

Ministry of Electricity (MOE)  
Power Distribution Office  
Baghdad - IRAQ

Specification No.	D-26
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*Technical Specification of  
Distribution Transformer  
11 / 0.416 kV*

Revision	Year 2017
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## **1- Scope of the Tender**

Tenderer are invited for the design , manufacture , testing and supply of a 11000/416 volt, oil immersed copper winding outdoor type (Directly under the sun) transformers to be supplied complete with all necessary fittings , accessories off-load tap changer , insulating oil and spare parts . . . etc.

The transformer is to be hermetically sealed (without conservator tank) bolted cover with bushing insulators on both H.T and L.T sides for the following ratings: 100, 250, and 400. For 630, and 1000 kVA should be plug in type (according to the tender requirements), a valid ISO 9001 certificate required.

## **2- General Requirements**

The transformers shall be of first class quality and design for continuous satisfactory operation as continuity of supply is of prime consideration. The design shall be allow all necessary precaution for the safety of operation and maintenance personnel. The transformers shall operate satisfactorily under variations of load, voltage or short circuit or other conditions which may occur on the system provided that these variations are within the assigned rating of the apparatus. All the equipment shall be designed to obviate the risk of accidental short circuit.

### **2-1 Climatic Conditions**

The materials used shall be suitable for the following climatic conditions prevailing at the site:

#### **2.1.1 Ambient temperature**

Highest maximum (in the shade) +55<sup>0</sup> C for about 6 hrs a day.

Lowest minimum -10<sup>0</sup> C

Maximum yearly average +30<sup>0</sup> C

Maximum daily average +40<sup>0</sup> C

#### **2.1.2 Sun temperature**

Black objects under direct sunshine attain a temperature of 80<sup>0</sup> C.

### 2.1.3 Air humidity

Maximum	92% at 40° C
Minimum	12%
Yearly average	44%

### 2.1.4 Sand storm

In general, the atmosphere is dusty which may result in a layer of dust being deposited on all exposed surfaces. Also fine dust particles may penetrate even through minute openings.

## 2-2 Altitudes

From sea level up to (1000m).

## 2-3 System Data

### 2-3-1 High voltage side:-

Nominal voltage .....	11000 Volts
Short circuit level .....	25 kA at 11000 volts
Frequency .....	50 HZ.
Highest system voltage .....	12000 volts
System .....	3-phase, 3-wire with neutral isolated but provision is made for earthing through an earthing resistance of 21.1 ohms to limit the earth fault current to 300 Amp.

### 2-3-2 Low voltage side:-

Nominal voltage .....	400/230 volts ± 10%
System .....	3-Phase, 4-wire neutral solidly earthed.
Short circuit level .....	According to the short circuit level of H.T side and the rated power and impedance voltage of the transformer

## **2-4 Standards**

All the equipment shall be in accordance with the latest issue of the International Electro-technical Commission (IEC specification).

## **2-5 Deviation:**

The tenderer shall particularly mention in his tender all deviations from the specification described in these tender specification.

## **2-6 Schedules:**

The tender shall duly fill in the schedules A&B of guaranteed technical particulars, prices, delivery and deviations attached to this specification. Incomplete tenders are liable to rejection.

## **2-7 Guarantee:**

The tenderer shall confirm than the transformer guaranteed against all defects arising from faults design, materials and workmanship, for a period of (12) months from commissioning or (18) months from arrivals, whichever period expires earlier.

## **3- System Composition**

The transformer shall operate in distribution systems where most of the network is overhead lines and comprising partly underground cable.

#### 4- **Technical Specification**

4.1 The transformers shall be copper winding. Hermetically sealed of the bolted cover and should have the following characteristics:-

Rated outputs .....	100, 250, 400, 630, and 1000 kVA
Duty .....	Step-down, outdoor bushing type for 100, 250, and 400 kVA. Plug in type for 630 and 1000 kVA (according to the tender requirements)
Type .....	3-phase
Rated voltage at no load ...	HV side -11kV LV side - 416 volts
System Highest Voltage ...	HV side 12 kV
System frequency .....	50 HZ
Interphase Connection .....	HV side - Delta LV side - star with neutral brought out
Vector Group .....	Dyn 11
Type of cooling .....	ONAN
Temperature rise .....	( i ) 45 K in top oil by thermometer ( ii ) 50 K in winding by resistance

4.2 The efficiency (at unity power factor and 100% of rated power) of the transformer should be not less than the following:

1. 100 kVA ..... 98.1%
2. 250 kVA ..... 98.6%
3. 400 kVA ..... 98.7%
4. 630 kVA ..... 98.8%
5. 1000 kVA ..... 98.9%

4.3 The duration of the short circuit to rise the temperature of windings from 105 °C to 250 °C should be not less than (5 Sec.) according to IEC 60076, part 5 , clause (4.1.5).

4.4 The thickness of the radiator plates should be shock resistant and do not affect heat dissipation according to tender requirements as follows:

- For 250 and 400 kVA transformer, not less than 1.2 mm.
- For 630 and 1000 kVA transformer, not less than 1.5 mm.

- 4.5 The noise level should be  $\leq 55$  dB at 0.3 meter distance according to IEC standards
- 4.6 The low voltage winding must be of copper foil for 250, 400, 630, and 1000 kVA transformers.
- 4.7 Off-load tap changer should be five tapping for ( $\pm 2.5\%$ ,  $\pm 5\%$ ) on the HV winding for off-circuit operation externally. The mechanical operation must be of the robust and definite position type with a click indicating position arrived during tap changing with suitable pad-lock.
- 4.8 Terminal arrangement of transformers.
- 4.8.1 The HV side:
- Terminal is to be a clamp type with eyebolt or flat bar type with nut suitable for conductors up to 70 mm<sup>2</sup> copper (for 100, 250, 400 kVA).
- 4.8.2 The low voltage terminals are to be flat bar type with holes suitable for compression type thimble the sizes of LV side:
- For 100 KVA transformer 4x1x70 mm<sup>2</sup> copper (1 hole per phase).
  - For 250 KVA transformer 8x1x95 mm<sup>2</sup> copper (not less than 2 holes per phase).
  - For 400KVA transformer 7x1x150 mm<sup>2</sup> copper (not less than 3 holes per phase).
  - For 630 KVA transformer 11x1x240 mm<sup>2</sup> copper (not less than 3 holes per phase).
  - For 1000 KVA transformer 14x1x240 mm<sup>2</sup> copper (not less than 3 holes per phase).
- 4.9 Terminal arrangement of outdoors transformers must be porcelain bushing insulator (brown colored preferable) mounted on the top cover of transformer for both HV and LV, with arcing horn (double air gap is preferable) on HV bushing for outdoor transformer only. Neutral bushing should distinguished from phase bushing by longer distance of separation.

## **5- Fittings and Accessories**

- Terminal marking plate.
- Tapping switch.
- Two valves (3/4 inches) diameter fitted on cover and bottom of tank, switch locks.
- Thermometer pocket with thermometer including maximum temperature measurement indicator with two separate free contacts.
- Lifting lugs.
- Pressure relief valve.
- Earthing terminal on tank.
- Rating and diagram plate to be chromium plated of the engraved type with kVA rating and serial number engraved inside on the cover of the transformer at a suitable place.
- Skid mounting to be vertical with the length of the transformer.
- Oil level indicator, to be of mechanical type located on the top cover of transformer to indicate the oil level with the temperature variation, protected by metallic envelop.

## **6- Painting**

- The painting should be oil and weather (dust, humidity and heat .... etc.) resistant type and the final coat is to be aluminum paint or equivalent. Any alternative finishing which gives better heat radiation is accepted and must be confirmed by calculations.
- Ministry of Electricity logo must be engraved on the cover or side of the transformer at a suitable place.

## **7- Insulating oil**

The transformer is to be shipped with first filling of oil which shall be (uninhibited insulation oil), according to the latest IEC 60296.

## **8- Tender Price Evaluation (losses considerations)**

### **8.1 Cost of the transformer**

The cost of transformer will consider the age of the transformer, the iron losses, copper losses, and the initial price of the transformer. This cost will be used for comparison between the values of different tenderers and not the initial price of the transformer only.

The following equation will be applied to calculate the cost of transformer.

*Cost according to loss evaluation (for one transformer) = Initial price + (Guaranteed  $I_e \times 1800$  + Guaranteed  $C_u \times 600$ )*

Where:

- $I_e$  = Iron (no-load) losses: 1800 USD per kW at rated voltage and frequency.
- $C_u$  = Copper (Load) losses: 600 USD per kW at rated power and principle tapping at 75°C.

### **8.2 Loss evaluation**

The tolerance permitted is +10% of the evaluated guaranteed total losses mentioned in the offer. Any transformer with total losses more than + 10% will be rejected. For transformer with total losses within +5% of the evaluated guaranteed losses , no penalty shall be made , for transformers where the total losses between 105% to 110% of the total evaluated guaranteed losses , the contract price shall be reduced by the cost of the difference between the total losses and the 100% of the total evaluated guaranteed losses according to the following values.

- $I_e$  = Iron losses (kW).
- $C_u$  = Copper losses (kW).
- $Q$  = number of transformers required in the tender.

For any transformer with total losses less than 100% of the guaranteed losses, no variation to the contract price shall be made.

*Total penalty (USD) =  $Q \times [(Measured I_e - Guaranteed I_e) kW \times 1800 USD/kW + (Measured C_u - Guaranteed C_u) kW \times 600 USD/kW]$*

## **9- Tests**

### **9.1 Inspection:**

The material shall be subjected to inspection and test by owner inspectors or international inspector at any time during manufacture. The manufacture shall provide all inspection facilities for the said inspection and inspection shall be made at the place of manufacture or at international testing facilities according to the tender requirements. The inspector shall have the right of rejecting any portion of the material at any time during manufacture if it does not meet with the requirements of this specification in all particulars. He shall have the right of overseeing the packing and shipping of all material to be supplied.

### **9.2 Tests at manufacture work:**

Tests at manufacture's factory shall comprise type tests (if required according to the tender requirements) and routine tests according to the approved parameters in schedules A & B.

#### **a) Type tests**

The type tests prescribed shall be carried out on one unit of each capacity:

- 1- Test of temperature rise according to the latest IEC 60076.
- 2- Full wave impulse voltage withstand test according to the latest IEC 60076.
- 3- Cost of these tests to be borne by the manufacturer.

#### **b) Routine tests**

Each transformer shall be subjected to all the routine tests specified according to the latest IEC 60076.

#### **c) Special tests**

(If required according to the tender requirements).

### **9.3 Test reports**

Five copies of the test reports will be mailed within 8 days after the tests have taken place. These reports will indicate:

- a) The results of the tests.
- b) The calculation of performance of the items.

- c) The guarantee figures to show that each apparatus performs the conditions of the specification within the guaranteed values (schedules A & B).

#### **9.4 Test Certificates**

- a) The tenderer shall furnish the Ministry of Electricity (MOE) with six copies of test certificates.
- b) No equipment shall be shipped without obtaining the (MOE) inspector prior approval of the certificates.

#### **9.5 Witnessing tests**

Unless otherwise agreed to, all tests at factory shall be witnessed by an authorized representative from (MOE).

The cost of travelling & accommodation of the authorized inspectors to witness the test at the place of manufacture for required days, to be on tenderer account.

### **10- Drawing, Instruction Book and Literature.**

#### **10.1 Documents to be submitted with the tender**

The following documents shall be submitted by the tenderer along with his offer:-

- a) Full and technical specification of transformer including schedule A&B of guaranteed technical particulars.
- b) An outline drawing showing the plan , front and side elevation of the transformers , dimensions , terminals , equipment , and all accessories of the transformers.
- c) Catalogues of the manufacturer for transformers.
- d) Valid ISO-9001 certificate of the manufacturer for transformers.
- e) Test certificate for identical transformers.
- f) Reference list of manufactured and exported transformers.
- g) Incomplete offers are liable to rejection.

**10.2 Documents to be furnished by the successful tenderer**

Within a period of 2 weeks from the commencement date, the successful tenderer shall furnish the following documents for final approval:-

- a) 24 sets (or according to the tender requirements) of prints on paper on all drawings.
- b) 24 copies (or according to the tender requirements) of all instruction books and technical maintenance of the transformer, OFF Load tap changing gear and other ancillary equipment.
- c) 24 copies (or according to the tender requirements) of instruction for erection of the equipment.
- d) 24 copies (or according to the tender requirements) of spare parts list with catalogue number.

**10.3 Language**

The language to be used in the drawings and instruction book shall be English.

**10.4 Dimension:**

Due to the space requirement in our system it is important for the participants in this tender to make sure that the dimension of each type of the required transformers to be as small as possible the following table is indicative as a maximum for each single dimension:-

**Table of Dimension**

Transformer (kVA)	Length (mm)	Width (mm)	Height (mm)
100	1220	600	1200
250	1230	700	1300
400	1400	1000	1400
630	1500	1200	1600
1000	1700	1400	1800

### **10.5 Approval of drawings:**

The successful tenderer shall prepare and submit to the (MoE) all necessary drawings and specifications (schedule A & B) complete with explanations in due time and obtain approval of the same before commencing manufacture.

Failure to comply with this clause shall make the equipment or parts or parts there of liable to rejection.

## **11- Packing**

The supplier will pack or protect the goods in the most appropriate manner.

He will be responsible for any loss or damage arising from careless packing or protection up to the place of final destination after completion of the inspection and tests at the factory, each item shall be packed for export shipment. All parts provided for shipping purposes only and which are to be removed at the time of erection shall be conspicuously tagged.

The method of packing shall be such as to protect all the items against excessive corrosion of dampness, and shall afford adequate protection against breakage or other injury, or loss due to breakage of cases or crates from the time the items leaves the factory until finally installed at the substation during which time, the apparatus will travel by rail by a long sea voyage again by rail or truck to the site of the substation. The equipment will also undoubtedly stand on wharves and in the open during and in between periods of transportation and will thereby be exposed to heavy rain, hot sun, humid climate and sudden changes of temperature.

Owing to the numerous handlings, the containers should be very strong also extra ordinary care should be given to the packing of the equipment and especially the items having insulating material to prevent the injury due to moisture, from sources external to the packing or from excessive condensation with the packing.

## 12- Spare parts and special tools for each rating

This clause is optional according to tender requirements.

### 12.1 Spare parts

No.	Item	Quantity (from the total quantity of the contract)
1	HV / LV winding	3%
2	HV bushing with its accessories	10%
3	LV bushing with its accessories	10%
4	Tap changer	3%
5	Pressure relief valve	2%
6	Oil level indicator	10%
7	Cover gasket	10%

**Note: Unit price per set and per piece for each item are required.**

### 12.2 Special tools:

All special tools required for maintenance of transformer shall be included in the scope of supply. An itemized list of special tools together with prices shall be submitted with the tender.

### Schedule "A"

**Schedule of the Guaranteed Performance and Other Technical Particulars (To be filled by the Tenderer for each rated capacity of 100, 250, 400, 630, and 1000 kVA).**

No.	Description	Unit	Specifications	
			Required	Proposed
<b>1</b>	<b>General</b>			
1.1	Manufacturer Name		To be filled in	
1.2	Country of Manufacturing		To be filled in	
1.3	Type			
1.4	Model		To be filled in	
1.5	Applicable Standards		IEC 60076	
1.6	Location of service		Outdoor	
1.7	Short circuit Test Report			
1.8	Date of carried out		To be filled in	
1.9	Testing laboratory name and country		To be filled in	
1.10	Certificate Provided		Yes	
<b>2</b>	<b>Ratings</b>			
2.1	Continuous maximum rating	KVA	To be filled in	
2.2	Rated voltage ratio			
	• Primary	kV	11(+2 x 2.5%/- 2 x 2.5%)	
	• Secondary	kV	0.416Y/0.24	
2.3	Number of phase		3	
2.4	Frequency	Hz	50	
2.5	Vector group symbol		Dyn11	
2.6	Cooling method		ONAN	
2.7	Maximum temperature rise at rated power			
	• Top oil by thermometer	K	45	
	• Winding by resistance	K	50	
	• Hot spot of winding max ambient temperature (55 <sup>0</sup> C)	K	To be filled in	
2.8	Impedance voltage at continuous rated power	%	To be filled in	
2.9	Winding connection:			
	• Primary		Delta	
	• Secondary		Star (Neutral brought out)	

<b>3</b>	<b>Rated insulation level for Primary</b>			
	• Impulse withstand voltage (1.2/50µs)	kV peak	75	
	• One minute 50Hz withstand voltage	kV rms	28	
<b>4</b>	<b>Design Details</b>			
4.1	Off-load tap changer			
	• manufacturer		To be filled in	
	• Tapping range		+5%/-5%	
	• Tapping step		2.5%	
4.2	Exciting current referred to HV side and 50 Hz			
	• At 90% rated voltage.	A	To be filled in	
	• At 100% rated voltage.	A	To be filled in	
	• At 110% rated voltage.	A	To be filled in	
4.3	Power factor of exciting current at 100% rated voltage and 50 Hz	%	To be filled in	
4.4	Iron losses at 50 HZ			
	• At 90% rated voltage.	kW	To be filled in	
	• At 100% rated voltage.	kW	To be filled in	
	• At 110% rated voltage.	kW	To be filled in	
4.5	Copper losses at full load (on rating) and at 75 <sup>0</sup> C	kW	To be filled in	
4.6	Total losses.	(kW)	To be filled in	
4.7	Resistance voltage at full load and at 75 <sup>0</sup> .	(%)	To be filled in	
4.8	Reactance voltage at full load and at 75 <sup>0</sup>	(%)	To be filled in	
4.9	Impedance voltage at full load 75 <sup>0</sup> :			
	• At normal tap.	(%)	To be filled in	
	• At highest tap.	(%)	To be filled in	
	• At lowest tap.	(%)	To be filled in	
4.10	Resistance of HV winding per phase at 20 <sup>0</sup> C	Ω	To be filled in	
4.11	Resistance of LV winding per phase at 20 <sup>0</sup> C	Ω	To be filled in	
4.12	Regulation at full load at 75 <sup>0</sup> C			
	• At 1.0 power factor.		To be filled in	
	• At 0.8 p.f lagging.		To be filled in	
4.13	Efficiency at 75 <sup>0</sup> C:			
	• At 100% load	(%)	To be filled in	
	• At 75% load	(%)	To be filled in	

	• At 50% load	(%)	To be filled in	
	• At 25% load	(%)	To be filled in	
4.14	Calculated thermal time constant	Hrs.	To be filled in	
4.15	Maximum flux density at normal voltage and frequency and at normal ratio for:			
	• Core.	(KI/sq.cm)	To be filled in	
	• Yoke.	(KI/sq.cm)	To be filled in	
4.16	Maximum flux density at 110% voltage and frequency and at normal voltage and frequency and at normal ratio for:			
	• Core	(KI/sq.cm)	To be filled in	
	• Yoke	(KI/sq.cm)	To be filled in	
4.17	Insulation level of:			
	• Core bolts.	kV	To be filled in	
	• Core bolts washer.	kV	To be filled in	
	• Side plates.	kV	To be filled in	
	• Core laminations.	kV	To be filled in	
4.18	Current density in windings for:			
	• H.V. winding	(Amps/sq.cm)	To be filled in	
	• L.V. winding	(Amps/sq.cm)	To be filled in	
4.19	Insulation on copper.	kV	To be filled in	
4.20	Insulation strength of winding.			
	a) Impulse full wave for:			
	(I) H.V.	(kV)	To be filled in	
	(II) L.V.	(kV)	To be filled in	
	b) Impulse chopped wave for:			
	(I) H.V.	(kV)	To be filled in	
	(II) L.V.	(kV)	To be filled in	
	c) Applied voltage test	(kV)	To be filled in	
	d) Induced voltage test	(kV)	To be filled in	
4.21	Insulation strength of terminals.			
	• Over voltage test	(kV)	To be filled in	
	• Minimum wet withstand voltage	(kV)	To be filled in	
	• Minimum impulse withstand	(kV)	To be filled in	
	• Minimum puncture or oil-immersed withstand voltage	(kV)	To be filled in	

4.22	Type of core		To be filled in	
4.23	Max. noise level at 0.3 meter	(dB)	55	
4.3	Type of oil (As per IEC requirement )		Yes	
4.4	Standards		IEC 60296	
4.5	Type of corrosion protection			
	• Inside tank		To be filled in	
	• Outside tank		To be filled in	
4.6	Type of valves		Clobe or gate valve	
<b>5</b>	<b>Dimension And Weight</b>			
5.1	Dimension of Transformer			
	• Under base to top most point.	mm	To be filled in	
	• Under base to bushing mounting flanges.	mm	To be filled in	
	• Overall breadth.	mm	To be filled in	
	• Overall length.	mm	To be filled in	
	• Crane lift for untanking core and coils	mm	To be filled in	
	• Crane lift for removal of bushings	mm	To be filled in	
5.2	Overall shipping dimensions of the largest package	mm	To be filled in	
5.3	Thickness of transformer tank			
	• Sides.	(mm)	To be filled in	
	• Bottom.	(mm)	To be filled in	
	• Corrugated radiators.	(mm)	To be filled in	
5.4	Volume of insulating oil	(liter)	To be filled in	
5.5	Net weight of insulating oil	(Kg)	To be filled in	
5.6	Total weight of transformer less oil	(tons)	To be filled in	
5.7	Weight of the largest shipping package	(tons)	To be filled in	
5.8	Net weight of core	(Kg)	To be filled in	
5.9	Net weight of copper			
	• H.V.	(Kg)	To be filled in	
	• L.V.	(Kg)	To be filled in	
5.10	Net untanking weight of:			
	• Core	(Kg)	To be filled in	
	• Frame	(Kg)	To be filled in	
	• Coil	(Kg)	To be filled in	

**Schedule "B"**  
**Oil Characteristics Table (To be filled by the Tenderer).**

No.	Description	Unit	Specifications	
			Required	Proposed
1	Name of manufacturer		To be filled in	
	Country of manufacturing		To be filled in	
	Type		To be filled in	
	Standards		IEC 60296	
2	Reference Name of Oil		To be filled in	
3	Sludge Value	%	0	
4	Flash Point (Closed)	°C	To be filled in	
5	Pour Point	°C	To be filled in	
6	Viscosity at 21 <sup>o</sup> C	CST	To be filled in	
7	Breakdown voltage (after treatment)	kV	>60 ex works ( >70 upon treatment)	
8	Acidity(Neutralization Value): • Total • Inorganic	mgKOH/g	To be filled in	
9	Saponification Value	mgKOH/g	To be filled in	
10	Copper Diceleration		To be filled in	
11	Crackle		To be filled in	
12	Specific Gravity		To be filled in	
13	Sulfur Content		To be filled in	
14	Dielectric Dissipation Factor at 90 °C (after treatment)		≤ 0.001	