EDMS 08-100-5

SPECIFICATION

FOR

OIL-IMMERSED DISTRIBUTION TRANSFORMERS

FROM 25 kVA UP TO 5000 kVA

10.5 - 11 / 0.4 kV

Issue: Nov. 2024/ Rev- 5

- This revision contains option items that must be selected by EDC before bidding.
- EDMS 25-401 for Mineral Insulating Oil shall be attached.
- EDMS 25-400 for silica-gil
- EDMS 11-400 for Outdoor Surge Arrester shall be attached if applicable.

EEHC DISTRIBUTION MATERIALS SPECIFICATION	EDMS 08-100-5
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1. SCOPE

This specification specifies the minimum technical requirements for design, manufacturing, testing, inspection, supply and delivery of three-phase conventional or hermetically sealed, two-winding oil-immersed distribution transformers. The required transformers are step-down transformers to convert the medium voltage level (11 kV) into low voltage level 0.4 kV. The transformers shall be suitable for indoor /outdoor installations of the power networks of Egyptian Electricity Distribution Companies (--EDCs).

2. APPLICABLE STANDARDS

The equipment/material covered in this specification shall comply with the latest edition/amendment of the standards given in Table (1). Where any provision of this specification differs from those of the standards listed below, the provisions of this specification shall apply. Any deviations from the listed standards or the provisions of this specification should be clearly set out in the offer.

Table (1)

Standard No.	Description
IEC 60076 Power Transformers	Part 1 General
	Part 2 Temperature rise for liquid-immersed transformers
	Part 3 Insulation levels and dielectric tests
	Part 4 Lightning impulse and switching impulse testing
	Part 5 Ability to withstand short circuit
	Part 7 Loading guide for oil-immersed power transformers
	Part 10 Determination of sound levels
	Part 20 Energy Efficiency
IEC 60214 Tap-changers	Part 1 Performance requirements and test methods
	Part 2 Application guidelines
IEC 60437	Radio interference test on high-voltage insulators.
IEC 60507	Artificial pollution tests on high-voltage ceramic and glass insulators to be used on a.c. systems
IEC 60137	Bushings for alternating voltages above 1 kV.
IEC 60404-1	Magnetic Materials classifications.
ANSI C57 12.90	Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
IEC 60296	Fluids for electro technical applications – Mineral insulating oils for electrical equipment
EN 50464-4	Endurance test (tank test for hermetically sealed transformers)

3. ENVIRONMENTAL CONDITIONS

The electrical and mechanical properties of the required transformers should be guaranteed under the environmental conditions given in Table (2).

Table (2)

Ambient temperature	-5°C to +45°C (50°C as option according to …EDC) (35°C monthly average of the hottest month, 25°C yearly average)
Maximum relative humidity	95 %
Altitude	Up to 1000 m above sea-level

4. DESIGN CRITERIA

4.1 Rated Power

- The transformer should be able to deliver the maximum continuous power rating for an unlimited time at the main tapping of the tap changer without exceeding the allowable temperature rise limit, if the applied voltage is equal to the rated voltage and maintained at its rated frequency.
- The maximum continuous power rating is selectable from the following set of standard rates:
  (25 – 50 – 63 – 100 – 160 – 200 – 300 – 400 – 500 – 630 – 800 – 1000 – 1250 – 1500 – 1600 – 2000 – 2500 – 3000 – 3500 – 4000 – 5000 kVA)

4.2 Voltage Transformation Ratio

- The transformation ratio should be (10.5 - 11000/400 V).
- The deviation of the transformation ratio measured at no-load and 50 Hz should not exceed 0.5% from its nominal value.

4.3 Vector Group

- The winding connection group of the transformers should be delta on the primary side and star on the secondary side in accordance with the vector group Dyn11 as specified in IEC 60076.

4.4 Tapping Range

- The transformers should be equipped with three-phase, three-wires, lockable manual off-load tap-changer located on the high voltage winding. The tap-changer switch is mounted on the tank cover.
- The voltage regulation (referred to input voltage) should be affected in seven steps having the sequences given in Table (3).

Table (3)

Tap No.	1	2	3	4	5	6	7
Voltage Regulation	+ 5 %	+ 2.5 %	0 %	- 2.5 %	- 5 %	- 7.5 %	- 10 %

4.5 Overload Capacity

– Permissible overload capacity should be in accordance to IEC 60076-7.

4.6 Short-circuit Withstand

– Transformers should be capable to withstand, without damage, the thermal and mechanical effects of short circuits at its terminals for three seconds at least. The short circuit level of 11 kV network is 500 MVA.

4.7 Temperature Rise Limits

– The transformer should be able to deliver its maximum continuous ratings without exceeding the following permissible temperature rise limits:

- Top oil level temperature rise 45 ºC
- Winding temperature rise measured by resistance method 55 ºC
- Hot spot 60 ºC

4.8 Cooling

– Cooling is done by the natural circulation of the internal insulating oil and the external air i.e. ONAN cooling. (ONAF cooling is an option according to. .EDC requirements).

– The oil should meet the requirements of the latest revision of EDMS 25-401.

4.9 Insulation Level

– The following test voltages should be applicable to the transformers:

- High voltage impulse withstand voltages: 75 kV
- Power frequency withstand voltage: 28 kV / 1 minute
- Low voltage Power frequency withstand voltage: 3 kV / 1 minute

4.10 Impedance Voltage

– The short-circuit impedance (or impedance voltage Z% expressed as a percentage of rated voltage) measured at mid-tap at 95 ºC should be as follows:

- 4 % for transformers of power rates (from 25 kVA up to 630 kVA)
- 5 % for transformers of power rates (800 – 1000 – 1250 kVA)
- 6 % for transformers of power rates (1500 – 1600 – 2000 – 2500 kVA)
- 7 % for transformers of power rates (3000 – 3500 – 4000 – 5000 kVA)

– According to IEC 60076-1, the measured short-circuit impedance is subjected to a tolerance of ± 10% of the specified value.

4.11 Bushings

- The transformer bushings shall be made of porcelain. Generally, it shall comply with the requirements of IEC 60137.
- The creepage distance should not be less than 2 cm/kV for indoor transformers and 4 cm/kV (4.5 cm/Kv **optional** according to ..EDC requirements) for outdoor transformers.
- To avoid overvoltage damage each high voltage bushing should be fitted with a duplex arcing horn electrodes made of steel. The vertical distance of arcing horn should be set at 86 mm. according to VDE0111/261.
- For transformers with power rates from 500 kVA and higher, the low voltage bushing should be provided with copper flags. For the transformers with power rates below 500 kVA, the low voltage bushing should be provided with suitable copper bars or copper flags.
- MV bushings should be labeled U, V, W by using indelible black color paint on the tank cover (metal plate fixed by rivets, bolts, or accepted way so that they cannot be removed). Phase identification by adhesive stickers is not acceptable.
- LV bushings should be labeled u, v, w by using indelible black color paint on the tank cover (metal plate fixed by rivets, bolts, or accepted way so that they cannot be removed). Phase identification by adhesive stickers is not acceptable.
- **Surge arrestor for outdoor transformers** (Option as per ...EDC requirements):
- A surge arrestor should be fixed to the medium voltage bushing. It should meet the requirements of the latest revision of EDMS 11-400.

4.12 Core

- The core should be made of low loss steel lamination which are made of grain oriented, annealed, high permeability, non-ageing, cold rolled silicon steel /amorphous type.
- The core, framework, clamping arrangement and general structure should be mechanically robust to withstand any shocks during transportation, installation, operation or faults.
- The core construction should ensure the efficient cooling of its internal parts, the elimination of core vibration when loaded and the minimization of harmonic voltage especially the third harmonics.
- The core joints should be properly interleaved. Precautions shall be taken to keep the noise level at 48-56 dB. According to rated capacity and at measured distance of (one) meter, at mid tap& no-load &eliminate vibration in the core when loaded& to diminish harmonic voltage as far as possible especially the third harmonics

4.13 Windings

- The winding conductors should be made of the best quality and high conductivity

electrolytic copper in compliance with the relevant IEC publication.

- The windings should be clamped effectively to withstand any shocks, vibrations and forces produced by the most severe short circuit currents.

4.14 Oil-expansion Conservator

- The oil-expansion conservator should be made of sheet steel with an adequate capacity to allow the extreme changes in the oil level e.g. when the transformer is off circuited at 0 ºC and when the transformer is full loaded at 45 ºC ambient. The quantity of oil should be plainly marked on the conservator. The conservator should be provided with oil level indicator (sight glass at low voltage side), dehydrate breather with silica-gel as latest revision of Specs. EDMS 25-400, oil filling and drain plugs and a connection pipe for connecting the oil to the transformer.

4.15 Tank

- The transformer tank should be made of best quality plate steel with bolted cover fitted with neoprene cork seals suitable for the specified temperatures. The tank should be rigid enough to withstand, without deformation, the mechanical stresses arising from transformer lifting, transport, or due to short-circuit effects inside the transformer.
- **Radiators**
  1. should be welded to the tank.
  2. Removable radiators can be accepted for rating greater than 2000kVA, (optional according to ..EDC requirements)

     For removable radiators required:

     - This design shall be type tested and cooling type (ONAN, ONAF etc,….) shall be mentioned in test report
     - This design shall be have separate approval certificate cooling type shall be mentioned
     - Calculation of No. of radiator and its size shall be submitted to ..EDC for approval

  - The manufacturer shall be inform us transformer room minimum dimensions in both cases natural air cooling / forced air cooling (m^3 /h & C°) for tr. room
  - The tank shall have detachable radiators with flanged shut off valves at each end.
  - The radiator fins shall be welded with stiffening rods (horizontally and diagonally). In addition suitable ironwork shall be fitted to the radiator groups to prevent vibration during operation of the transformers.

- The design of the radiators shall be such that dust and sand cannot accumulate and block or restrict circulation of the air.
- Each radiator shall be provided with an air release vent and drain plug.
- The radiators shall withstand the pressure and vacuum conditions specified for the tank.

- Radiator interior shall be with corrosion proof painting and outer surface shall be either hot-dip galvanized or painted per EDMS 29-301-1.
- For shipping purposes, the radiator valves shall be furnished with a gasketed blanking plate.

– **For hermetically sealed transformers** (option as per …EDC requirements)
  - The tank should have sufficient expansion for oil breath, and should withstand an internal presser of 30 kN/m^2
  - The transformer tank can be hermetically sealed by means of a nitrogen cushion.

4.16 Accessories

– The supplied transformers should be equipped with the following accessories:
  - Drain valve complete with control tap
  - Welded lifting shackles
  - Tank earthing: two M 10 studs with nut washers should be used.
  - Dial thermometer for oil temperature reading with a range 0 – 120 °C (with two contacts)
  - Buchholz relay with alarm and trip contacts. (for power rates ≥ 500 kVA)

– **For hermetically sealed transformers** (option as per …EDC requirements), the following accessories should be installed:
  - Pressure Relief valve (PRV).
    A vent should be provided to prevent rupturing of the transformer. This should be capable of withstanding the variations of pressure in normal service.
  - Multi-function integrated device.

4.17 Wheels

– The enclosure base should be fitted with four bi-directional wheels to facilitate moving of the transformers during installation in two perpendicular directions.
– Wheels should have a locking facility to secure the transformer in its position.

5. TRANSFORMER LOSSES

– The transformer should be designed for minimum losses.
– When comparing between different tenders, the present worth (PW) value of the annual capitalized cost of guaranteed losses in the transformers should be added according to the following formula:

$$PW = K \times 8760 \times C \left[W_i + (LSF) \left(P^2 \right) W_{cu} \right]$$

Where
K = Present worth factor (L.E)
$K = ((1+i)^N - 1) / i\,(i+1)^N)$
i: latest interest rate from Central Bank of Egypt.
N: number of years. (20 years)

C = Cost of kWH. (According to the max commercial cost of kWH and can be adjusted as per EEHC latest update)
LSF = Loss factor for the load = 0.4.
W_i = Iron (no-load) losses in kW at rated voltage and main tapping
W_{cu} = Copper (load) losses in kW at full load and 95 ºC.
P = Peak load (P.U.) = 0.8.

– The values of the required losses are given in Table (4)

Table (4)

Power (KVA)	No load losses (W) at 400 V		Load losses (W) at 95ºC	% Z (Tolerance ±10%)
	Silicon steel type	Amorphous type		
25	120	23	650	4
50	168	31	875	4
63	224	37	1260	4
100	272	74	1505	4
160	384	84	2170	4
200	456	103	2520	4
300	576	130	3815	4
400	638	160	4638	4
500	700	190	5460	4
630	825	250	6430	4
800	1015	300	7700	5
1000	1222	360	9450	5
1250	1500	425	11700	5
1500	1785	480	13860	6
1600	1950	500	14900	6
2000	2736	550	15750	6
2500	3400	670	16300	6
3000	3950	785	19750	7
3500	4075	835	22850	7
4000	4200	844	25950	7
5000	5000	1040	31500	7

6. MARKING

- Transformer serial No. and rated power should be engraved on tank cover at LV side.
- Each transformer should be fitted with a name plate of weather proof materials fitted in a visible position, showing the information listed below. Entries on the plate should be indelibly marked by etching or engraving:
  - a) Manufacturers serial number
  - b) Year of manufacture
  - c) IEC Codes.
  - d) Customer (__EDC) P.O No.
  - e) Cooling type.
  - f) Type: Conventional /Hermetically Sealed.
  - g) Number of phases
  - h) Rated power
  - i) Rated frequency
  - j) Rated voltages
  - k) Rated currents
  - l) Vector group
  - m) Impedance voltage
  - n) Type of oil
  - o) Total weight / Weight of oil
  - p) Connection diagram
  - q) Short circuit duration
  - r) A table giving tapping voltages of the positions

7. TESTING and INSPECTION

7.1 General

- Tests shall be carried out on finished transformers in accordance with the latest relevant standard and as specified herein.
- All tests shall be carried out by and at the expense of the tenderer who shall supply all the apparatus, instruments and equipment.
- Routine tests shall be carried out in the presence and under the control of the inspecting engineer of __EDC, except in specified or approved cases where test certificates are accepted. All test results shall be reviewed and approved in writing by __EDC.
- The contractor should advise testing dates. The contractor shall not be entitled to any extension of the time of completion due to the failure of any test or the rejection of any part of the materials as a result of any test.

– Routine tests shall be carried out in the supplier's factory or at any other mutually approved place.

7.2 **Type Tests:**

– Type tests should be carried out on one transformer for each type according IEC standard the type tests should include and not limited to the following:

1- Full wave lightning impulse voltage withstand test. IEC 60076
2- Temperature rise test. IEC 60076

7.3 **Special Tests**

1. Noise level Test according to IEC 60076-10
2. Short Circuit test

- The supplier shall submit short circuit test in a approved lap by the EEHC , otherwise supplier shall comply with the following:

a. Short circuit calculations for transformer need approval shall be submit to Extra High Voltage Research Center for review with same sample transformer with its drawing.
b. Supplier shall be guarantee transformer for3 years, guarantee will continues to be vailed for this period or till submit short circuit test whichever is earlier
c. Supplier will get approval for one year only and renewed yearly if there is no complain form any --EDC during guarantee period (3 years)

7.4 **Routine Tests:**

– Routine tests should be applied on each transformer and include the following:

1- Measurement of d.c. winding resistance. (the allowable deviation in the dc resistance value between phases should be less than 5% [deviation = (R_{max} - R_{min}) /R_{averg}].
2- Turns ratio and polarity check or vector-group symbol at all tap positions. Bushing positions must have permanent markings at this stage of production.
3- Measurement of impedance voltage
4- Measurement of load losses.
5- Measurement of No-load losses.
6- Induced over voltage withstand test.
7- Separate – source power frequency voltage withstand test.

8- Electrical oil tests.
9- Insulation tests between windings and earth and between winding each other (absorption factor (R60/R15 $\geq$ 1.3)).
R60: insulation resistance at 60 second.
R15: insulation resistance at 15 second.

7.5 Penalty and Rejection

7.5.1 Rejection of material:

- Failure of any material to comply with any one of the requirements of this specification shall constitute grounds for rejecting that material, except if the __EDC inspection engineer convinced that the material could satisfactorily be repaired. In such case, the contractor should be obliged to replace the defective material without being entitled to any extra payment or to any extension of time to complete the contract.

7.5.2 Penalty and rejection for decreased efficiency:

- The contractor should keep the no-load losses and load-losses to be within the guaranteed values.
- Should the measured losses exceed the allowable tolerances, then __EDC representative should reject the transformer with such losses. However, if the losses deviation lies within the allowable tolerances (10 % of the total losses), then the excess losses should be evaluated as per the following formula and the contractor should be penalized accordingly:

$$PW = K \times 8760 \times C\,[dW_i + (LSF)\,(P^2)\,dW_{cu}] \quad LE$$

Where
K = Present worth factor (L.E)
$K = ((1+i)^N - 1) / i\,(i+1)^N$)
i: latest interest rate from Central Bank of Egypt.
N: number of years. (20 years)
C = Cost of kWH. (According to the max commercial cost of kWH and can be adjusted as per EEHC latest update)
LSF = Loss factor for the load = 0.4.
dW_i = Excess in iron (no-load) losses in kW at rated voltage and main tapping
W_{cu} = Excess in copper (load) losses in kW at full load and 95 ºC.
P = Peak load (P.U.) = 0.8.

- No credit should be given for any decrease in the losses below the guaranteed values.

7.5.3 Replacement of rejected material and equipment

- In case of any rejected material or equipment, the contractor should be obliged to replace it without extra payment.

8. SUBMITTALS

8.1 Submittals required with tender:

- The tenderer shall complete and return one legible copy of the attached Data Schedule for each rate of the offered transformers.
- Dimensional drawings of the offered transformers including interconnection diagrams of all components and assemblies.
- Original catalogues shall be submitted to facilitate evaluation of the offer.
- All information should be in English language, clearly readable, with IEC standard symbols and SI units.
- Type and special test reports/certificates from an independent testing laboratory shall be submitted to __EDC.
- Approval certificate issued by Egyptian Electricity Holding Company.
- List of deviations & clauses to which exception is taken (if any).
- **Spare parts list** (option as per __EDC requirements).
  The tendrer should submit a list of recommended spare parts.

8.2 Submittals required following award of contract:

- The contractor should provide with shipment of the transformer complete installation, operation and maintenance instruction/manuals suitable for the specific supplied item(s), including information from the manufacturer of each purchased accessory.
- It should include interconnected diagrams, drawings and instructions describing procedures for items that will be shipped to be assembled and interconnected for operation when installed.
- These should contain strict instructions as required for carrying, moving by skidding or rolling, and lifting the transformer and accessories.
- The manual should include the instructions for tap changing, enclosure assembly, disassembly, temperature indicator reading, setting procedures and other information designed to assist in proper operation and periodic maintenance of the supplied equipment.
- Key interlocking should be identified, and serial number should be supplied.
- All manuals, instructions and supporting drawings and parts lists supplied by the manufacturer and supplemental instruction and data supplied by accessory manufacturers

should be in English, clearly readable and arranged in such format to make the subject items easily identifiable.

- The contractor should provide a complete set of "as manufactured" drawings and wiring diagrams including interconnection diagrams of all components and assemblies of the equipment which assist in operation and maintenance of the equipment.
- All drawings should be compatible with current industrial standards and good industrial practice.
- All information should be in English language, clearly readable, with IEC standard symbols, device model, numbers and other requirements.
- All Dimensions should be in centimeters.

9. GUARANTEE

- The supplier guarantee the transformer against all defects arising out of faulty design or workmanship, or of defective material for a period of 12 months from putting in service or 18 months from delivery date.
- In case of supplying for the first time, the guarantee period should be extended to 4 years at least from delivery date.

10. TECHNICAL DATA SCHEDULE

- The tenderer must fill in thoroughly the attached technical data schedule.
- Any offer does not accompanied with clear and complete technical data schedule shall be rejected.

TECHNICAL DATA SCHEDULE
DISTRIBUTION TRANSFORMER (10.5 - 11 / 0.4 kV)

1- Manufacturer	
2- Type	
3- Standard specification	
4- Rated output at 45ºC ambient (kVA)	
5- Method of cooling	
6- Oil type	
7- System of connection	
8- Material of insulation	
. HV winding	
. LV winding	
. Major insulation	
9- Material of core and its cross-section area (mm²)	
10- Turns ratio	
11- No load losses (watts)	
12- load losses at full load current and 95ºC winding temperature (watts)	
13- Resistance per phase at 95ºC For primary (ohms)	
For secondary (ohms)	
14- Cross-sectional area of cu windings For primary (mm²)	
For secondary (mm²)	
15- Permissible symmetrical S.C current at L.V side terminals for 2 sec (kA)	
16- Primary voltage at normal tapping (volts)	
17- Permissible overload duration without change of specified temperature rise according to IEC 60354	yes [ ] no [ ]
18- Full load current at LV side (Amps)	
. Full load current at HV side (Amps)	
. No load current at LV side (Amps)	
19- Impédance voltage (%)	
20- Temperature rise at rated output above 45°C ambient temperature	
A- At oil top level (°C)	
B- Winding temperature (°C)	
C- Core temperature (°C)	

21-Tapping switch (on H.V. Side)	
. No. of steps	
. Value of the step (%)	
22-Medium voltage insulators	
. Length of leakage (mm)	
. Arc gap (mm)	
23-Means for firmly bracing of trans. winding to avoid loosening them due to S.C	
24-Transformers should be complete with all accessories in tendered specifications	yes [ ] no [ ]
25-Transformers should be manufactured according to standards mentioned in tendered spec. and will satisfy all requirements in tender specifications	yes [ ] no [ ]
26-Tender specifications are attached with our offer and each page is signed by us	yes [ ] no [ ]
27-Overall dimensions (Length x Width x Height) (mm x mm x mm)	
28-Total weight of transformer with oil (kg)	
Weight of oil (kg)	
29-Noise level (db.)	
30-Color of silica gel	

I/we guarantee the correctness of above data for transformers we are offering to Electricity Distribution Company.

Signature of tenderer: …….. Date: / /