

Technical Specifications

FOR 33kV/LV & 11kV/LV TRANSFORMERS

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5.0 DISTRIBUTION TRANSFORMERS

5.1 General

This section specifies the requirements for the design, manufacture, testing and delivery to Kampala of distribution transformers specified herein including:

Distribution Transformers

- Three phase distribution transformers (33 kV/LV and 11 kV/LV)
- Single phase distribution transformers (33 kV/LV and 11 kV/LV)

5.1.1 Standards

The equipment specified in this section shall conform to the latest edition of the appropriate IEC specifications and/or other recognized international standards. In particular:

IEC 60060-1(1989-11)	High Voltage Test Techniques
IEC 60060-2(1994-11)	
IEC 60060-2(1994-1)	
IEC 60060-1(1989-03)	
IEC 60071-1(1993-11)	Insulation Coordination
IEC 60071-2(1996-12)	
IEC 60076-1(1993-03)	Power transformers
IEC 60076-2(1993-04)	
IEC 60076-3 am 1(1981-01)	
IEC 60076-3(1993-01)	
IEC 60076-3(1980-01)	
IEC 60076-3 am 1(199 -01)	
IEC 60076-5(1976-01)	
IEC 60076-5 am 2 (1994-02)	
IEC 60076-8(1997-11)	
IEC 60099-1(1991-06)	Non linear resistor type gap Surge Arrestors for AC systems
IEC 60099-5(1996-02)	Selection and application recommendations
IEC 60137(1995-12)	Bushings for alternating voltages above 1 kV
60156(1995-08)	Method of determination of electric strength of insulating oils
IEC 60296(1982-01)	Specification for unused mineral insulating oils for transformers and switchgear
IEC 60354(1991-10)	Loading guide for oil immersed transformers
IEC 60529(1989-11)	Classification of Degrees of Protection provided by Enclosures

IEC 60551-1(1995-08)	Determination of transformer and reactor sound levels
IEC 60606	Application guide for power transformers
IEC 60616(1978-01)	Terminal and tapping markings for power transformers
IEC 60722(1982-01)	Guide to lightning and switching impulse testing of power transformers and reactors
IEC 60733	Determination of water in insulating oils, and in oil-impregnated paper and pressboard
BS 3643	ISO metric screw threads
BS 5493	Protective coating of iron and steel structures against corrosion.
DIN 42500	Three-phase oil-immersed public distribution transformers.

5.1.2 Inspection and Testing

A representative appointed by the Purchaser may inspect the manufacture's plant.

Tests shall be performed in accordance with the relevant IEC standards supplemented by the specific requirements indicated below. In the absence of IEC recommendations the tests must be equivalent at least to the conditions, provisions and definitions of the above-mentioned standards.

(a) Distribution Transformers

Distribution transformer tests will be divided into the following categories:

(i) Routine Tests

Each transformer shall have the following tests performed on it, in accordance with IEC 60076-1.

- Measurement of winding resistance
- Measurement of voltage ratio and check of voltage vector relationship
- Measurement of impedance voltage, short-circuit impedance and load loss
- Measurement of no-load loss and current
- Dielectric tests
- Insulating oil test
- Separate source voltage test
- Induced over voltage test
- Measurement of paint thickness
- Test for effectiveness of sealing

(ii) Type Tests and Special Tests

Suppliers shall include with their offers type test and special test certificates, carried out in accordance with IEC 60076-1, which are issued by an approved, internationally

acknowledged, reputable, independent, testing laboratory. Transformer offers without type test certificates shall be considered non-responsive.

In addition the Purchaser may call for type tests and special tests to be carried out at the Manufacturer's Works and witnessed by the Purchaser or representative at Supplier's expense. Such tests would be on random samples at the discretion of the Purchaser and failure to meet the conditions of test could result in the rejection of a complete batch of transformers.

The following test shall performed on each design:

- Lightning impulse voltage test, chopped on the tail (primary and secondary windings)
- Temperature rise test
- Short-circuit withstand test
- Tank stiffness test
- Corrugated tank fatigue test (if applicable)
- Acoustic sound level measurements
- Pollution test – Composite transformer bushings shall be tested in accordance with either of the following two test procedures:
 1. Natural ageing test procedure for outdoor insulator products
 2. Ageing test under operating voltage simulating weather condition (5000-hour test), in accordance with IEC 61109

NB: Copies of type test and routine test certificates, in English, shall be submitted with the tender.

5.1.3 Packing

Transformers shall be delivered filled with oil, equipped and supplied with all specified equipment mounted. Screws and bolts shall be thoroughly tightened to ensure no leakage of oil.

5.1.4 Operating Characteristics

In addition to the General Technical Requirements, the following minimum and maximum operating characteristics, where stated, shall apply to all distribution transformers specified in this section:

Primary Voltage	33 kV and 11 kV
Secondary voltage (no load) Three/Single Phase Single Phase	433/250V 250V
Vector group (three phase)	Dyn11
Vector group (single phase)	li0
Off-loading tappings (primary side)	+5.0%, +2.5%, 0%, -2.5%, -5% 33 kV or 11 kV

Primary Voltage	33 kV and 11 kV
Insulation levels (IEC 60076)	L75/AC28/AC3(11 kV) LI70/AC70/AC3(33 kV)
Short circuit impedance voltage at 75°C <500 kVA >500 kVA	4% 5%
Cooling type	ONAN
Insulation temperature class (IEC 60076)	A
Maximum winding temperature rise	65°C
Maximum allowable noise level at 0.3 metre measured in accordance with IEC 60551 (tolerance 2 dB(A))	
<ul style="list-style-type: none"> ▪ 25 kVA ▪ 50 kVA ▪ 100 kVA ▪ 200 kVA ▪ 315 kVA ▪ 500 kVA ▪ 630 kVA 	45 dB(A) 48 dB(A) 50 dB(A) 51 dB(A) 55 dB(A) 56 dB(A) 58 dB (A)

Local climatic conditions under which the transformers will operate and to be taken into consideration are given in the table below. The supplier shall take into account the altitude of 1500 m in the design of the transformer and such equipment as bushings etc. In this connection, all transformers will have to be tropicalised.

Climatic Design Parameter	Climatic Design Value
Altitude	1,500 metres
Ambient Air Temperature	
average	25°C
minimum	10°C
maximum	40°C
Annual Isokeraunic Level	150 days
Climate	Tropical
Relative Humidity	20 – 100%
Wind Speed	
average	37 km/h
maximum	72 km/h

5.1.5 Losses

The no load and load losses are to be as low as is consistent with reliability and economical use of materials. The cost of losses is to be minimised. The following capitalisation formula, providing the net present value (NPV) of the total cost, will be used in the evaluation of the tenders

$$\text{Total Cost} = A + C_i P_i + C_c P_c$$

where

A	=	Cost of purchasing, US\$;
P _i	=	No-load losses, kW;
P _c	=	Load losses, kW;
C _i	=	Capitalised cost of no-load loss, US\$/kW;
C _c	=	Capitalised cost of load loss, US\$/kW;

The economic life of a transformer is assumed to be 25 years, and

C _i	=	Cost per kilowatt of no-load Losses	=	5500 US\$/kW
C _c	=	Cost per kilowatt of load Losses	=	3300 US\$/kW

5.2 Three Phase and Single Phase Distribution Transformers

Three phase distribution transformers (33 kV/LV and 11kV/LV) shall be selected from the following series of ratings:

Pole Mounted	Ground Mounted
25 kVA	200 kVA
50 kVA	315 kVA
100 kVA	500 kVA
200 kVA	630 kVA
315 kVA	
500 kVA	

Single-phase distribution transformers (33kV/250V and 11kV/250V) shall be rated at 25kVA.

5.3 Distribution Transformer Construction

5.3.1 General

The transformers shall only be double-wound, oil immersed naturally cooled (ONAN) and hermetically sealed type tank with bolted cover.

The core shall be high grade *cold rolled, grain oriented electrical sheet steel* (CRGOESS). The primary and secondary windings shall be constructed from high conductivity copper or aluminium. All turns of windings shall be adequately supported to prevent movement. In cases where turns are spaced out, a suitable inter-turn packing shall be provided. Transformers manufactured with Aluminium foil or sheet type LV windings of proven design will be accepted.

No material which can be deleteriously affected by the action of oil under the operating conditions of the transformers shall be used in the design of transformers or leads or bushings.

The core shall be insulated from the general transformer tank to withstand a power frequency test of 2 kV for one minute but reliably earthed to the transformer tank by a single connecting link.

Construction features shall permit local repairs to be easily carried out in the event of equipment failure.

All tapping ratings shall apply at the 33 kV or 11 kV voltage.

5.3.2 Transformer Tank

The transformer tank shall be fabricated from steel and be of robust construction; all welds shall be made by the electric arc process and the slag carefully removed after each run.

The tank shall have a bolted cover which shall provide the only access to the inside of the transformer.

With the exception of radiator elements, all external joints shall be seam welded. Cooling radiators shall be of robust and simple construction and preferably be of the corrugated tank side form. Complicated shapes shall not be acceptable, and horizontal stiffeners on tanks should be avoided. The bearing surface of the tank to which bushings are clamped shall be substantially flat.

All matching faces of joints to be made oil tight shall be finished with a smooth surface to ensure that the gasket material will make a satisfactory joint.

Flanges and covers of tanks shall be of sufficient thickness to prevent any depression occurring which would retain water around the bolts.

Bolts shall be spaced at sufficiently close intervals to avoid buckling of either flanges or covers and provide reasonably uniform compression of the gasket.

Each transformer shall be provided with a minimum of two closed lifting lugs. The minimum diameter of the hole or width of the slot shall be 25 mm. The two lifting lugs shall

be located such that there will be a minimum of 50 mm between the lifting chain and the nearest part of the bushings.

All transformers shall be suitable for both indoor and outdoor installation.

Pole mounted transformers

Generally the single phase transformers (25 kVA) and the three phase (50 kVA, 100 kVA, 200 kVA, 315 kVA and 500 kVA) transformers will be pole mounted outdoors, although some may be ground mounted outdoors or installed indoors in customer premises.

All pole-mounted transformers shall be suitable for mounting on pole platforms and shall have four mounting lugs with 12-mm diameter holes suitable for bolting the transformer to the platform. The distance between the mounting studs shall be 520mm and shall meet the requirement of DIN 42500.

Ground mounted transformers

Ground mounted transformers shall have closed HV and LV terminal bushings except for those rated 33-kV/500 kVA and above. The latter shall be mounted on transformer plinths 1.8 m above the ground with open HV terminal bushings and closed LV bushings.

The ground-mounted transformers shall be equipped with suitable base frame and wheel for mounting. Wheel shall rotate 90° without dismantling and shall meet the requirement of DIN 42500. The distance between the mounting skids shall be 670mm for transformers up to 800kVA and 820mm for transformers rated 1000 – 1600kVA.

Suppliers must clearly state in the offer whether the design is for hermetically sealed transformers with nitrogen cushion.

Transformers with ratings in excess of 500kVA shall be fitted with thermometer pockets complete with screwed captive cover.

5.3.3 Transformer Core and Coils

To ensure that the core and coils of transformers are seated on the floor of the tank, supporting frames shall be designed to accommodate variations in tank height.

The core and coil assembly shall have the core and coils rigidly connected to the tank and suitably closed lifting lugs shall be provided for removing the core and coil assembly from the tank.

5.3.4 Transformer Sealing

A satisfactory lid-sealing gasket shall be provided on each transformer to maintain the seal at extremes of operating temperature. A cold oil level mark shall be provided inside each transformer marked C.O.L.

5.3.5 Internal and External Finish

Internal and external tank and radiator surfaces shall be thoroughly cleaned by shot blasting or be given an acid and phosphate dip treatment to remove rust and scale and to provide an adherent, moisture resistant coating. Due care shall be given to avoid over pickling resulting in pitting or unduly heavy deposit of phosphate. This resultant coating shall provide a surface which shall offer good paint adhesion and a resistance to corrosion.

All painting shall be suitable for tropical conditions. The intent shall be to give maximum protection to ensure long-term safe operation in a highly aggressive environment.

5.3.6 Rating Plate

A stainless steel rating plate shall be fitted to each transformer. The information shall be deeply etched including the diagram of the connections of the windings, the vector diagram showing the general phase relations of the transformer, and a diagrammatic plan of the transformer cover showing the terminal positions and marking and other essential particulars. The plate shall be mounted in an accessible position and preferably adjacent to the tapping switch if this is located on the side of the tank.

The rating plate shall be fitted below the LV terminals. Rating and diagram plates shall be attached by 5 mm brass screws in each corner to mild steel brackets welded horizontally. The rating plate shall show the data specified in IEC 60076-1(1993-03).

In addition, the rating in kVA shall be stenciled in black paint on the tank wall below the high voltage bushings in figures approximately 50 mm high. The letters 'kVA' are not required.

5.3.7 Terminal Marking

All transformers shall have the primary and secondary terminal markings plainly and indelibly marked on the transformer adjacent to the relevant terminal. These markings shall preferably be 25 mm in height. Terminal markings for three phase transformers shall be ABC/abcn and for single phase transformers $A_1 A_2 / a_1 a_2$.

5.3.8 Terminal Leads

Outgoing leads shall be brought out through bushings. The leads shall be such that the core and coils may be removed with the least possible interference with these leads, and they shall be specially supported inside the transformer to withstand the effects of vibration and short circuits.

5.3.9 Bushings

All bushings shall be porcelain clad, of the highest quality and in accordance with IEC 60137(1995-12). They shall be sealed in a manner to prevent ingress of moisture and to facilitate removal. The neutral bushings and stems shall be identical to those provided for phase terminations. Bushing palms shall be made of brass and have one 13 mm hole.

Each bushing shall be indelibly marked with the name or trademark of the manufacturer.

The HV bushings of the ground/pole-mounted transformers shall carry a set of arcing horns for over voltage protection of the corresponding BIL (Basic Installation Level).

The HV bushings on the transformers shall be fitted with moulded heat recoverable insulating covers suitable for 25 mm² AAC conductor to provide protection of the bushing palm. Bids excluding bushings shall be considered non-responsive.

5.3.10 Earthing Connections

Earthing terminals shall be provided with connection facilities for 50mm² copper stranded conductor. The bolts shall be located on the lower side of the transformer and be of M12 size. Each shall be clearly indicated with an engraved 'earth symbol'.

Two earthing connections are required on each transformer. In the event that the core and windings are suspended from the transformer lid, one earth connection shall be attached to the lid.

5.3.11 Gaskets

Any gaskets provided with the transformers shall be suitable for making oil tight joints, and there shall be no deleterious effects on either gaskets or oil when the gaskets are continuously in contact with hot oil and fungi. No gaskets shall be used in which the material of the gasket is mounted on a textile backing. Exterior gaskets shall be weatherproof and shall not be affected by strong sunlight.

5.3.12 Oil

All transformers shall be filled to the required level with new, unused, clean, standard mineral oil in compliance with IEC 60296(1982-01) or 60296-1(1986-01) and shall be free from all traces of polychlorinated biphenyl (PCB) compounds.

5.3.13 Radio Interference

When operated at voltages up to 10% in excess of the normal system rating, transformers shall be substantially free from partial discharges (i.e. corona discharges in either internal or external insulation) which are likely to cause interference with radio or telephone communication.

5.3.14 Tappings

There shall be a tapping switch on the primary side of each transformer :

Five voltage tappings shall be provided on the primary side of each transformer and shall give +5.0% + 2.5%, 0, -2.5% and -5%, steps of the primary nominal voltage.

The tappings shall be selected by an 'off load' tapping switch with an external hand wheel with provision for locking onto a selected tapping. The switch shall have a positive action designed to eliminate the possibility of stopping in an intermediate position. The shaft shall be adequately sealed so that no seepage of oil occurs under all conditions of service.

The tap change positions shall be clearly and indelibly marked.

5.3.15 Failure to Meet Guaranteed Values

If tolerances complying with IEC 60076 for total losses are exceeded, the manufacturer shall compensate the Purchaser US\$ 1,000 for each kilowatt in excess. The tap position giving maximum losses will be considered.

If the short circuit impedance or the voltage ratio exceeds the tolerances, the Purchaser has the right to reject the transformers.

If tolerances for no-load current are exceeded, a penalty of US\$1,000/kVA shall be imposed for every kVA in excess of the tolerances.

The purchaser reserves the right to apply penalties or reject any equipment in the event of non-compliance with the specification.

5.3.16 Surge Arrestors

The transformers shall be supplied complete with surge arrestors. The surge arrestors to IEC 60099, Distribution Class, with rated nominal discharge current of 5 kA will be used for the protection of distribution transformers.

The surge arrestors shall be of the non-linear resistance single pole type suitable for outdoor use on a three phase 50 Hz system.

System Voltage		11 kV	33 kV
Lightning arrester rated voltage (rms)	kV	11 kV	33 kV
Nominal discharge current	kA	5	5
Front-of wave impulse sparkover voltage	kV	42	127
Maximum residual voltage at normal current	kV	37	110

The surge arrester shall be suitable for mounting either vertically or horizontally. The housing shall be of high quality porcelain of heavy construction to provide prolonged life under outdoor conditions.

Terminations shall be suitable for connection of compression terminal lugs and supplied with nuts and bolts for the lugs.

A disconnection device (earth lead isolation) to disconnect the arrester from earth and provide visual indication in the event of failure, where provided, will earn bonus points.

The Supplier shall indicate the method used to provide pressure relief to prevent explosive shattering of the porcelain housing. No chemical action shall take place, nor shall the arrester material show deterioration as a result of the specified operating duty. No maintenance other than routine inspection shall be required under service conditions. The transformers supplied without surge arrestors shall be considered non-responsive

Note:

The bidders must complete the following questionnaires in detail. Not all specifications contained in the main write-up of this document have been included in the questionnaires. The bidders should therefore ensure that all these specifications are provided on separate schedules. Any deviations, modifications or alterations may also be offered with reasons.

QUESTIONNAIRE FOR TECHNICAL PARTICULARS
DISTRIBUTION TRANSFORMERS

i. 33 kV/LV, 3 Phase group

Tenderer

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
1.0	GENERAL			
1.1	Manufacturer			
1.2	Rated Power	kVA		
1.3	Outdoor/Indoor			
1.4	Tropicalization		Tropicalised	
1.5	Ground (GM) /Pole mounted (PM)			
1.6	Rated high voltage	kV	33	
1.7	Rated low voltage	kV	0.433	
1.8	Number of Phases		3	
1.9	Frequency	Hz	50	
1.10	Vector group		Dyn 11	
2.	CORE DETAILS			
2.1	Core or shell type		Core type	
2.2	Core material		CRGOESS	
2.3	Minimum Magnetic Flux Density (at rated voltage and frequency)	T	1.8	
3.0	TRANSFORMER WINDINGS			
3.1	HV windings			
3.1.1	Number of Windings		Two (2)	
3.1.2	Type (wire, foil, round or profile)		Wire or foil	
3.1.3	Material		Copper	
3.2	LV windings			
3.2.1	Type (wire, foil, round, profile)		Wire or foil	
3.2.2	Material		Copper	
4.0	OPERATING CHARACTERISTICS			
4.1.1	Permissible load of Neutral point	%	100	
4.1.2	No Load losses	kW		
4.1.3	Load Losses	kW		
4.1.4	Maximum Ambient Temperature	0C		
4.1.5	Maximum service Attitude	m	1500	
4.1.6	Temperature rise limit at all tap changer settings -Oil/Windings	0C	35 60/65	
4.1.7	Cooling method		ONAN	
4.1.8	Noise level at measuring distance of 2m in accordance to IEC 551	dB (A)	List according to KVA	
4.1.9	Impedance at rated power and voltage	%	4	
4.1.10	Tapping range (off load)	+/- %	5	
4.1.11	Number of steps		5	
4.1.12	Rated current tap changer			
4.1.13	Operating Voltage/Normal tapping			

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
	-Primary	kV	33	
	-Secondary at no load	kV	0.433	
	-Secondary at full load (pf=0.95) lagging	kV		
4.1.14	Continuos Power at all taps		Yes	
5.0	TESTS			
5.1.0	Routine tests to IEC 60076		On each unit	
5.1.1	Separate Source over voltage with stand tests	kV		
	- Test voltage Primary	kV	70	
	- Test voltage Secondary	kV	3	
5.1.2	Induced over voltage with stand tests:			
	- Test voltage primary step 1	kV	66	
	- Test voltage Secondary	kV	0.83	
	- Frequency	Hz		
	- test duration	s		
5.1.3	Full wave lightening impulse test			
	- test voltage primary	kV	170	
	- test voltage secondary		NA	
5.1.4	Insulation level and Tests			
	- Primary windings	kV	36	
	- Secondary windings	kV	1.1	
5.2	Tests on Bushings			
5.2.1	Power frequency withstand voltage			
	a) HV Bushings -dry one minute	kV		
	-wet one minute	kV	95	
	b) LV Bushings -dry one minute	kV		
	-wet one minute	kV	10	
5.2.2	Insulation level			
	-Primary Bushings	kV	52	
	-Secondary Bushing	kV	3.6	
6.0	BUSHINGS			
6.1.0	HV Bushings			
6.1.1	Type designation		ABC	
6.1.2	Standard referred	kV	IEC 137	
6.1.3	Material		Porcelain	
6.1.4	Creepage	mm	900	
6.2.0	LV Bushings			
6.2.1	Type designation		ABC	
6.2.2	Standard referred			
6.2.3	Material		Porcelain	
6.2.4	Creepage	mm	40	
7.0	TERMINALS			
7.1.0	HV Terminals			
7.1.1	Material		Brass	
7.1.2	Type designation		abcn	
7.1.3	Range of LV feeder cross-section	mm ²	25 – 100mm ²	
7.2.0	LV Terminals			
7.2.1	Type designation			

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
7.2.2	Range of LV feeder cross-section	mm ²		
8.0	SURGE ARRESTORS			
8.1.0	Standard referred to			
8.1.1	Rated voltage (rms)	KV	53	
8.1.2	Nominal discharge current	KA	5	
8.1.3	Front of wave impulse spark over voltage	KV	127	
8.1.4	Maximum residual voltage at normal current	KV	110	
9.0	INSULATING OIL			
9.1.0	Standard Specification		IEC 60296	
9.1.1	Class according to standards			
9.1.2	Trade mark			
9.1.3	Top oil thermometer			
10.0	TRANSFORMER TANK			
10.1.0	Type of tank		Upper flange Hermetically sealed	
10.1.1	Dimensions of tank steel -Base -Top -Side	mm mm mm		
11.0	MASSES, MEASURES, DRAWINGS AND TEST CERTIFICATES			
11.1.0	Dimensions of complete transformer (including bushing) -height -depth -width	mm mm mm		
11.1.1	Shipping dimensions -height -depth -width	mm mm mm		
11.1.2	Height of transformer crane hooks	mm		
11.1.3	Transportation mass	Kg		
11.1.4	Untanking mass	Kg		
11.1.5	Mass of insulating liquids	Kg		
11.1.6	Drawings		Shall be provided	
11.1.7	Test certificates (Type and Routine Tests)		Shall be provided	

QUESTIONNAIRE FOR TECHNICAL PARTICULAR
DISTRIBUTION TRANSFORMERS

ii. 33 kV/LV, Single Phase group

Tenderer

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
1.0	GENERAL			
1.1	Manufacturer			
1.2	Rated Power	kVA		
1.3	Outdoor/Indoor			
1.4	Tropicalization		Tropicalised	
1.5	Ground (GM)/Pole mounted (PM)			
1.6	Rated high voltage	kV	33	
1.7	Rated low voltage	kV	0.250	
1.8	Number of Phases		Single	
1.9	Frequency	Hz	50	
1.10	Vector group		li0	
2.	CORE DETAILS			
2.1	Core or shell type		Core type	
2.2	Core material		CRGOESS	
2.3	Minimum Magnetic Flux Density (at rated voltage and frequency)	T	1.8	
3.0	TRANSFORMER WINDINGS			
3.1	HV windings			
3.1.1	Number of Windings		Two (2)	
3.1.2	Type (wire, foil, round or profile)		Wire or foil	
3.1.3	Material		Copper	
3.2	LV windings			
3.2.1	Type (wire, foil, round, profile)		Wire or foil	
3.2.2	Material		Copper / Aluminium	
4.0	OPERATING CHARACTERISTICS			
4.1.1	Permissible load of Neutral point	%	100	
4.1.2	No Load losses	kW		
4.1.3	Load Losses	kW		
4.1.4	Maximum Ambient Temperature	0C		
4.1.5	Maximum service Attitude	m	1500	
4.1.6	Temperature rise limit at all tap changer settings	0C	35	
	-Oil/Windings		60/65	
4.1.7	Cooling method		ONAN	
4.1.8	Noise level at measuring distance of 0.3m in accordance to IEC 551	dB (A)	List per KVA rating	
4.1.9	Impedance at rated power and voltage	%	4	
4.1.10	Tapping range (off load)	+/- %	5	
4.1.11	Number of steps		5	
4.1.12	Rated current tap changer			

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
4.1.13	Operating Voltage/Normal tapping			
	-Primary	kV	33	
	-Secondary at no load	kV	0.250	
	-Secondary at full load (pf=0.95) lagging	kV		
4.1.14	Continuos Power at all taps		Yes	
5.0	TESTS			
5.1.0	Routine tests to IEC 60076		On each unit	
5.1.1	Separate Source over voltage with stand tests	kV		
	- Test voltage Primary	kV	70	
	- Test voltage Secondary	kV	3	
5.1.2	Induced over voltage with stand tests:			
	- Test voltage primary step 1	kV	66	
	- Test voltage Secondary	kV	0.83	
	- Frequency	Hz		
	- test duration	s		
5.1.3	Full wave lightening impulse test			
	- test voltage primary	kV	170	
	- test voltage secondary		NA	
5.1.4	Insulation level and Tests			
	- Primary windings	kV	36	
	- Secondary windings	kV	1.1	
5.2	Tests on Bushings			
5.2.1	Power frequency withstand voltage			
	a) HV Bushings	kV		
	-dry one minute	kV	10	
	-wet on minute			
	b) LV Bushings	kV		
	-dry one minute	kV		
	-wet one minute			
5.2.2	Insulation level			
	-Primary Bushings	kV	52	
	-Secondary Bushing	kV	3.6	
6.0	BUSHINGS			
6.1.0	HV Bushings			
6.1.1	Type designation	kV		
6.1.2	Standard referred		IEC 60137	
6.1.3	Material		Porcelain	
6.1.4	Creepage	mm	900	
6.2.0	LV Bushings			
6.2.1	Type designation			
6.2.2	Standard referred			
6.2.3	Material		Porcelain	
6.2.4	Creepage	mm	40	
7.0	TERMINALS			
7.1.0	HV Terminals			
7.1.1	Material		Brass	
7.1.2	Type designation		A ₁ A ₂	
7.1.3	Ray of jumper cross-section	mm ²	25-100mm ²	

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
7.2.0	LV Terminals		Brass	
7.2.2	Type designation		A ₁ A ₂	
7.2.3	Range of LV feeder cross-section	mm ²	25-100mm ²	
8.0	SURGE ARRESTORS			
8.1.0	Standard referred to	kV	IEC 60099	
8.1.1	Rated voltage (rms)	KV	33kV	
8.1.2	Nominal discharge current	KA	5	
8.1.3	Front of wave impulse spark over voltage	KV	127	
8.1.4	Maximum residual voltage at normal current	kV	110	
9.0	INSULATING OIL			
9.1.0	Standard Specification		IEC 60296	
9.1.1	Class according to standards			
9.1.2	Trade mark			
9.1.3	Top oil thermometer			
10.0	TRANSFORMER TANK			
10.1.0	Type of tank		Upper flange Hermetically sealed	
10.1.1	Dimensions of tank steel			
	-Base	mm		
	-Top	mm		
	-Side	mm		
11.0	MASSES, MEASURES AND DRAWINGS			
11.1.0	Dimensions of complete transformer (including bushing)			
	-height	mm		
	-depth	mm		
	-width	mm		
11.1.1	Shipping dimensions			
	-height	mm		
	-depth	mm		
	-width	mm		
11.1.2	Height of transformer crane hooks	mm		
11.1.3	Transportation mass	Kg		
11.1.4	Untanking mass	Kg		
11.1.5	Mass of insulating liquids	Kg		
11.1.6	Drawings		Shall be provided	
11.1.7	Test certificates(Type and Routine Tests)		Shall be provided	

QUESTIONNAIRE FOR TECHNICAL PARTICULAR
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iii. 11 kV/LV, 3 Phase group

Tenderer

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
1.0	GENERAL			
1.1	Manufacturer			
1.2	Rated Power	kVA		
1.3	Outdoor/Indoor			
1.4	Tropicalization		Tropicalised	
1.5	Ground (GM) /Pole mounted (PM)			
1.6	Rated high voltage	kV	11	
1.7	Rated low voltage	kV	0.433	
1.8	Number of Phases		3	
1.9	Frequency	Hz	50	
1.10	Vector group		Dyn 11	
2.	CORE DETAILS			
2.1	Core or shell type		Core type	
2.2	Core material		CRGOESS	
2.3	Minimum Magnetic Flux Density (at rated voltage and frequency)	T	1.8	
3.0	TRANSFORMER WINDINGS			
3.1	HV windings			
3.1.1	Number of Windings		Two (2)	
3.1.2	Type (wire, foil, round or profile)		Wire or foil	
3.1.3	Material		Copper	
3.2	LV windings			
3.2.1	Type (wire, foil, round, profile)		Wire or foil	
3.2.2	Material			
4.0	OPERATING CHARACTERISTICS			
4.1.1	Permissible load of Neutral point	%	100	
4.1.2	No Load losses	kW		
4.1.3	Load Losses	kW		
4.1.4	Maximum Ambient Temperature	0C		
4.1.5	Maximum service Attitude	m	1500	
4.1.6	Temperature rise limit at all tap changer settings	0C	35	
	-Oil/Windings	0C	60/65	
4.1.7	Cooling method		ONAN	
4.1.8	Noise level at measuring distance of 2m	dB (A)		
4.1.9	Impedance at rated power and voltage	%	4	
4.1.10	Tapping range (off load)	+/- %	5	
4.1.11	Number of steps		5	
4.1.12	Rated current of tap changer			

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
4.1.13	Operating Voltage/Normal tapping			
	-Primary	kV	11	
	-Secondary at no load	kV	0.433	
	-Secondary at full load (pf=0.95) lagging	kV		
4.1.14	Continuos Power at all taps		Yes	
5.0	TESTS			
5.1.0	Routine tests to IEC 60076		On each unit	
5.1.1	Separate Source over voltage withstand tests	kV		
	- Test voltage Primary	kV	28	
	- Test voltage Secondary	kV	3	
5.1.2	Induced over voltage with stand tests:			
	- Test voltage primary step 1	kV	23.10	
	- Test voltage Secondary	kV	0.83	
	- Frequency	Hz		
	- test duration	s		
5.1.3	Full wave lightening impulse test			
	- test voltage primary	kV	75	
	- test voltage secondary		NA	
5.1.4	Insulation level and Tests			
	- Primary windings	kV	12	
	- Secondary windings	kV	1.1	
5.2	Tests on Bushings			
5.2.1	Power frequency withstand voltage			
	a) HV Bushings -dry one minute	kV		
	-wet on minute	kV	38	
	b) LV Bushings -dry one minute	kV		
	-wet one minute	kV	10	
5.2.2	Insulation level			
	-Primary Bushings	kV	17.5	
	-Secondary Bushing	kV	3.6	
6.0	BUSHINGS			
6.1.0	HV Bushings			
6.1.1	Type designation	kV		
6.1.2	Standard referred		IEC 60137	
6.1.3	Material			
6.1.4	Creepage	mm	300	
6.2.0	LV Bushings			
6.2.1	Type designation			
6.2.2	Standard referred			
6.2.3	Material		Porcelain	
6.2.4	Creepage	mm	40	
7.0	TERMINALS			
7.1.0	HV Terminals			
7.1.1	Material		Brass	
7.1.2	Type designation		ABC	
7.1.3	Range of LV feeder cross-section	mm ²	25 – 100	
7.2.0	LV Terminals			

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
7.2.2	Type designation		Abcn	
7.2.3	Range of LV feeder cross-section	mm ²	25 – 100	
8.0	SURGE ARRESTORS			
8.1.0	Standard referred to	kV	IEC 60099	
8.1.1	Rated voltage (rms)	kV	11	
8.1.2	Nominal discharge current	KA	5	
8.1.3	Front of wave impulse spark over voltage	kV	42	
8.1.4	Maximum residual voltage at normal current	kV	37	
9.0	INSULATING OIL			
9.1.0	Standard Specification		IEC 60296	
9.1.1	Class according to standards			
9.1.2	Trade mark			
9.1.3	Top oil thermometer			
10.0	TRANSFORMER TANK			
10.1.0	Type of tank		Upper flange Hemertically sealed	
10.1.1	Dimensions of tank steel			
	-Base	mm		
	-Top	mm		
	-Side	mm		
11.0	MASSES, MEASURES AND DRAWINGS			
11.1.0	Dimensions of complete transformer (including bushing)			
	-height	mm		
	-depth	mm		
	-width	mm		
11.1.1	Shipping dimensions			
	-height	mm		
	-depth	mm		
	-width	mm		
11.1.2	Height of transformer crane hooks	mm		
11.1.3	Transportation mass	Kg		
11.1.4	Untanking mass	Kg		
11.1.5	Mass of insulating liquids	Kg		
11.1.6	Drawings		Shall be provided	
11.1.7	Test certificates(Type and Routine Tests)		Shall be provided	

QUESTIONNAIRE FOR TECHNICAL PARTICULAR
DISTRIBUTION TRANSFORMERS

iv. 11 kV/LV, Single Phase group

Tenderer

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
1.0	GENERAL			
1.1	Manufacturer			
1.2	Rated Power	kVA		
1.3	Outdoor/Indoor			
1.4	Tropicalization		Tropicalised	
1.5	Ground (GM) /Pole mounted (PM)			
1.6	Rated high voltage	kV	11	
1.7	Rated low voltage	kV	0.250	
1.8	Number of Phases		Single	
1.9	Frequency	Hz	50	
1.10	Vector group		li0	
2.	CORE DETAILS			
2.1	Core or shell type		Core type	
2.2	Core material		CRGOESS	
2.3	Minimum Magnetic Flux Density (at rated voltage and frequency)	T	1.8	
3.0	TRANSFORMER WINDINGS			
3.1	HV windings			
3.1.1	Number of Windings		Two (2)	
3.1.2	Type (wire, foil, round or profile)		Wire or foil	
3.1.3	Material		Copper	
3.2	LV windings			
3.2.1	Type (wire, foil, round, profile)		Wire or foil	
3.2.2	Material		Copper / Aluminium	
4.0	OPERATING CHARACTERISTICS			
4.1.1	Permissible load of Neutral point	%	100	
4.1.2	No Load losses	kW		
4.1.3	Load Losses	kW		
4.1.4	Maximum Ambient Temperature	0C		
4.1.5	Maximum service Attitude	m	1500	
4.1.6	Temperature rise limit at all tap changer settings	0C	35	
	-Oil/Windings	0C	60/65	
4.1.7	Cooling method		ONAN	
4.1.8	Noise level at measuring distance of 0.3m		List according to KVA	
4.1.9	Impedance at rated power and voltage	%	4	

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
4.1.10	Tapping range (off load)	+/- %	5	
4.1.11	Number of steps		5	
4.1.12	Rated current of tap changer			
4.1.13	Operating Voltage/Normal tapping			
	-Primary	kV	11	
	-Secondary at no load	kV	0.250	
	-Secondary at full load (pf=0.95) lagging	kV		
4.1.14	Continuous Power at all taps		Yes	
5.0	TESTS			
5.1.0	Routine tests to IEC 60076		On each unit	
5.1.1	Separate Source over voltage with stand tests	kV		
	- Test voltage Primary	kV	28	
	- Test voltage Secondary	kV	3	
5.1.2	Induced over voltage with stand tests:			
	- Test voltage primary step 1	kV	23.10	
	- Test voltage Secondary	kV	0.83	
	- Frequency	Hz	50	
	- test duration	s		
5.1.3	Full wave lightening impulse test			
	- test voltage primary	kV	75	
	- test voltage secondary		NA	
5.1.4	Insulation level and Tests			
	- Primary windings	kV	12	
	- Secondary windings	kV	1.1	
5.2	Tests on Bushings			
5.2.1	Power frequency withstand voltage			
	c) HV Bushings			
	-dry one minute	kV		
	-wet on minute	kV	38	
	d) LV Bushings			
	-dry one minute	kV		
	-wet one minute	kV	10	
5.2.2	Insulation level			
	-Primary Bushings	kV	17.5	
	-Secondary Bushing	kV	3.6	
6.0	BUSHINGS			
6.1.0	HV Bushings			
6.1.1	Type designation	kV		
6.1.2	Standard referred		IEC 60137	
6.1.3	Material		Porcelain	
6.1.4	Creepage	mm	900	
6.2.0	LV Bushings			
6.2.1	Type designation			
6.2.2	Standard referred			
6.2.3	Material		Porcelain	
6.2.4	Creepage	mm	300	
7.0	TERMINALS			
7.1.0	HV Terminals			
7.1.1	Material		Brass	

NO.	DESCRIPTION	UNIT	REQUIRED	TENDERED
7.1.2	Type designation		ABC	
7.1.3	Ray of LV feeder cross-section	mm ²	25-100	
7.2.0	LV Terminals			
7.2.1	Type designation		Abcn	
7.2.2	Range of LV feeder cross-section	mm ²	25 – 100	
8.0	SURGE ARRESTORS			
8.1.0	Standard referred to	kV	IEC 60099	
8.1.1	Rated voltage (rms)	KV	11	
8.1.2	Nominal discharge current	kA	5	
8.1.3	Front of wave impulse spark over voltage	kV	42	
8.1.4	Maximum residual voltage at normal current	KV	37	
9.0	INSULATING OIL			
9.1.0	Standard Specification		IEC 60296	
9.1.1	Class according to standards			
9.1.2	Trade mark			
9.1.3	Top oil thermometer			
10.0	TRANSFORMER TANK			
10.1.0	Type of tank		Upper flange Hemertically sealed	
10.1.1	Dimensions of tank steel			
	-Base	mm		
	-Top	mm		
	-Side	mm		
11.0	MASSES, MEASURES AND DRAWINGS			
11.1.0	Dimensions of complete transformer (including bushing)			
	-height	mm		
	-depth	mm		
	-width	mm		
11.1.1	Shipping dimensions			
	-height	mm		
	-depth	mm		
	-width	mm		
11.1.2	Height of transformer crane hooks	mm		
11.1.3	Transportation mass	Kg		
11.1.4	Untanking mass	Kg		
11.1.5	Mass of insulating liquids	Kg		
11.1.6	Drawings		Shall be provided	
11.1.7	Test certificates (Type and Routine Tests)		Shall be provided	