acceptable where the vendor has listed in his quotation the requirements he cannot or does not wish to comply with and the purchaser has accepted, in writing.

In the absence of a list of deviations it will be assumed by the purchaser that the vendor complies fully with this specification.