ABU DHABI SEWERAGE SERVICES COMPANY (ADSSC)

GENERAL SPECIFICATION FOR ELECTRICAL WORKS

DIVISION 16 ELECTRICAL

SECTION 16150 POWER DISTRIBUTION TRANSFORMERS

DOCUMENT CONTROL SHEET

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1 DISTRIBUTION TRANSFORMERS – DRY TYPE (CAST RESIN)

1.1 GENERAL

a) The scope covers 1,000kVA and 1,500kVA dry-type cast-resin transformers, complete with all necessary accessories. Larger transformers may be used with the approval of ADSSC.

b) The transformers shall be designed and manufactured, as appropriate, to the following:

i. IEC 60076-11 (Dry-type power transformers).
ii. IEC 60905 (Loading Guide for dry-type transformers).
iii. BS 2562 (Specification for cable boxes for transformers and reactors).
iv. BS 7844 (Three-phase dry-type distribution transformers 50Hz, from 100 to 2500kVA with highest voltage for equipment not exceeding 36kV. Supplementary requirements for transformers with highest voltage for equipment equal to 36kV.)
v. The Latest Abu Dhabi Distribution Company (ADDC) specifications.

c) It is mandatory for manufacturers to have valid ISO 9000 series Certification issued by an Internationally Recognised Agency of West Europe, USA or Japan and should have been tested in a "Recognised Independent Testing Laboratory" as per the relevant IEC standards, including "Short Circuit Withstand Tests".

d) The Manufacturer shall have documented supply record of similar transformers working satisfactorily in the same climatic and service conditions for the last five (5) years as a minimum prerequisite to submit their offer.

e) The transformers shall be installed in a non-air-conditioned room without any forced ventilation duty at the specified ambient conditions.

f) The Contractor shall submit technical specifications of the transformer and associated switchgear and cables together with shop drawings to ADWEA for approval prior to the manufacturing of the equipments. A duly stamped and approved copy by ADWEA shall be submitted to the engineer at site for record prior to the commencement of any work.

g) The Contractor shall ensure supervision and certification of the testing of transformers and associated HV/MV switchgear and cables at site by ADWEA's engineers.

1.2 DESIGN AND CONSTRUCTION

1.2.1 RATING

The normal rating specified shall be the continuous rating inside the housing under the maximum specified temperature and humidity in Abu Dhabi. The transformers shall be designed for the following withstand voltages:

i. Power Frequency Withstand Voltage 38kV
ii. Impulse Withstand Voltage 95kV

1.2.2 VOLTAGE RATIO

The rated (no load) voltage ratio of the transformer on normal tapping shall be 11000/433 Volts.

1.2.3 TEMPERATURE RISE

The permissible temperature rise for the HV and LV windings shall correspond to the type of insulation used. The maximum temperature rise (by resistance) of the transformer while carrying its full rated current continuously at any tapping shall be less by ten (10) K than the standard limit of IEC 60076-11 Table IV.

1.2.4 CONNECTIONS

The transformer shall conform to BS EN 60076 (IEC 60076) with a Vector Group reference Dyn11 with a fully rated neutral. The interface lead links shall be moulded in resin. All the terminals shall be clearly and permanently marked.

1.2.5 OFF CIRCUIT TAPPINGS

a) The transformer shall be equipped with an off-circuit tap changer having a range of ±5% in 5 steps each of 2.5% which operated by an off-circuit tapping switch, with a clearly marked position indicator.

b) The connected links shall be of high quality and the connections shall pass the Short Circuit test and not be affected by transformer vibration.

1.2.6 IMPEDANCE VOLTAGE

The Impedance Voltage of dry type (cast resin) transformers shall be 4% when sized 630kVA or less or 6% if 800kVA or greater.

1.2.7 NOISE LEVEL

The noise level shall not exceed 70dB. The transformer shall be installed inside residential commercial buildings and be securely anchored to noise-reducing support blocks.

1.2.8 HV AND LV WINDING

a) HV and LV windings shall be of high-grade electrolytic copper and be encapsulated in glass fibre or quartz-reinforced epoxy resin. Encapsulation of the winding shall be achieved by vacuum impregnation at an elevated temperature and shall be free of bubbles and voids.

b) The coil assemblies shall be acoustically insulated from each other and from the base frame. The winding must not absorb any humidity during long storage period (exceeding one year) in atmospheric conditions of Abu Dhabi.

c) The insulation material used shall be self-extinguishing when ignited by direct flame or arc. No toxic gases shall form during heating and/or burning. When subjected to a continuous bolted short-circuit on the LV terminals, the transformer shall not explode or expel molten material.

d) Authorised test certificate from recognised testing laboratories shall be made available for ADSSC approval prior to commencement of manufacture.

e) The ageing properties of the insulation materials shall be sufficiently high to compare the life expectancies of these transformers to oil-filled transformers.

1.2.9 SUPPRESSION OF HARMONIC VOLTAGES

The transformer shall be designed with particular attention to the suppression of harmonic voltages, particularly the third and fifth, so as to eliminate wave form distortion and any possibility of high frequency disturbances, inductive effects or of circulating currents between the neutral points at different transforming stations reaching such a magnitude as to cause interference with communication circuits.

1.2.10 MAGNETIC CIRCUIT

The design of the magnetic circuit shall be such so as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and the production of flux components at right angles to the plane of the laminations which may cause local heating.

1.2.11 CORE ASSEMBLY

a) The core shall be constructed of the best quality low-loss cold-rolled grain-oriented steel laminations insulated on both sides. The flux density in any part of the core shall not exceed 1.6 Tesla. Limbs and yokes shall preferably be shaped and assembled with minimum use of steel bolts. Laminations should be jointed, compressed and braced to minimise stray losses and noise.

b) The assembled core shall be braced in suitable steel frames that make up the base-frame and the lifting facilities for complete transformer. The core assembly shall enable the removal of the coils in the field, if required.

c) Suitably dimensioned lifting guying and pulling eyes shall be provided for easy moving of the unit. The base frame shall be skid-mounted with relocatable wheels.

c) The entire core assembly shall be covered with a resin-based lacquer for corrosion protection before the coils are mounted.

1.2.12 CABLE TERMINATIONS

a) The transformer housing shall be fitted with cable boxes suitable for bottom entry cable termination.

b) The HV cable terminals shall have palm and holes suitable for terminating 95mm^2 3-core, copper, XLPE-insulated, tape and wire screened, double steel tape armoured and PVC served cable.

The LV Cable terminals shall be suitable for terminating 630mm^2 single-core, copper, AWA cable, 2- and 3- core/phase for 1,000kVA and 1,500kVA transformers respectively in addition to the core(s) for the neutral.

c) The transformer shall be supplied complete with dry-type heat-shrinkable termination kits along with all the necessary cable lugs, grip type glands, etc. Cable support shall be provided in such a way as to relieve the strain on the cable termination.

d) The HV cable box shall not be detachable and shall be bottom entry only.

e) The LV cable box shall have removable gland plates so entry can be achieved from the bottom as well as the top.

f) The tap changing link shall be provided on a separate mounting plate rather than on the cast resin HV winding so as to avoid any burning of the links and resin arising out of loose connection due to frequent changing of the links or due to human error.

1.2.13 INTERNAL EARTHING ARRANGEMENT

a) All metal parts of the transformer, with the exception of the individual core laminations, core bolts and associated individual clamping plates shall be maintained at the same fixed potential.

b) The top main core clamping structure shall be connected to the enclosure by a copper strap. The bottom clamping structure shall be earthed by a suitable method. Details shall be submitted.

1.2.14 EARTHING TERMINAL

Provision shall be made to connect external earthing conductors at positions close to the bottom of the enclosure at two points. Earthing terminals shall be adequately sized to receive the external earthing conductor/strip.

1.2.15 TRANSFORMER HOUSING

a) The transformer shall be housed in a protective zinc-coated steel housing with sufficient ventilation to offer a degree of protection of IP20 minimum. The complete unit (transformer and housing) shall form one movable and liftable unit.

b) Adequate ventilation shall be provided through vermin-proof louvers and the unit shall be fitted with plain bi-directional rollers. The perforated bottom plate shall have sufficient clearance from the floor level to guarantee sufficient flow of natural air ventilation.

c) A Hand hole shall be provided with transparent cover to reach the tap changers. The cover shall be operable with special key/tool only. A danger sign with cautionary notice in both “ARABIC” and “ENGLISH” shall be affixed on the cover.

d) A Temperature Indicator and Alarm shall be provided in an easy-to-access location. Facility shall be provided to connect a remote alarm to the unit.

1.2.16 EMERGENCY LOADING

The transformer shall be able to operate under emergency loading conditions as per IEC 60905.

1.3 CAPITALISATION OF LOSSES

a) The transformer iron and copper losses shall be capitalised and added to the tender prices to determine the overall economical price for evaluation purpose using the following capitalised value per kW for iron and copper losses:

i. Iron losses = UAE Dirhams 13,000/kW.
ii. Copper losses = UAE Dirhams 5,000/kW.

b) If the tests of the completed transformer show that the actual losses exceed the guaranteed values, the excess losses shall be valued in accordance with the above formula for each transformer and shall be deducted from the money due to the contractor as performance penalties. No tolerance will be allowed on the figures stated in the technical schedules.

1.4 INSPECTION AND TESTING

Inspection and Testing shall be in accordance with Section 15001: General M&E Specification.

1.5 ACCESSORIES

Transformers shall be equipped with all the accessories deemed necessary for proper operation and meeting IEC 60076-11, plus those required by the particular specification. Additional available accessories shall be quoted as optional.

1.5.1 WINDING TEMPERATURE MONITORING SYSTEM

a) As a minimum, each transformer shall have solid-state winding temperature monitoring elements installed in the low-voltage windings. They shall initiate an alarm whenever the maximum absolute winding temperature is reached.

b) The temperature monitoring device provided shall have 2 (two) potential-free contacts for trip/alarm. The temperature calibration shall be matched with the insulation classification and shall be used in conjunction with the winding temperature indicator.

1.5.2 DIMENSIONS

Transformers shall be installed indoors in areas of limited space. Transformers of compact design are preferred.

1.5.3 CORROSION PROTECTION

Surface preparation and painting of transformers and enclosure shall be suitable for the environmental conditions of Abu Dhabi.

1.6 NAME PLATES

a) Nameplates shall be of Steel/Aluminium and must be attached permanently to the transformer where they can be read from the ground.

b) Nameplate information as called for by IEC 60076-11 is required. This includes:

i. Type of Transformer.
ii. Applicable Specifications.
iii. Manufacturers Name.
iv. Serial Number.
v. Year of Manufacture.
vi. Number of Phases.
vii. Rated Power.
viii. Rated Frequency.
ix. Rated Voltage.
x. Rated Current.
xi. Vector Group.
xii. Impedance Voltage at Rated Current.
xiii. Type of Cooling.
xiv. Total Mass.

c) Additional information, either on the same or on an additional nameplate, is required as follows:

i. Graphic representation of winding.
ii. Connections and Terminal Designations.
iii. Temperature Rise of Windings at Rated Load.
iv. Design Ambient Temperature.
v. No Load and Load Losses.
vi. Contract Reference.

d) A Standard Danger and Warning Sign in both Arabic and English with the ADSSC logo shall be fixed to the transformer in a prominent location.

2 DISTRIBUTION TRANSFORMERS – OIL IMMERSED AIR COOLED

2.1 GENERAL

a) The Scope covers the design, manufacture and testing of the following:

i. 500kVA, 1,000kVA, 1,500kVA, 2,000kVA and 2,500kVA 11/0.433kV Oil-immersed ground-mounted Power Distribution Transformers. Larger transformers may be used with the approval of ADSSC.
ii. 100kVA, 200kVA 11/0.433kV Pole-Mounted Transformers. All transformers shall be complete with all necessary accessories.

b) The transformers shall be designed and manufactured, as appropriate, to the following:

i. IEC 60076 (Power Transformers)
ii. BS 7735, IEC 60354 (Guide to loading of Oil-immersed power transformers).
iii. BS 2562 (Specification for cable boxes for transformers and reactors).

iv. BS 7821 (Three phase oil-immersed distribution transformers, 50Hz, from 50 to 2500kVA with highest voltage for equipment not exceeding 36kV. General requirements and requirements for transformers with highest voltage for equipment not exceeding 24kV).
v. BS 6436 (Specification for ground mounted distribution transformers for cable box or unit substation connection).
vi. BS EN 61330 (High-voltage/low-voltage prefabricated substations).
vii. BS 148, IEC 60296 (Specification for unused and reclaimed mineral insulating oils for transformers and switchgear).
viii. The Latest Abu Dhabi Distribution Company (ADDC) specifications.

c) All transformers shall be fully Type Tested, including Short Circuit Test in KEMA, ASTA or any other recognised Western European independent testing laboratory.

d) It is mandatory for manufacturers to have valid ISO 9000 series Certification issued by an Internationally Recognised Agency of West Europe, USA or Japan and should have been tested in a "Recognised Independent Testing Laboratory" as per the relevant IEC standards, including "Short Circuit Withstand Tests".

e) The Manufacturer shall have documented supply records of similar transformers working satisfactorily in the same climatic and service conditions for the last five (5) years as a minimum prerequisite to submitting their offer.

2.2 SYSTEM CHARACTERISTICS

The system characteristics are defined in Section 15001: General M&E Requirements.

2.3 DESIGN AND CONSTRUCTION

2.3.1 TYPE

The transformer shall be hermetically sealed, ONAN naturally cooled, outdoor skid-mounted, oil-immersed, core type and shall comply in general with the requirement of BS EN 60076 / IEC 60076 except that the temperature rise shall not exceed 50°C of winding by resistance and 40°C of oil by thermometer.

2.3.2 RATING

The transformer rated kVA shall be the continuous steady load rating under the specified temperature and humidity.

2.3.3 VOLTAGE RATIO

The rated (no load) voltage ratio of the transformer on normal tapping shall be 11000/433 Volts.

2.3.4 TEMPERATURE RISE

The transformer shall be capable of carrying full rated current continuously under the maximum specified ambient temperature at any tapping, without the temperature rise of oil in the hottest region exceeding 40°C, as measured by thermometer and of the winding not exceeding 50°C, as measured by resistance. Calculations demonstrating the above shall be submitted with the offer.

2.3.5 CONNECTIONS

The transformer shall conform to BS EN 60076 (IEC 60076), be connected Delta Star with a Vector Group Reference Dyn11. The Neutral terminal shall be brought out and be fully rated in all cases.

2.3.6 OFF CIRCUIT TAPPINGS

The transformer shall be equipped with an off-circuit tap changer having a range of ±5% in 5 steps of 2.5% each operated by an off-circuit tapping switch, with clearly marked position indicator. Locking facilities shall be provided such that the lock can be inserted only when the switch is on a definite tap position.

2.3.7 IMPEDANCE VOLTAGE

Typical impedance voltage of the transformer shall be as follows:

i. 500/200/100kVA = 4.75%
ii. 1,000kVA = 4.75%
iii. 1,500kVA = 5.50%
iv. 2,000kVA = 6.00%
v. 2,500kVA = 6.55%

2.3.8 DUTY UNDER FAULTS

The transformer shall be capable of sustaining a three phase symmetrical short circuit on the LV side with power maintained on the HV side without damage or distress for three seconds. A Short circuit test certificate performed on a similar transformer in a recognised independent testing laboratory shall be provided. Any offer not accompanied with such certificates will be rejected.

2.3.9 TANK

The core and winding assembly shall be contained within a tank of welded sheet steel construction. It shall be hermetically sealed with a bolted tank cover. All flanged joints shall incorporate gaskets to prevent entry of water or loss of oil. All transformers shall be subject to an oil leakage test. The following details shall be submitted:

a) Tank type.

b) Maximum internal withstand pressure of the transformer and details of pressure relief device provided.

c) If recycling of transformer oil is recommended, complete details of re-cycling and refilling.

d) Complete recommended method of maintenance for the design life of the transformer.

2.3.10 FINISH AND COATINGS

The transformer tank and its accessories shall be adequately protected against corrosion. The tank shall be sand blasted and then immediately zinc sprayed, followed by a zinc chromate based primary paint and two coats of durable oil and weather resisting paint. The final coat of paint shall be of silver colour.

The inside of tanks shall be coated with oil-resisting varnish or paint so that the oil cannot come into contact with tank metal at any point. Alternative methods of protection may also be considered. Details shall be submitted with the offer.

2.3.11 COOLING

Cooling of the transformer shall be by natural circulation of oil through banks of plain external cooling tubes. Panel-type radiator or corrugated tanks are also acceptable provided they withstand the specified test pressure.

2.3.12 FLUX DENSITY

The core shall be constructed of the best quality low-loss, cold-rolled grain-oriented steel laminations. The flux density in any part of the core shall not exceed 1.6 Tesla at normal voltage and frequency.

The core plates shall be insulated from one another to reduce the core loss to a minimum and the core shall be held together by bolts and clamping plates all of which shall be adequately insulated.

The completed core shall be provided with lifting eyes to facilitate its removal from the transformer tank and shall be adequately braced and supported to prevent movement during transit or service.

2.3.13 WINDINGS

The maximum current density in both HV and LV windings shall not exceed 1,600A/in^2 (2.48A/mm^2). All windings shall be fully insulated for power frequency test voltages of 38kV and impulse test voltage of 95kV. Insulation shall be Class 'A' to BS EN 60085 (IEC 60085). Aluminium winding is not acceptable.

2.3.14 BUSHING, TERMINALS AND CABLE BOXES FOR GROUND-MOUNTED TRANSFORMERS

The HV and LV Cable Box shall be mounted on the sides of the tank with horizontal bushings arranged for cables approaching vertically from below.

a) Bushings shall be replaceable without having to open the tank cover. Bushings and terminations shall be capable of withstanding the voltages applied during the winding test. Due attention shall be given to LV terminal bushings where connected to a flange-type distribution feeder pillar.

b) The 11kV cable box shall be designed for air-insulated dry type termination suitable for 3-core XLPE, double steel tape armour, PVC-served, from 50-95mm^2 copper cable according to the transformer rating.

c) Clearances between the phases and phase to earth shall be liberally designed to allow cable core crossing in the box. Bushings and terminations shall be adequate for the winding tests.

d) Each transformer shall be supplied with complete heat shrinkable termination kits with all necessary cable lugs, compression cable gland and clamps, etc. The cost of such kits is deemed to be included in the tender price.

e) The LV connection from the transformer to the Substation LV Distribution Board (if applicable) shall comprise 3No. single core copper 630mm^2 XLPE, AWA PVC-served cables per phase for a 1,500kVA transformer in addition to the core(s) for the neutral. The exact details of the cable shall be handed over to the successful tenderer.

f) The LV Cable Box for a 200kVA transformer shall be suitable for 2No. 4-core 240mm^2 copper cable terminations.

g) The cable boxes on the transformer shall be suitable for this arrangement and shall be complete with all necessary fittings, crimp type

cable lugs of specified size, compression glands, armour, bonding straps, tapes, etc.

2.3.15 FITTINGS

In addition to Standard Fittings as per BS EN 60076 (IEC 60076), the transformer shall be fitted with the following:

i. Rating Plate.
ii. Terminal Marking Plate.
iii. Lifting Lugs.
iv. Earthing Terminal for Tank.
v. Tank Filling and Draining Valve.
vi. Oil Level Indicator.
vii. Dial-type Thermometer with maximum reading pointer and two adjustable Multi-contacts for Alarm and Trip.
viii. Pressure Relief Device.
ix. Jacking Lugs.
x. Skid and rollers (rollers shall be supplied for 1,500kVA transformers and above).

2.4 ADDITIONAL SPECIFICATION FOR POLE-MOUNTING TRANSFORMER

2.4.1 MOUNTING ARRANGEMENT

The transformer shall be supplied complete with base channels suitable for mounting on cross arm channel as per Drawing No. WED/OH/10.

2.4.2 HV TERMINALS

HV bushing shall be rated for 22kV insulation level. The outdoor bushing shall be as per 20 NF 250 according to DIN 42531. The bushing and fittings shall not be affected by the sulphurous atmosphere conditions on site, humidity, dust, sand acid or alkaline fumes.

HV bushings shall be fitted with two gap type adjustable arcing horns. Each gap set at 30mm and adjustable gap range shall be 45-80mm.

2.4.3 LV CABLE BOX

The transformer shall have an LV cable box as specified under Clause 2.3.14 and be designed to receive a 4-core 240mm^2 copper cable or as specified under Clause 2.3.14. Clamps shall be provided on the body of the transformer to support the cable in position and to relieve strain on the bushing.

2.4.4 DIMENSIONS

The transformers shall have standard proportional dimensions. The bushing for ground-mounted transformers shall be mounted on the sides of the tank to reduce the overall height of the transformers. In any case, the height shall not exceed 1,900mm for 1,500kVA and 1,000kVA transformers.

2.5 EMERGENCY LOADING

The transformer shall operate under emergency loading conditions as per BS 7735 (IEC 60354) with transformer winding hot spot temperature not exceeding 140°C after thermal equilibrium has been reached at rated load.

2.6 INSPECTION AND TESTING

Inspection and Testing shall be in accordance with Section 15001: General M&E Specification. It shall include the following:

Type and Routine Tests shall be carried out in accordance with BS EN 60076 (IEC 60076). The tests shall be applied in the presence of ADSSC or a nominated representative.

a) Routine Tests:

i. Measurement of Winding Resistance.
ii. Voltage Ratio Measurement.
iii. Check of Voltage Vector Relationship.
iv. Measurement of Impedance Voltage and Load Losses.
v. Measurement of No-Load Loss and Current.
vi. Insulation Resistance Measurement.
vii. Separate - Source Voltage withstand Test.
viii. Induced Over-Voltage withstand Test.
ix. External Construction Inspection.
x. Check of Oil Leakage.

All transformers shall be tested for oil leakage when completely assembled. The oil pressure shall be equivalent to a level of four metres of oil above normal oil and shall be applied for a period not less than 6 hours.

b) Type Tests:

i. Temperature Rise Test on the transformer.
ii. The Impulse withstand test on the transformer shall be applied on the HV winding leg only and shall be in accordance with BS EN 60060 (IEC 60060) and BS EN 60076 (IEC 60076).

c) Short Circuit Test:

i. A Short Circuit test need not be performed, if already performed on a similar transformer. A Type Test Certificate shall be made available.

2.7 TRANSFORMER LOAD AND NO-LOAD LOSSES

The acceptable maximum losses at 75°C and rated voltage, full site-rated load and main tap shall be as shown below. Tenders having transformers with losses exceeding the following values will not be considered:

Site Rating	Losses in kW	
kVA	No Load	Load @ 75°C
2,500	2.85	25.0
2,000	2.25	23.8
1,500	1.65	20.6
1,000	1.34	12.5
500	0.9	7.15
200	0.40	3.8
100	0.28	2.0

Tolerance for total losses shall be +10%, and for component losses it shall be +15% of each component loss, provided the tolerance for total losses is not exceeded.

2.8 CAPITALISATION OF LOSSES

If the actual losses as verified by tests of any transformer exceed the maximum permissible values, but within allowable tolerance, the excess losses will be capitalised as per the following values and will be deducted from the monies due to the Contractor:

i. Iron Losses = UAE Dirhams 13,000/kW.
ii. Copper Losses = UAE Dirhams 5,000/kW.

If the actual losses exceed the allowable tolerance, the transformer may be rejected or the capitalised value of the excess losses will be deducted from the contract price using the above formula.

2.9 OPERATION AND MAINTENANCE MANUAL

Operation and Maintenance Manuals shall comply with the requirements of Section 15001: General M&E Specification and Section 16670: Documentation Format.

END OF SECTION