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0.1 Circulation List

COPY NO.	COPY HOLDER
1	Standards Manager
Electronic copy (pdf) on KPLC server currently: http://172.16.1.40/dms/browse.php?fFolderId=23	

0.2 Amendment Record

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)		Approved by (Name & Signature)
Issue 5 Rev 2	2015-09-02	-Cancels & replaces Issue 5, revision 0	M. Apudo		Dr. Eng. Peter Kimemia
			N. Mungai		
			Eng. S. Nguli		
			Eng. S. Kimitei		
			J. Kinda		
			S. Macharia		
			G. Welimo		
			F. Omondi		
			B. King'esi		
			G. Korir		
			H. Njenga		
			Z Oluoch		
			J. Kasimu		

FOREWORD

This specification has been prepared by the Standard Department in collaboration with Network Management and Regional Coordination divisions, all of The Kenya Power & Lighting Company Ltd (abbreviated as KPLC) and it lays down requirements for pole mounted three phase oil type distribution transformers. The specification is intended for use by KPLC in purchasing the transformers.

It is expected that manufacturers will provide energy efficient standard design transformers that will provide high level of efficiency and significant initial cost saving. The manufacturer shall also submit information which demonstrates satisfactory service experience with products which fall within the scope of this specification.

1. SCOPE

1.1. This specification is for newly manufactured oil-immersed, air-cooled, outdoor type pole mounted three phase distribution transformers for 11kV and 33kV distribution systems operated at 50 Hz.

The specification covers transformers of the following voltage ratios and ratings:

- **11000/420V: 50 KVA, 100 KVA, 200 KVA and 315 KVA**
- **33000/420V: 50 KVA, 100 KVA, 200 KVA and 315 KVA.**

1.2. The specification also covers inspection, test of the transformer and schedule of Guaranteed Technical Particulars as well as schedule of materials to be filled, signed by the manufacturer and submitted for tender evaluation.

1.3. The specification stipulates the minimum requirements (including features to deter vandalism) for pole mounted three phase distribution transformers acceptable for use in the company (KPLC) and it shall be the responsibility of supplier to ensure adequacy of the design, good workmanship, good engineering practice and adherence to standards, specifications and applicable regulations in the manufacture of the transformers for The Kenya Power & Lighting Company Ltd.

1.4. The specification does not purport to include all the necessary provisions of a contract.

2. REFERENCES

The following standards contain provisions which, through reference in this text constitute provisions of this specification. Unless otherwise stated, the latest editions (including amendments) apply.

ISO 1461:	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods.
IEC 60076- 1, 2, 3, 4, 5, 7&10:	Power transformers – Part 1: General; -Part 2: Temperature rise; - Part 3: Insulation levels dielectric tests and external air clearances; - Part 4: Guide to the lightning impulse testing-power transformers and reactors; - Part 5: Ability to withstand short circuit;-Part 7: Loading guide for oil immersed power transformers - Part 10: Determination of sound levels.
IEC 60554-3-1:	Specification for cellulosic paper for electrical purposes- Part 3: Specification for individual materials, sheet 1- General purpose electrical paper.
IEC 60317-0-1:	Specifications for particular types of winding wires – Part 0: General requirements –Section 1: Enameled round copper wire
IEC 60296:	Specification for unused mineral insulating oil for transformers and switchgear.
IEC 60214:	Tap-changers - Part 1: Performance requirements and test methods, Part 2: Application guide
IEC 60512:	Connectors for electronic equipment
IEC 60641-3-1:	Pressboard and press paper for electrical purposes –Part 3: Specifications for individual materials – Sheet 1: Requirements for pressboard, types B.0.1, B.0.3, B.2.1, B.2.3, B.3.1, B.3.3, B.4.1, B.4.3, B.5.1, B.5.3 and B.6.1
IEC 60422:	Mineral insulating oils in electrical equipment – Supervision and maintenance guidance
IEC 60071:	Insulation Co-ordination: Part 1 definitions, principles and rules

BS EN 10025:	Hot rolled products of structural steels
BS 381C:	Specification for colors for identification coding and special purposes
BS EN 50464-1:	Three phase oil immersed distribution transformers 50 HZ from 50 KVA to 2500 KVA with highest voltage for equipment not exceeding 36 KV – Part 1: General requirements
BS 2627:	Specification for wrought aluminum for electrical purposes.
BS EN 755-6:	Aluminum and aluminum alloys. Extruded rod/bar, tube and profiles. Hexagonal bars, tolerances on dimensions and form

Department of Energy10 CFR Part 431: Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards Rule.

Manual on Transformers – Publication No. 295 CBIP 2006

3. TERMS AND DEFINITIONS

The terms and definitions given in the reference standards shall apply and shall include the following:

a) **HV** – High voltage at 11,000 volts and 33,000 volts
b) **LV** – Low voltage at 420 volts

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4. REQUIREMENTS

4.1. Service Conditions

4.1.1. Operating conditions

The transformer shall be suitable for continuous outdoor operation in tropical areas with the following conditions.

a) Altitude: up to 2,200m above sea level;
b) Temperature: average of +30°C with a minimum of -1°C and max +40 °C;
c) Humidity: up to 95%;
d) Pollution: Design pollution level to be taken as "*Heavy*" (Pollution level III) for inland and "*Very Heavy*" (Pollution level IV) for coastal applications in accordance with IEC 60815.
e) Isokeraunic level: 180 thunderstorm days per year

4.1.2. **System characteristics**

4.1.2.1. The transformer will be connected to overhead system which is of unearthed construction (i.e. without continuous aerial earth wire). Rated fault current for 11,000volts system is 13.1kA and for 33,000 volt system is 25kA.

4.1.2.2. The primary system has a nominal voltage of 11000 volts and 33000 volts and system highest voltage of 12000 volts and 36000 volts respectively. The primary system is three phase 3-wire 50 Hz and the secondary is 420 volts three phase 4-wire. The target three phase voltage at the consumer terminals is 400V±6% at 50Hz.

4.1.2.3. The Transformer shall be operated at a high loading factor. Loading shall be as per IEC 60076-7.

4.2. General Requirements

4.2.1. The transformers shall be outdoor oil-immersed, of ONAN classification and core type windings designed, manufactured and tested in accordance with IEC 60076-1:2011 and all the all relevant parts (latest editions). Any deviations/additional requirements shall be as stated in this specification.

4.2.2. The transformer shall be designed for service (functional) life of at least twenty five (25) years in line with the minimum insulation life of 180,000h (20.55 years) as per IEC 60076-7 Table 3.

4.2.3. The transformer shall be a two winding type three-phase integral unit with connections and phase displacements symbols clearly marked on the nameplate i.e. D for high voltage and y & n for low voltage.

4.2.4. The transformer shall be hermetically sealed type each with bolted top cover. The hermetically sealed type completely filled system in which the expansion of the oil is taken up by elastic movement of the permanently sealed, usually corrugated tank as per clause 9.3 of IEC 60076-1:2011. All the active parts including tap-changer contacts and HV lead-outs shall be completely submerged in oil and a pressure relief valve located on the LV side in a steel tube with the height not extending beyond HV bushing. The design shall allow for oil expansions under normal and fault conditions as per service conditions in clause 4.1.

NOTE: *The expansion of the liquid shall be taken by elastic movement of the permanently sealed corrugated tank or radiators.*

4.2.5. The transformer and its component parts shall be able to carry loading beyond rated power under permissible loading given by IEC 60076-7, Table 4 and clause 4.3.2 for distribution transformers. The bushings, tap changers and other auxiliary equipment shall be selected so as not to restrict the loading capability of the transformer.

4.2.6. The transformer shall be designed to minimize the risk or accidental short-circuit caused by animals, birds or vermin. The manufacturer shall consider the safety of operators and maintenance staff in the design of the transformer in particular the following aspects as per clause 9.1.2 of IEC 60076-1:2011:

(i) Accessibility to parts with high temperatures;
(ii) Accessibility to live parts;
(iii) Lifting and handling provisions
(iv) Access for maintenance
(v) Working at a height

4.2.7. All parts of the transformer, including bushings insulators with their mountings, shall be designed to eliminate pockets of water. Rain water shall not collect anywhere on the top cover; the gaskets shall be concealed by an overlap between the top cover and tank flanges by 10mm width.

4.2.8. Corresponding parts liable to be replaced shall be interchangeable.

4.2.9. The design of fittings and accessories shall not allow for siphoning of oil by vandals. All fittings and accessories shall be secured from the inside of the transformer and/or have openings that do not allow for oil siphoning.

4.2.10. All components and materials used in the construction of the transformer shall comply with the requirements of the relevant IEC/ISO standards where they exist unless otherwise stated. Type test reports from ISO/IEC 17025 accredited laboratories for these component parts and materials from respective manufacturers shall be submitted for tender evaluation to verify conformity to their respective manufacturing standards.

4.2.11. All current carrying surfaces - connections and contacts shall provide adequate cross-sectional area suitable for continuous current carrying capacity without undue heating. Fixed connections shall be secured by bolts & nuts or set screws to ISO 898-1&2 of adequate sizes, securely tightened. Lock nuts shall be used on stud connections carrying current. All leads from the winding to the terminals of the bushings shall be adequately supported to prevent damages caused by vibrations including a systematical pull under short circuit conditions. All bolts and nuts in current carrying parts shall be made of copper alloy with at least 70% copper content.

4.2.12. The choice of materials and processes used in the manufacture of the transformer shall be compatible with the insulating oil and avoid development of acidity in the insulating oil.

4.2.13. The maximum sound levels shall be in accordance with BS EN 50464-1 and Table 5. The sound level shall be measured and tested in accordance with IEC 60076-10 or NEMA - TR1 and shall not exceed the guaranteed maximum level (without tolerance). The guaranteed values shall be stated in the bid for tender evaluation.

4.2.14. The transformer shall be designed to withstand a constant acceleration of at least 1g in all directions (in addition to the acceleration due to gravity in the vertical directions) without any damage, demonstrated by static force calculations based on a constant value of acceleration as per clause 5.7.4.2 of IEC 60076-1:2011.

4.2.15. Each transformer shall be suitable for pole mounting on a steel channels. It shall be complete with two steel channels under base with suitable mounting holes.

4.2.16. Drawings and documentation for each size of transformer offered shall be submitted with the tender clearly detailing important dimensions, any special features of the offered design, clearances, accessories, fittings and the features of the offered design that make it impossible for vandals to siphon oil from the transformer even after forceful breakage of the accessory/fitting.

4.2.17. Design drawings (by the manufacturer) complete with manufacturer's guaranteed technical particulars (GTP) shall be submitted to KPLC for approval before manufacture. The design drawings shall be detailed and shall include the following:

a) Overall dimensions of the transformer and relevant electrical clearances. This shall include all perspectives and respective:
   (i) Weight of oil,
   (ii) Weight of LV winding conductor
   (iii) Weight of LV winding conductor
   (iv) Core material,
   (v) Copper/aluminium winding material,
   (vi) Insulating materials and
   (vii)Steel tank/core clamp structure.
b) Core/coil/insulation dimensions, clearances (internal and external) and stacking/coil winding sequence detail.
c) Drawing of nameplate to scale.
d) Dimensional drawing of bushings, tap-changer and clamps.
e) Legend for all technical engineering drawings with manufacturer name, logo, model number, revision/drawing number and key
f) Detailed drawing of surge arrestor mounting and constituent parts.

g) Detailed drawing of arcing horns where applicable.

NOTE: *All design drawings **MUST BE** stamped and signed by the manufacturer's authorised personnel.*

4.3. Ratings

4.3.1. The transformers shall be of the following ratings:

(a) 11000/420V: 50 KVA, 100 KVA, 200 KVA and 315 KVA
(b) 33000/420V: 50 KVA, 100 KVA, 200 KVA and 315 KVA.

4.3.2. The transformer shall be capable of carrying its full normal rating continuously at any tap under the conditions stated in clause 4.1 without :
(i) Undue stress,
(ii) Overheating, or
(iii) Temperature rise exceeding 50°C in top oil or 55°C in windings above ambient
(iv) Temperature rise of winding hot spot and of metallic part in contact with cellulose outside the winding block shall not exceed 65°C, above ambient, as per IEC 60076-7 Table 4.

NOTE: *The loading capabilities shall be demonstrated by a temperature rise test. This test shall be done in the presence of Kenya Power representatives during factory acceptance testing.*

4.3.3. The transformer shall be capable of withstanding the maximum fault level at its rated voltage and impedance for two (2) seconds. The design should cater for the expected lifetime of the transformer. As a minimum, the short-circuit apparent power of 11kV and 33kV systems shall be taken as 500MVA and 1000MVA respectively (as per IEC 60076-5) in order to obtain the value of the symmetrical short circuit current to be used for the design and tests.

4.3.4. The thermal ability of the offered transformer design to withstand short circuit shall be demonstrated by calculation carried out in accordance with the requirements of clause 4.1.1 to 4.1.5 of IEC 60076-5.

4.3.5. The calculation showing details and compliance with the requirements of clause 4.1.1 to 4.1.5 of IEC 60076-5 shall be submitted with tender for purposes of tender evaluation. The duration of the current to be used for the calculation of the thermal ability to withstand short circuit shall be two (2) seconds as per IEC 60076-5.

4.3.6. The ability of the transformer to withstand the dynamic effects of short circuit shall be demonstrated by tests and complete test reports (including oscillograms and records of the condition of the transformer before and after the short-circuit test) shall be submitted with the bid for tender evaluation.

4.4. Winding, Insulation and Connections

4.4.1. General

4.4.1.1. The transformer vector group shall be Dyn11 with respect to the 11kV windings (or 33kV as appropriate) and low voltage winding (420V) as per Annex D of IEC 60076-1:2011. The star point of the low voltage winding shall be brought out to a neutral bushing of the same size as the LV phase bushing and rod.

4.4.1.2. The transformer shall be capable of operation without danger on any particular tapping at the rated KVA when the voltage may vary by + 20% and -5% of the voltage corresponding to the tapping.

4.4.1.3. The windings and connections as well as the insulating material shall not soften, ooze, shrink or collapse during service. The materials shall be non-catalytic and chemically inactive in transformer oil during service.

4.4.2. Winding material

4.4.2.1. The primary windings shall be made of Grade 3, enameled round copper wire as per IEC 60317-0-1 or shaped aluminium coil conforming to BS 2627 .The windings shall be full coiling without segmenting. The characteristics of copper and aluminium required shall be as per IEC 60076-5 and Table 1

4.4.2.2. The secondary windings shall be made of either:

(i) Enameled round copper wire or foil /strip of copper as per IEC 60317-1 OR;

(ii) Foil /strip of aluminium – the Aluminium shall be of either grade 1050, 1060, 1070 or 1350 with at least 99.50% aluminium equivalent to 61% conductivity of copper with properties conforming to BS 2898 and Table 2. *(AL. LV winding NOT Applicable)*

4.4.2.3. The current density in LV winding shall not exceed 2.8A/mm^2 for copper and 1.4A/mm^2 for aluminium winding. The current density in HV winding shall not exceed 2.8A/mm^2 for copper and 1.4A/mm^2 for aluminium winding. This will be checked through the relationship: Conductor area = Current per phase/Current density.

Table 1: Characteristics of copper and aluminium winding wire

Property	Material	
	Copper	Aluminium
Specific heat at 100 °C (J/kg· °C)	398.4	928
Density at 100 °C (kg/m^3)	8,894	2,685
Resistivity at 100 °C (μΩ·m)	0.0224	0.0355

Table 2: Characteristics of copper and aluminium foil/strip

Property	Material	
	Copper	Aluminium
Ultimate tensile strength, N/mm^2	205 - 250	60 – 95
Density in 20^{0}C, kg/dm^3	8.91	2.703
Elongation, % , min	>30	>25
Maximum resistance at 20^{0}C, Ωmm^2/m	≤ 0.01724	≤ 0.02825

NOTE: *KPLC will inspect and/or test built-up winding for its quality, weight of copper or aluminium, insulation materials properties and overall weight of coil assembly. The size of conductor used for different windings shall also be checked during stage inspection to check the current density.*

4.4.3. **Insulating materials**

4.4.3.1. The HV and LV windings shall be separated so as to allow for cooling and ease of repair. Insulating sleeves for the transformer tapping's shall be in crepe paper and inter layer insulation shall be in Kraft Paper/ cellulosic paper, press paper and/or crepe paper.

4.4.3.2. There shall be double layer enamel insulation for the copper winding conductor. The insulation shall be of class A with temperature class of 105°C as per IEC 60085.

4.4.3.3. Physical and electrical properties of insulation materials shall be as follows:

a) Press paper

Press paper shall be either a Grade K Thermally Upgraded Press paper or Grade K T/U diamond dotted press-paper (thermo pox)

(i) Grade K Thermally Upgraded Press paper

Grade K Thermally Upgraded Press paper shall be made of sulphate wood pulp and used mainly as a layer insulating paper in low voltage and high voltage windings of oil

immersed distribution transformers. Thermally upgraded paper is a cellulose based paper that has been chemically modified to reduce the rate at which the paper decomposes. Thermally upgraded paper shall be able to retain a much higher tensile and bursting strength than untreated papers when exposed to elevated temperatures. The technical characteristics shown in Table 3 shall be as per IEC 60641-2, 60243-1

(ii) Grade K - Diamond dotted press paper - Electrical insulating press papers with B-stage resin dots

Grade K T/U diamond dotted press-paper (thermo pox) is a press paper with qualities to improve the mechanical strength of oil immersed transformer windings without reducing partial discharge levels in accordance with IEC Standards 60641-2 and 60243-1.

b) Crepe paper

Crepe Papers shall be of type 3.2-130-100F or better in accordance with IEC 60554-3-3. It shall have high elongation insulating properties useful for joining and forming tapping leads of transformers. They shall have low dissipation factor suitable for high voltage bushings of transformers, wire wrapping, and shielded rings placed within end sections of power transformer windings. Crepe Papers shall be made a from high quality electrical grade Kraft base papers (100% sulphate wood pulp). The technical characteristics of the paper according to IEC Standards 60554-2 and 60243-1 shall be as per Table 3.

Table 3: Properties of insulating materials

Property		Units	Crepe paper Type 67/130	Press paper	
				Grade K T/U	Grade K T/U Diamond dotted press paper (Thermo pox)
Apparent density,		g/cm^3	-	1.0	1.0
Grammage		g/m^2	134	-	-
Conductivity of aqueous extract		mS/m	1.9	2.2	2.2
Electric strength in oil		kV/mm	-	50	50
Tensile strength	Machine direction	MPa	4.5	2.4	2.4
	Cross machine direction		4.6	7.5	7.5

c) Kraft Paper/Cellulosic paper

Shall be designation type 1.4-2L with apparent density greater than 0.95g/cm^3, conductivity over 4mS/m and air permeability "medium" below 0.05µm/PA.s as per IEC 60554-3-1.

4.4.3.4. The radial spacer blocks shall be made of pre-compressed pressboard material – type B.3.1 or B.3.3 as per IEC 60641-3-1, which will not soften while in contact with oil or fray out into fibers or edges. The slots shall be so dimensioned that the blocks will not come out of the slots.

4.4.4. Connections

4.4.4.1. The windings and connections shall be properly braced to withstand shocks during transportation or due to short circuit and other transient conditions during service.

4.4.4.2. All active parts comprising of the core, windings and insulation materials used in the construction of the transformer shall be dried under vacuum and impregnated with hot oil.

4.4.4.3. All joints shall be brazed / crimped to withstand the vibrations due to short circuits, transportation and load fluctuations.

4.5. Tapping

4.5.1. Tapping Range

The medium voltage winding shall have tapings at ± 2 x 2.5% operated by an off-circuit switch (tap-changer) with marked position indicators. Tapping details shall be included on the transformer name plate.

4.5.2. Tapping Method

4.5.2.1. Tapping shall be carried out by means of an off-load tap changer. The tap-changer (ratio tap-switch) shall be designed manufactured and tested as per IEC 60214-1 and IEC 60076-1:2011.

4.5.2.2. The tapping shall be selected by an 'off load' tapping switch with an external hand wheel and a shaft connected to a linear horizontal contacts and a provision for locking on to a selected tapping. The shaft shall be adequately sealed so that no seepage of oil occurs under all conditions of service.

4.5.2.3. The ratio tap-switch shall be located on the top cover of the transformer with sufficient electrical clearance and well submerged in oil. The tap switch shaft shall be of minimum 8mm diameter and a suitable height approximately 150mm to enable the active linear contacts to be fully submerged in oil at all times.

4.5.2.4. The gap between the ratio tap-switch contacts to the top inside cover of the tank shall be minimum 130mm.

4.5.2.5. The voltage operating positions, together with tap change positions shall be clearly and indelibly marked. The ratio tap-switch position No. 1 shall correspond to highest voltage on the HV side.

4.5.2.6. The make contacts of the tap changer shall be robust and of sufficient surface area. The tap switch shall comply with relevant requirements of IEC 60214-1 & IEC 60512.

4.6. Core and Flux Density

4.6.1. Core

4.6.1.1. The core shall be made of new high permeability material or domain-refined material (CRGO) as per Table 4 and of class C.22 Anisotropic (oriented) steel sheet (lamination) with dimensional properties as per Table 4 and IEC 60404 Part 1 & Part 8-7 and IEC 60740-1.

4.6.1.2. The CRGO material shall be cold rolled having inorganic insulating coating to prevent any form of corrosion (galvanic or oxidation).The tenderers shall be required to provide type test reports confirming compliance to the provisions of the standards of manufacture for purposes of tender evaluation.

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

4.6.1.4. Every care shall be exercised in the selection, treatment and handling of core steel to ensure that as far as practicable, the laminations are flat and the finally assembled core is free from distortion.

4.6.1.5. Adequate cooling shall be provided for the core.

Table 4: CRGO Maximum Specific Loss

Material with high permeability as per IEC 60404-8-7	
Nominal Thickness	Maximum specific total loss at 50 Hz
mm	W/kg
0.23	0.90 to 1.00
0.27	1.03 to 1.10
Domain-refined material	
Nominal Thickness	Maximum specific total loss at J= 1.7T at 50 Hz
mm	W/kg
0.23	0.80 to 0.90
0.27	0.85 to 0.95

4.6.1.6. There shall be no movement of the core assembly relative to the tank during transport, installation as well as in service due to sudden jerks caused by short circuits and fluctuating loads.

4.6.1.7. The cores shall be clamped effectively with metal U-shape mild steel clamps or cross-arms and be fitted with core lifting lugs. During factory acceptance testing, the manufacturer shall demonstrate experimentally or via a previous test report, that the whole structural frame-work supporting the transformer windings and the core can definitely withstand repeated transformer short-circuits. All steel sections used for supporting the core shall be thoroughly sand blasted or shot blasted after cutting, drilling and welding before painting. Any non-magnetic or high resistance alloy shall be of established and approved quality.

4.6.1.8. Adequate lifting lugs shall be provided to enable core and winding to be lifted. The lifting lugs shall allow a factor of safety of at least 2.

4.6.1.9. The supporting framework of the cores shall be so designed as to avoid the presence of pockets which would prevent complete emptying of the tank, or cause trapping of air during filling.

4.6.1.10. The insulation structure for the core to bolts and core to clamp plate shall be such as to withstand a voltage of at least 2.5 kV 50Hz for one minute as per IEC 60076-1:2011 clause 11.12.

4.6.2. **Flux Density**

4.6.2.1. The primary voltage variation, which may affect the flux density at every tap, shall be kept in view while designing the transformer.

4.6.2.2. The transformer shall be so designed that the working flux density shall not exceed 1.6 Tesla at normal voltage, frequency and ratio. Tenderers with higher flux density than specified shall not be considered. The lower limit shall be determined by the manufacturer and provided in the bid documents.

4.6.2.3. Tenderers shall indicate in their bid the continuous allowable maximum flux for one minute and five seconds as per IEC 60401-1.

4.6.2.4. The limit of flux density at which core material used saturates shall also be stated in the tender. The name and grade of core material shall be stated in the tender.

4.6.2.5. The tender shall be submitted complete with magnetization curve of the core material, design calculations and data/documents demonstrating compliance to flux density requirements for purposes of tender evaluation.

4.7. Losses

4.7.1. The short circuit impedance and maximum sum total of the transformer losses, measured at full load operation, unity power factor and rated voltage shall be as per BS EN 50464-1 and shall not exceed values indicated in Table 5. Measured values of the no-load losses and the full load losses shall be corrected to 75°C. These are measured at nominal tap.

Table 5: Total Transformer Losses and short circuit impedance

Voltage Class	Rating KVA	TOTAL LOSSES (no-load + load losses) at 75°C, Watts	Short- circuit impedance %
11/0.420kV Transformers	50	840	4
	100	1395	
	200	2685	
	315	3690	
33/0.420kV Transformers	50	1210	
	100	1863	
	200	3050	
	315	4492	

4.7.2. The sound power level, no-load losses and full load losses at 75°C (unity power factor) shall be as per Table 6:

Table 6: Sound Power Level, No-load and Full Load Losses at 75°C

Voltage Class	Rating KVA	Sound power level (LWA), dB(A)	No-load Losses, Watts	Load losses) at 75°C, Watts	TOTAL LOSSES (no-load + load losses) at 75°C, Watts
11/0.420kV Transformers	50	39	90	750	840
	100	41	145	1250	1395
	200	49	310	2375	2685
	315	52	440	3250	3690
33/0.420kV Transformers	50	50	160	1050	1210
	100	54	293	1570	1863
	200	63	530	2520	3050
	315	63	672	3820	4492

NOTE: *Tenders shall state losses both for nominal tap and extreme taps in the GTPs.*

4.7.3. No-load and Load Losses stated in Table 6 shall be treated as maximum values. Bidders offer on losses shall be submitted in the tender for purposes of tender evaluation.

4.8. Capitalization

4.8.1. Transformer losses shall be capitalized at the following rates to facilitate evaluation and comparison of tenders. Loss capitalization shall be as per Table 7.

4.8.2. Losses will be capitalized at the above rates and added to the bid price according to the formula below:

Gep =Gbp + G ($), where Gep = Bid evaluation price, Gbp = Bid price and

G ($) = Adjustment for the cost of the operation and maintenance for 25 years (all in US Dollars)

G ($) is obtained by using the following formula:

G ($) = US$ 2577 X {Total load losses, ONAN rating (copper loss + stray loss) at rated current at 75^0 C in KW} + US$ 4339 X {Total no load losses in KW (core losses)}.

Table 7: Loss capitalization

Total load losses, ONAN rating (copper loss + stray loss) at rated current at 75^0 C in KW	US$ 2577 per kW for 25 years
Total no load losses in KW (core losses)	US$ 4339 per kW for 25 years

4.8.3. The guaranteed transformer losses used in the above capitalization formula shall be the maximum allowed and no positive tolerance shall be allowed during acceptance testing.

NOTE: *The manufacturer will be penalized double the capitalization rate for every kilowatt by which the actual tested transformer losses exceed the guaranteed losses upon which bids are evaluated. Manufacturers shall possess 0.1 class instruments for measuring losses.*

4.9. Bushings and Clearances

4.9.1. Bushings

4.9.1.1. The windings shall be brought out separately through open type bushings of outdoor weatherproof design for both 11kV and 33kV class bushings. The bushings shall be manufactured and tested in accordance with IEC 60137 and DIN 42531. The 33kV bushing design shall be as per the drawing attached in Annex B.

4.9.1.2. The 33kV class high voltage (HV) bushing shall be fitted with adjustable arcing horns with arcing distance "C" set at the factory to withstand the conditions stated in clause 4.1 as per drawing attached in Annex B.

4.9.1.3. The HV bushings shall be made of either porcelain of grade C-120 ceramic material or equivalent complying to IEC 60627-3 or composite (polymeric) material made of high quality reinforced high temperature vulcanized (HTV) silicone rubber based on dimethyl siloxane, which exhibit hydrophobicity with the capability to transfer hydrophobicity to the layer of pollution.

4.9.1.4. The LV bushing shall be a two part bushing. The bottom portion shall be made with toughened epoxy insulator material and the top portion made of porcelain material, brown in colour and shall be mounted on the top cover of the transformer.

4.9.1.5. The neutral bushing of the transformer shall be identical to the corresponding LV phase terminal bushings in terms of bushing and bushing rod sizes.

4.9.1.6. The external spacing and air clearances shall be so coordinated that there shall be no flashover from the terminal of one winding to the terminal of another winding or to the body of the transformer.

4.9.1.7. The specific creepage distance of bushings shall not be less than 25mm/kV, based on the maximum phase to phase voltage. When specifically requested by KPLC in the tender document, the creepage distance shall not be less than 31mm/kV for coastal installations, based on the maximum phase to phase voltage.

4.9.1.8. The design of the bushing such as number of bushing sheds, shed profile, diameter of the shed, shall not rely on the drawing in in Annex B but shall be as per the requirements of IEC 60815.

4.9.1.9. Bushing terminals shall be grooved clamp type (bolted) connectors –

a) LV connectors - shall be two (2) grooved palms (one (1) permanently fixed to the bushing rod and one (1) removable) complete with stainless steel fasteners suitable for aluminium conductors. All the fasteners shall be of size M8 - bolts, nuts and washers (flat round and spring).

b) HV terminal connectors shall receive ACSR on HT side. The terminals shall be directly screwed on to the bushing rod to secure effective sealing of the bushing.

4.9.1.10. Terminal arrangement and marking on the HV and LV sides shall be **A, B, C** and **n, a, b, c** respectively.

4.9.1.11. The terminal connector sizes and materials are as per Table 8:

Table 8: Terminal Connectors (Bolted Type)

Rating	HV Terminal Connector		LV Terminal Connector	
	Material	Size of conductor	Material	Size of conductor
50KVA	Alloy of copper - Brass, tinned(coating thickness of 100µm)	50mm^2	Tinned bi-metallic (copper/aluminium) tinned (coating thickness of 100µm)	1x50mm^2 AAC
100KVA				2x50mm^2 AAC
200KVA				3x100mm^2 AAC
315KVA				3x100mm^2 AAC

4.10. Clearances

4.10.1. External air clearances

4.10.1.1. When totally assembled, as in service, electrical clearances in air shall be adequate to withstand the assigned impulse withstand test voltages.

4.10.1.2. Care shall be taken to ensure that all fittings/accessories are suitably positioned so as not to interfere with the external connection to the bushing terminals and clearances.

4.10.1.3. Minimum external air clearances (with terminal clamps fitted) shall be as per Table 9.

Table 9: External Clearances in Air

Nominal System Voltage between Phase Centers		11kV	33kV
Minimum clearance phase-to-earth and phase-to-neutral	mm	200	400
Minimum clearance phase-to-phase between phases of the same winding	mm	200	400
Minimum creepage distance	mm	300	900

NOTE: *As per clause 16.1 of IEC 60076-3:2013, the clearances in air specified by the standard are only applicable when clearances in air are not specified by the purchaser. In addition, the standard does not consider the risk from intrusion of birds and other animals*

4.10.2. Internal clearances

Internal clearances shall be as per Table 10:

Table 10: Internal clearances

Description		11kV	33kV
Minimum radial clearance of LV coil and core	mm	5	5
Minimum radial clearance of LV coil and earth	mm	5	5
Minimum radial clearance between LV and HV	mm	12	30
Minimum electrical clearance between the surface of the tank, tapping leads and edge of windings	mm	30	50
Minimum radial clearance between HV and HV windings	mm	15	20

4.11. Insulation Levels

The complete transformer arranged for service, shall be capable of withstanding the voltages indicated in Table 11 and shall comply fully with the requirements of IEC 60076 Part 3.

Table 11: Insulation Levels as per IEC 60076-1:2011 and IEC 60071-1:2006

Nominal system voltage (kV, rms)	**Highest system voltage,** (kV, rms)	**Internal Insulation**	
		Lightning Impulse withstand voltage, positive, (kV, peak)	**Power frequency withstand voltage,** (kV, rms)
0.42	1.1kV	-	3
11	12	95	28
33	36	200	70

NOTE:

1. *The insulation levels specified are for the internal insulation as per IEC 60076-3 and IEC 60071-1.*
2. *Altitude correction applied on the external clearances and bushings selection to attain required external insulation as per IEC 60076-3 and IEC 60815.*

4.12. Transformer Tank and Tank Cover

4.12.1. The tank shall be bolted top cover type constructed using tested steel plates conforming to EN 10025 and shall have of sufficient thickness and strength. The tank shall be complete with specified accessories and fittings. It shall be designed so as to and sides of the transformer tank shall be 4mm, 4mm and 3mm respectively.

All joints of tank and its fittings shall be oil tight and no bulging shall occur during service.

4.12.2. The internal clearance of tank shall be such that it shall facilitate easy lifting of core with windings from the tank.

4.12.3. The main tank body shall be pressure tested and a certificate issued/signed by an ISO/IEC 17025 Accredited Laboratory ascertaining the soundness of all welded joints in accordance with relevant ISO standards. A copy of the certificate shall be submitted with the transformers during delivery to KPLC stores.

4.12.4. The tank shall be complete with lifting lugs suitable for lifting the complete transformer with oil. The lifting lugs shall be welded on the side walls and shall avy duty type made of suitable grade of steel plate of least 8mm thick and shall be reinforced with a factor of safety of at least 2 (based on weight of complete transformer filled with oil).

4.12.5. Steel radiators (corrugations) of adequate thickness to deter oil vandalism shall be used for cooling. The transformer shall be capable of giving continuous rated output without exceeding the specified temperature rise.

4.12.6. Top tank cover shall be of such a design and construction as to prevent accumulation of water and shall be bolted to the flange on the tank top to form a weatherproof joint. The top cover fixing shall be with hot dip galvanized steel bolts and synthetic rubber-and-cork composition gasket of 6mm minimum thickness. The bolts shall each have two flat washers and one spring washer.

4.12.7. The top cover bolts shall include at least four (4) non-standard bolts of dome shaped head with non-standard profile that cannot be opened by use of standard Allen-screws, pipe wrenches, spanners etc. to deter un-authorized opening. One (1) piece of the key/tool for every twenty (20) transformers for opening the special bolts shall be provided to Kenya Power during delivery. They shall be delivered to Electrical Plant Transformer Workshop, Isiolo Road, Nairobi.

4.12.8. Provision shall be made in form of a removable jumper, to provide for good electrical connection between the top cover and the transformer tank. The jumper shall be sufficiently rated to carry the fault currents without damage. It shall be of tinned copper 25mm x1.2mm and shall be secured by stainless steel bolt & nut.

4.13. Paint Work

4.13.1. External and internal surfaces of all transformer tanks and other fabricated steel items shall be cleaned of scale, rust and surface dirt by shot blast cleaning or other suitable approved method. After cleaning, these surfaces should be immediately covered with paint.

4.13.2. The exterior shall be thoroughly cleaned by shot blasting or other approved method and given priming coat/ epoxy painting followed by two coats of contrasting colours of durable weather-resisting paint. The final colour of the exterior surfaces shall be Dark Admiralty Grey colour No. 632 as per BS 381C with a total dry film thickness of between 100 and 130 microns.

4.13.3. The interior of all transformer tanks and other oil-filled chambers shall be cleaned of all scale and rust by shot blasting or other approved method. Hot oil resistant varnish/paint shall be used for painting the inside the transformer tank and oil filled chambers. The manufacturer shall demonstrate this for inside of radiators and pipe connections.

4.13.4. Radiators shall be thoroughly degreased and treated externally by phosphating and/or other rust-inhibiting process.

4.13.5. Radiators shall be flood-painted with a primer and two coats of durable weather and oil resisting paint. The final external coat shall be high gloss of shade No. 632 (Admiralty Grey) according to BS 381C. The total paint thickness shall not be less than 85µm at any point.

4.14. Transformer Oil

4.14.1. Cooling of the transformer shall be by natural circulation of oil and natural circulation of air (ONAN).The transformer shall be supplied filled with new oil.

4.14.2. The oil shall be new, unused and shall comply with all the requirements of IEC 60296 and IEC 60422:2013(class 1: un-inhibited oil) and as per current KPLC specification No. KP1/6C.1/13/TSP/08/001 (Shall be attached during tender).

4.15. Surge Arresters

4.15.1. Each transformer shall be complete with surge arresters mounted on brackets (one number per phase) fitted under the HV bushings with steel earth strip of at least 50mm x 6mm wide connected to the body of the transformer with necessary fixing arrangements.

4.15.2. The fixing arrangement for the surge arresters shall be universal type to accept a wide range of surge arresters and shall be subject to approval by KPLC before manufacture.

4.15.3. All the ferrous parts of the mounting brackets shall be protected against corrosion by hot dip galvanizing to ISO 1461.

4.15.4. The surge arresters (to IEC 60099-4&5) shall be as per current KPLC specification No. KP1/6C.1/13/TSP/11/32.

4.16. Fittings and Accessories

4.16.1. The transformer shall be complete with the following fittings and accessories:

a) **Pressure relief device:**

(i) An approved pressure relief device of suitable size shall be mounted on the top cover steel tubing (with a skirt to protrude at least 2.5mm in to the tank to prevent gas accumulation) for the rapid release of any pressure that may be generated in the tank,

(ii) The device shall be capable of maintaining the oil tightness of the transformer under all conditions of normal service. It shall prevent the ingress of rain/moisture or oil flow from the transformer after the operation of the device to relieve an internally generated pressure

(iii) It shall not protrude higher than the height of the transformer HV bushings.

b) **Oil level gauge**:
This shall be clearly readable by an operator standing at ground level at a distance of 5 meters away from the transformer mounting. The oil level gauge shall have maximum and minimum oil level markings which shall fall within range of the gauge. The nominal oil level shall be at the center of the range. The oil level gauge shall be mounted on the top cover steel tubing OR top of the transformer tank for sealed type transformer.

c) **Earthing terminals**:
There shall be two (2) earthing terminals (with cable lug) on the side of the body of the transformer below the radiators diagonally opposite each other. Each terminal shall have two flat washers, one spring washer and lock nut, all in stainless steel. The earthing terminal lugs shall be in tinned copper and shall be suitable for 50mm^2 conductor.

d) **Lifting lugs:**
Separate lifting lugs for core, top cover and complete transformer (as per requirements given in this specification).

e) **Off-circuit tap changer:** Voltage tappings shall be provided on the primary side of each transformer. Tapping step shall be ± 2 x 2.5%. The tappings shall be selected by an 'off load' tapping switch with an external hand wheel with provision for locking on to a selected tapping. The shaft shall be adequately sealed so that no seepage of oil occurs under all conditions of service. The voltage operating positions, together with tap change positions shall be ` clearly and indelibly marked.

f) **Clamp connectors:**
If required, LV clamp connectors shall be made of tinned copper alloy (brass, bronze or phosphor bronze). The tin coating thickness shall be 100µm.

g) Thermometer pocket to be used during temperature rise test.

h) Jacking lugs

i)Combined drain plug and sampling device.

j)Surge arrester mounting brackets as per clause 4.15

k) **Arcing horns**:
Arcing horns shall be provided on each 33kV HV bushing as per attached drawings

4.16.2. All fittings and accessories shall be designed and secured in such a manner that makes it impossible for vandals to siphon oil from the transformer even after forceful breakage of the fitting/accessory. There shall be no oil leaks from the fittings and accessories.

4.16.3. Detailed drawings for the transformer (including internal details) and its components showing features that make it impossible for vandals to siphon oil from the transformer even after forceful breakage of the fitting/accessory shall be submitted to KPLC for approval before manufacture.

4.16.4. The tank shall be equipped with mounting rails at the bottom which shall facilitate lifting with a forklift.

4.17. Quality Management System

4.17.1. The supplier shall submit a quality assurance plan (QAP) that will be used to ensure that the transformer design, material, workmanship, tests, service capability, maintenance and documentation, will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008.

4.17.2. The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2008 certificate shall be submitted with the tender for evaluation.

4.17.3. The bidder shall indicate the delivery time of each type of transformer, manufacturer's monthly & annual production capacity and experience in the production of the type and size of transformer being offered. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers outside the country of manufacture for exact or similar rating of transformers sold in the last five years together with four customer reference letters shall be submitted with the tender for evaluation.

5. TESTS AND INSPECTION

5.1. The transformer shall be inspected and tested in accordance with the requirements of IEC 60076:2011 and this specification. It shall be the responsibility of the manufacturer to perform or to have performed all the tests specified. Tenderers shall confirm the

manufacturer's capabilities in this regard when submitting tenders. Any limitations shall be clearly specified in the bid document.

5.2. Copies of **Type Test Certificates & Type Test Reports issued by a third party testing laboratory that is accredited to ISO/IEC 17025** shall be submitted with the tender for the purpose of technical evaluation. A copy of the accreditation certificate to ISO/IEC 17025 for the testing laboratory shall also be submitted. Any translations of certificates and test reports into English language shall be signed and stamped by the Testing Laboratory that carried out the tests.

Copies of type test certificates and type test reports for the transformer offered to be submitted for tender evaluation shall include:

(i) Lightning Impulse Withstand Voltage Test - IEC 60076-3.
(ii) Short circuit withstand test to IEC 60076-5.
(iii) Temperature rise test to IEC 60076-2.
(iv) Measurement of no-load loss and current at 90% and 110% of rated voltage

NOTE: *Type Test Reports for a transformer of identical or higher voltage and identical or higher kVA rating and within the range of 11/0.420kV – 36/0.420kV and 50KVA- 500KVA shall be accepted as representative for any of the pole mounted three phase distribution transformer on tender. The type test reports shall be for a transformer of the same core design and construction as the transformer being offered. The type tests shall be valid for least five (5) years.*

NOTE: *Temperature rise test to IEC 60076-2 if conducted at the manufacturer's premises (factory) shall be in the presence of representatives of ISO/IEC 17025 accredited third party testing laboratory; who shall sign and stamp the certificates and test reports.*

5.3. The transformer shall be subject to acceptance tests at the manufacturer's works before dispatch. Acceptance tests shall be witnessed by two Engineers appointed by KPLC and shall include the following:

5.3.1. **Routine tests to IEC 60076-1: 2011 (to be done during acceptance testing at factory)**

a) Measurement of winding resistance - clause 11.2
b) Measurement of voltage ration and check of phase displacement - clause 11.2
c) Measurement of short circuit impedance and load loss – clause 11.4
d) Measurement of no-load loss and current – clause 11.5
e) Dielectric routine tests – IEC 60076-3

(i) Separate source voltage withstand test

(ii) Induced over-voltage

(iii) Insulation resistance

f) Leaking testing with pressure for liquid immersed transformers (tightness test) – clause 11.8

g) Tests on off-load tap-changer – mechanical tests as per IEC 60214-1.

h) Check of core and frame insulation for liquid immersed transformers with core or frame insulation – clause 11.12.

i) Any other test not listed above but specified by the latest edition of IEC 60076.

5.3.2. **Type Tests to IEC 60076 (to be done on one unit during acceptance testing at factory)**

a) Temperature rise test – To be performed on one unit during acceptance testing.
b) Lightning impulse withstand voltage test – To be performed on one unit during acceptance testing.
c) Measurement of no-load loss and current at 90% and 110% of rated voltage– To be performed on one unit during acceptance testing.

5.3.3. **Additional tests (to be done on samples during acceptance testing at factory)**

(i) Visual Inspection (verification of dimensions, fittings & accessories, markings & nameplates, paintwork, workmanship and finish) – IEC 60076-1.
(ii) Acoustic and sound level – IEC 60076-10 or NEMA - TR1.
(iii) Paint thickness – ISO 2944.

5.4. The manufacturer shall provide current e-mail address, fax and telephone numbers and contact person at the Testing Laboratory where the type tests were obtained.

5.5. Complete Test Reports for each transformer (including its individual components) shall be submitted to KPLC for approval before shipment.

5.6. On receipt of the transformers KPLC will inspect them before acceptance to stores and may perform or have performed any of the relevant tests (including verification of losses) in order to verify compliance with the specification. The supplier shall replace/rectify without charge to KPLC, transformers and components/fittings which upon examination, test or use fail to meet any of the requirements in the specification.

6. MARKING, LABELLING AND PACKING

6.1. The transformer and associated components shall be packed in a manner as to protect them from any damage in transportation and handling. The transformer shall first be mounted and bolted to wooden base blocks and then covered with a polythene cover. The transformer with the wooden base blocks shall then be secured tightly in the container to avoid transit movements.

6.2. The transformer shall be dispatched fully assembled, oil filled and complete with surge arrester mounting brackets fitted.

6.3. Each assembly and package of items associated with the transformer shall be suitably marked.

6.4. In addition to markings and labels required elsewhere in the specification, each transformer shall be provided with a rating and diagram plate of weatherproof material, fitted in a visible position, showing the appropriate details listed in clause 8 of IEC 60076-1:2011. The entries on the plate shall be indelibly marked (either by etching, engraving or stamping) and shall be legible and permanent.

6.5. In addition, the rating and diagram plate shall include load and no load losses for the highest, lowest and principle tap positions, temperature class of insulation, connection diagram and the inscription **'PROPERTY OF THE KENYA POWER & LIGHTING CO. LTD'** all marked indelibly and legibly as in 6.4.

7. DOCUMENTATION

7.1 The bidder shall submit its tender complete with technical documents required by Annex A (Guaranteed Technical Particulars) for tender evaluation. The documents to be submitted (all in English language) for tender evaluation shall include the following:

a) Guaranteed Technical Particulars fully filled and signed by the manufacturer;
b) Copies of the Manufacturer's catalogues, brochures, drawings and technical data;
c) Sales records for previous five years and reference letters from at least four of the customers;
d) Details of manufacturing capacity and the manufacturer's experience;
e) Copies of required type test certificates and type test reports by a third party testing laboratory accredited to ISO/IEC 17025;
f) Copy of accreditation certificate to ISO/IEC 17025 for the third party testing laboratory;

g) Manufacturer's warranty and guarantee; subject to 72 months from date of delivery to KPLC stores or 60 months from the date of commissioning, whichever period expires earlier

Note: *KPLC commissioning reports shall be accepted.*

h) Manufacturer's letter of authorization, copy of the manufacturer's ISO 9001:2008 certificate and other technical documents required in the tender.

7.2 The successful bidder (supplier) shall submit the following documents/details (from the manufacturer as per tender) to The Kenya Power & Lighting Company for approval before manufacture:

a) Guaranteed Technical Particulars fully filled and signed by the manufacturer;
b) Design drawings & construction details of the transformer including 3-D views and as per the requirements of clause 4.2.17;
c) Quality assurance plan (QAP) that will be used to ensure that the design, material, workmanship, tests, service capability, maintenance and documentation will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008;
d) Test Program to be used after manufacture;
e) Marking details and method to be used in marking the transformer;
f) Manufacturer's undertaking to ensure adequacy of the design, adherence to applicable regulations, standards and specification, ensure good workmanship and good engineering practice in the manufacture of the transformers for The Kenya Power and Lighting Company Limited;
g) Packaging details (including packaging materials and marking and identification of component packages).

NOTE: ***The drawings to be submitted by the supplier/manufacturer to KPLC for approval before manufacture shall be in standard format clearly indicating drawing number, parts list with material details and quantities, standards of manufacture, dimensions, ratings, approval details and identity of the manufacturer (as per manufacturer's authorization submitted during tendering).***

ANNEX A:SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR OFFERED TRANSFORMER *(to be filled and signed by the Manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data & calculations, sales records for past five years, four customer reference letters, details of manufacturing capacity, the manufacturer's experience, copies of complete type test reports and accreditation certificate to ISO/IEC 17025 for the third party testing laboratory for tender evaluation, all in English Language)*

TENDER NO. .....BIDDER'S NAME & ADDRESS .....

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*	BIDDER'S OFFER			
		50kVA	100kVA	200kVA	315kVA
-	Name and address of the Manufacturer				
	Country of manufacture				
	Manufacturer's Letter of Authorization				
	Model/Type Reference No. of the offered transformer				
	Drawing Reference Number				
	Manufacturer's warranty and guarantee certificate for the offered transformer				
1.	Scope: a) Design, manufacture, test, ship and deliver ground mounted three phase distribution transformer to KPLC store/site as per specification and terms of contract. b) Ensure adequacy of the design, good workmanship, good engineering practice and adherence to standards, specifications and applicable regulations in the manufacture of the transformers for KPLC				
2	Applicable Standards				
3	Terms and Definitions				
4.1.1	Operating Service Conditions: *indicate altitude, temperature range, humidity, pollution and isokeraunic level)*				
4.1.2.1-4.1.2.3	System Characteristics				
4.2	General Requirements	-	-	-	-
4.2.1	Outdoor, oil type, ONAN and core type				
4.2.2	Design Service Life				
4.2.3	Two winding, three phase integral unit				
4.2.4	Types of transformers offered				
4.2.4.1	Hermetically sealed type each with provision for oil expansion				
	Active parts submerged in oil and provision for oil expansion				
4.2.4.2	Free breathing type, conservator with cobalt free dehydrating breather& oil gauge				

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER			
			50kVA	100kVA	200kVA	315kVA
4.2.5	Design to facilitate operation, inspection, maintenance & repairs					
4.2.6	Safety & Regulatory Requirements					
4.2.7	No water pockets, rain water do not collect on top, cover with 10mm overlap to conceal gasket					
4.2.8	Corresponding parts to be interchangeable					
4.2.9	Fittings & accessories secured from inside or have openings that do not allow oil siphoning					
4.2.10	Test certificates for transformer components and materials – Attach for verification					
4.2.11	All connections & contacts of ample section and surface for required currents					
4.2.12	Materials used do not lead to acidity in oil					
4.2.13	State value of maximum noise level (BS EN 50464-1) or NEMA TR1					
4.2.14	Transportation to withstand 1g beyond gravitational acceleration					
4.2.15	Suitable for ground with mounting, steel channel under base					
4.2.16	Drawings of offered transformer					
	Overall dimensions of offered transformer (length, width & height) in mm					
4.2.17a) to g)	Design drawings for approval before manufacture					
	Overall dimensions of the transformer and relevant electrical clearances. This shall include all perspectives and respective:					
	(i)	Weight of oil,				
	(ii)	Weight of LV winding conductor				
	(iii)	Weight of HV winding conductor				
	(iv)	Core material,				
	(v)	Copper/aluminium winding material,				
	(vi)	Insulating materials and				
	(vii)	Steel tank/core clamp structure.				
	Core/coil/insulation dimensions, clearances (internal and external) and stacking/coil winding sequence detail.					
	Drawing of nameplate to scale.					
	Dimensional drawing of bushings, tap-changer and clamps.					
	Legend for all technical engineering drawings with manufacturer name, logo, model number, revision/drawing number and key					
	Detailed drawing of arcing horns where applicable.					
	Detailed drawing of arcing horns where applicable.					

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER			
			50kVA	100kVA	200kVA	315kVA
	All design drawings MUST BE stamped and signed by the manufacturer's authorised personnel.					
4.3.1	KVA, no-load voltage ratings and frequency					
4.3.2	Temperature Rise	Top Oil				
		Windings				
		Winding hot spot and of metallic part in contact with cellulose				
	Temperature Rise Test					
4.3.3	Fault level for 2 seconds					
4.3.4	Demonstration of thermal ability of offered transformer design to withstand short circuit (submit detailed calculation in accordance with clause 4.1.2 and 4.1.5 of IEC 60076-5)					
	Value of symmetrical short-circuit current I as per clause 4.1.2 of IEC 60076-5					
	Duration of the symmetrical short-circuit current as per clause 4.1.3 of IEC 60076-5					
	Maximum permissible values of the average temperature of each winding after short circuit as per clause 4.1.4 of IEC 60076-5					
	Short circuit current density (A/mm^2) HV winding					
	Short circuit current density (A/mm^2) LV winding					
	Average temperature θ_1 attained by each winding after short circuit (calculation of temperature as per clause 4.1.5 of IEC 60076-5)					
	Overload capacity for 2 hours after continuous full load run (indicate clause & standard)					
4.3.5	Calculation showing details and compliance with the requirements of clause 4.1.1 to 4.1.5 of IEC 60076-5					
4.3.6	Type test report for the ability of the offered transformer to withstand dynamic effects of short circuit					
4.4	Windings, insulation and connections		-	-	-	-
4.4.1.1	Vector group					
4.4.1.2	Voltage variations					
4.4.1.3	Insulating material shall not soften, ooze, shrink or collapse during service. The material shall be non-catalytic & chemically inert in transformer oil					
4.4.2	Primary windings					
4.4.2.1	Secondary windings					
4.4.2.2	Current density, A/mm^2	HV winding				
		LV winding				

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER			
			50kVA	100kVA	200kVA	315kVA
	Material of winding	HV winding				
		LV winding				
	Conductor area of winding mm^2	HV winding				
		LV winding				
	Resistance at 20^0C	HV winding				
		LV winding				
4.4.2.3	Characteristics of copper wire and aluminium wire					
	Copper	Standard of manufacture				
		Type designation or grade				
		Specific heat at 100 °C (J/kg· °C)				
		Density at 100 °C (kg/m^3)				
		Resistivity at 100 °C (μΩ·m)				
	Aluminium	Standard of manufacture				
		Type designation or grade				
		Specific heat at 100 °C (J/kg· °C)				
		Density at 100 °C (kg/m^3)				
		Resistivity at 100 °C (μΩ·m)				
	Characteristics of copper and aluminium foil/strip					
	Copper	Standard of manufacture				
		Type designation or grade				
		Ultimate tensile strength, N/mm^2				
		Density in 20^0C, kg/dm^3				
		Elongation, % , min				
		Maximum resistance at 20^0C, $\Omega mm^2/m$				
	Aluminium	Standard of manufacture				
		Type designation or grade				
		Ultimate tensile strength, N/mm^2				
		Density in 20^0C, kg/dm^3				
		Elongation, % , min				
		Maximum resistance at 20^0C, $\Omega mm^2/m$				
4.4.2.4	Stage inspection by Kenya Power					
	Insulating material		-	-	-	-
4.4.3.1	Separation of windings for cooling and ease of repair					
	Insulation sleeves material					
	Interlayer insulation material					
4.4.3.2	Double layer insulation					
	Temperature class of insulation					
	Crepe paper	Standard of manufacture				
		Type designation or grade				

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*			BIDDER'S OFFER 50kVA	100kVA	200kVA	315kVA
		Apparent density,					
		Grammage					
		Conductivity of aqueous extract					
		Electric strength in oil					
		Tensile strength	Machine direction				
			Cross machine direction				
	Presspaper – Grade type	Standard of manufacture					
		Type designation or grade					
		Apparent density,					
		Grammage					
		Conductivity of aqueous extract					
		Electric strength in oil					
		Tensile strength	Machine direction				
			Cross machine direction				
	Krapt paper/ Celullosic paper	Standard of manufacture					
		Type designation or grade					
		Apparent density					
		Conductivity					
		Air permeability					
	Radial spacer blocks	Standard of manufacture					
		Type designation or grade					
		Electrical and mechanical properties					
4.4.4	**Connections**						
4.4.4.1	Windings, joints & connections braced/brazed?						
4.4.4.2	Drying in vacuum & impregnating with hot oil						
4.5	**Tapping**			-	-	-	-
4.5.1	Tapping range						
4.5.2.	Tapping method and design						
4.5.2.1	Tap changer (ratio tap-switch)	Standard of manufacture					
		Type designation or grade					
		Mode of operation					
		Shank diameter					
		Height of ratio tap-switch					
4.5.2.3	Gap between ratio tap-switch top to the inside of the tank						
4.5.2.4	Tap switch position number 1, orientation						
4.6	**Core and Flux Density**			-	-	-	-
4.6.1	**Core**						
	Standard of manufacture of core material						
4.6.1.1	Type designation or Grade of core steel						
	Insulating material for CRGO to prevent corrosion						
4.6.1.2	Thickness of each single lamination						

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER 50kVA	100kVA	200kVA	315kVA
	Net core area, mm^2					
	Number of turns on LV, per phase					
	Stack factor/Building factor					
	Weight of core, kg					
	Specific loss in watts/kg (at 1.6T flux density)					
4.6.1.3	Static discharges & local heating					
4.6.1.4	Assembled core free from distortion					
4.6.1.5	Cooling for core					
4.6.1.6	Movement of core during transportation or in service					
4.6.1.7	Core clamping					
4.6.1.8	Lifting lugs for core, winding and complete transformer. Factor of safety at least 2.					
4.6.1.9	Oil pockets & trapping of air					
4.6.1.10	Insulation withstand of core to bolts and core to frame					
4.6.2	Flux density		-	-	-	-
4.6.2.1	Effect of primary voltage variations on flux density					
4.6.2.2	Maximum flux density					
	Lowest limit of flux density					
4.6.2.3	Allowable maximum flux density	1 min				
		5 s				
4.6.2.4	Flux density at which core saturates					
4.6.2.5	Magnetization curve and design calculations					
4.7	**Losses**		-	-	-	-
4.7.1	Short-circuit Impendence, %					
	Resistance at 75°C of HV Winding in ohms (at normal & extreme taps)					
	Resistance at 75°C of LV Winding in ohms					
	Minimum efficiency at 100% load (unity power factor), at 75°C					
	Total losses (no-load + load losses) at 100% load					
	No-load Losses at 75°C					
	Load Losses at 50% load, 75°C					
	Load Losses at 75% load, 75°C					
	Load Losses at 100% load, 75°C					
	I^2R component of load losses at 100% load, 75°C					
	Load Losses at 125% load, 75°C					
	Stray Losses at 50% load, 75% load, 100% load and 120% load, all at 75°C					
	Total losses at maximum tap Total losses at Minimum tap all at 75°C					
4.7.2	Sound power level					

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER 50kVA	100kVA	200kVA	315kVA
4.7.3	No-load and Load Losses shall be submitted in the tender					
4.7.4	Capitalization					
4.8	Bushings and clearances		-	-	-	-
4.8.1.1	Open, outdoor & weatherproof bushings to IEC 60137					
4.8.1.2	Bushings to be changed without opening transformer					
4.8.1.3	HV bushings to be polymeric or porcelain. Specify					
4.8.1.4	33kV Bushings complete with surge diverter bracket and arcing horns					
4.8.1.5	LV bushings shall be two part, bottom in toughened epoxy and top in porcelain, brown					
4.8.1.6	Neutral bushing identical to LV phase bushing					
4.8.1.7	Spacing & clearances					
4.8.1.8	Creepage distance of bushings: HV, LV, N					
	Coastal regions Creepage distance of bushings: HV, LV, N					
4.8.1.9	Clamp type bushing terminals for aluminum conductor					
	Materials, size and drawings for terminal connectors					
4.8.1.10	Marking and method of marking of terminals					
4.8.1.11	Continuous current rating of each bushing					
4.8.2	Clearances					
4.8.2.1	External air clearances					
4.8.2.1.1	Adequate to withstand impulse withstand test voltages					
4.8.2.1.2	Position of fittings & accessories not to interfere with external connection to bushing terminals					
4.8.2.1.3	Minimum external clearances & creepage					
	LV, mm (cable box)	Phase to phase				
		Phase to earth				
		Creepage distance				
	11kV, mm (cable box)	Phase to phase				
		Phase to earth				
		Creepage distance				
	33kV, mm (open)	Phase to phase				
		Phase to earth				
		Creepage distance				
4.8.2.2	Internal clearances					
	Minimum radial clearance of LV coil and core, mm					
	Minimum radial clearance of LV coil and earth, mm					
	Minimum radial clearance between LV and HV, mm					
	Minimum electrical clearance between the surface of the tank and tapping leads, mm					
	Minimum radial clearance between HV and HV windings, mm					
4.9	Insulation Levels (internal)					

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*	BIDDER'S OFFER			
		50kVA	100kVA	200kVA	315kVA
	LV: Power frequency withstand voltage				
	11kV: Lightning impulse & power frequency withstand voltages				
	33kV: Lightning impulse & power frequency withstand voltages				
	External insulation level and altitude correction (indicate offered insulation and altitude correction applied)				
4.10	Transformer Tank & Tank Cover	-	-	-	-
4.10.1	Bolted top cover design				
	Minimum thickness of top cover, bottom and sides of offered transformer respectively				
4.10.2	Inside clearance				
4.10.3	Pressure test of tank and test report during delivery				
4.10.4	Lifting lugs and factor of safety				
4.10.5	Steel radiators				
4.10.6	Top cover design, non-accumulation of rain water, gasket & non-standard bolts and nuts				
4.10.7	4 non-standard bolts on top cover				
4.10.8	Removable jumper of 25mm x 1.2mm tinned copper &stainless steel bolt & nut				
4.11	Paint Work	-	-	-	-
4.11.1	Method of cleaning before painting				
4.11.2	Final colour of exterior surfaces and paint thickness				
4.11.3	Cleaning and painting of interior of tank and other oil filled chambers				
4.11.4	Degreasing & treatment of radiators with anti-rust inhibitor				
4.11.5	Final colour of exterior of radiators & paint thickness &painting method				
4.12.1	Fittings and Accessories	-	-	-	-
4.12.1(a) i	Pressure at which pressure relief device operates				
ii	Pressure Relief Device & location				
4.12.1 (b)	Oil Level Gauge & location				
4.12.1 (c)	Earthing Terminals: location & to have stainless steel bolt, nut & washer and tinned copper terminal lug for 50mm^2 conductor				
4.12.1 (d)	Separate Lifting lugs for core, top cover, conservator & complete transformer				
4.12.1 (e)	Off-circuit tap changer & location				
4.12.1 (f)	Tinned copper jumper size and materials				

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER 50kVA	100kVA	200kVA	315kVA
4.12.1 (g)	Rating and diagram plate					
4.12.1 (h)	Clamp connectors					
4.12.1 (i)	Jacking Lags					
4.12.1 (j)	Combined drain plug and sampling device					
4.12.1 (k)	Surge arrester mounting brackets	Mounting Brackets dimensions				
		Universal type				
		Galvanized to ISO 1461				
4.12.1 (l)	Arcing horns					
4.12.2	Features to deter oil vandalism					
4.12.3	Detailed drawings					
4.12.4	Transformer mounting rails at bottom					
4.13	Transformer Oil – technical particulars shall be as per KP1/6C.1/13/TSP/08/001					
4.14	Surge Arresters technical particulars shall be as per KP1/6C.1/13/TSP/11/32.					
4.15	Quality Management System		-	-	-	-
4.15.1	Quality Assurance Plan to be based on ISO 9001:2008					
4.15.2	Declaration of conformity to IEC 60076					
	Copy of ISO 9001:2008 certificate submitted					
4.15.3	Monthly & annual production capacity					
	List of previous customers					
	Reference letters from at least four previous customers					
5.	Tests and Inspection		-	-	-	-
5.1	Test Standard					
	Responsibility of testing transformer & manufacturer's capability to carry out specified tests					
5.2	Copies of type test reports to IEC 60076		-	-	-	-
	Lightning impulse withstand test					
	Short circuit withstand test					
	Temperature rise test					
5.3	Acceptance tests at manufacturers premises					
5.3.1	Routine tests to IEC 60076					
5.3.2	Type tests to IEC 60076					
	Temperature rise test					
	Lightning impulse withstand test					
	No-load loss and current at:	90% rated voltage				
		110% rated voltage				
5.3.3	Additional tests (sample test)					
5.3.4	Sampling as per IEC 60410					
5.4	Contact details for testing authority					

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*	BIDDER'S OFFER			
		50kVA	100kVA	200kVA	315kVA
5.5	Complete test reports for approval before shipment				
5.6	Inspection or test by KPLC during delivery before acceptance to stores				
6.	Marking, Labeling & Packing	-	-	-	-
6.1	Packing: mounted & bolted on wooden base blocks				
6.2	Dispatch fully assembled & oil filled				
6.3	Assemble & package of items suitably marked				
6.4	Permanent Rating & Diagram plate indelibly marked (by etching, engraving or stamping)				
6.5	Content of marking				
7.1	Tender submitted with all technical documents				
7.2	Successful bidder to submit documents/details for approval before manufacture				
Other details required with the tender	Weight of complete transformer, kg				
	Weight of tank, kg				
	Material of tank				
	Weight of oil, kg				
	Weight of core, kg				
	Weight of HV windings (without insulation), kg				
	Weight of LV windings (without insulation), kg				
	Weight of insulation, kg				
	Manufacturer's experience				
	Detailed list of all the required fittings and accessories indicating type/model number, manufacturer and quantities				
	List catalogues, brochures and technical data submitted to support offer				
	Deviations from tender specifications (indicate supporting documents submitted)				

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Manufacturer's Name, Signature, Stamp and Date

B) 33kV TRANSFORMERS

ANNEX A: SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR OFFERED TRANSFORMER *(to be filled and signed by the Manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data & calculations, sales records for past five years, four customer reference letters, details of manufacturing capacity, the manufacturer's experience, copies of complete type test reports and accreditation certificate to ISO/IEC 17025 for the third party testing laboratory for tender evaluation, all in English Language)*

TENDER NO. .....BIDDER'S NAME & ADDRESS .....

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*	BIDDER'S OFFER			
		50kVA	100kVA	200kVA	315kVA
-	Name and address of the Manufacturer				
	Country of manufacture				
	Manufacturer's Letter of Authorization				
	Model/Type Reference No. of the offered transformer				
	Drawing Reference Number				
	Manufacturer's warranty and guarantee certificate for the offered transformer				
1.	Scope: a) Design, manufacture, test, ship and deliver ground mounted three phase distribution transformer to KPLC store/site as per specification and terms of contract. b) Ensure adequacy of the design, good workmanship, good engineering practice and adherence to standards, specifications and applicable regulations in the manufacture of the transformers for KPLC				
2	Applicable Standards				
3	Terms and Definitions				
4.1.1	Operating Service Conditions: *indicate altitude, temperature range, humidity, pollution and isokeraunic level)*				
4.1.2.1-4.1.2.3	System Characteristics				
4.2	General Requirements	-	-	-	-
4.2.1	Outdoor, oil type, ONAN and core type				
4.2.2	Design Service Life				
4.2.3	Two winding, three phase integral unit				
4.2.4	Types of transformers offered				
4.2.4.1	Hermetically sealed type each with provision for oil expansion				

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER			
			50kVA	100kVA	200kVA	315kVA
	Active parts submerged in oil and provision for oil expansion					
4.2.4.2	Free breathing type, conservator with cobalt free dehydrating breather& oil gauge					
4.2.5	Design to facilitate operation, inspection, maintenance & repairs					
4.2.6	Safety & Regulatory Requirements					
4.2.7	No water pockets, rain water do not collect on top, cover with 10mm overlap to conceal gasket					
4.2.8	Corresponding parts to be interchangeable					
4.2.9	Fittings & accessories secured from inside or have openings that do not allow oil siphoning					
4.2.10	Test certificates for transformer components and materials – Attach for verification					
4.2.11	All connections & contacts of ample section and surface for required currents					
4.2.12	Materials used do not lead to acidity in oil					
4.2.13	State value of maximum noise level (BS EN 50464-1) or NEMA TR1					
4.2.14	Transportation to withstand 1g beyond gravitational acceleration					
4.2.15	Suitable for ground with mounting, steel channel under base					
4.2.16	Drawings of offered transformer					
	Overall dimensions of offered transformer (length, width & height) in mm					
4.2.17a) to g)	Design drawings for approval before manufacture					
	Overall dimensions of the transformer and relevant electrical clearances. This shall include all perspectives and respective:					
	(i)	Weight of oil,				
	(ii)	Weight of LV winding conductor				
	(iii)	Weight of HV winding conductor				
	(iv)	Core material,				
	(v)	Copper/aluminium winding material,				
	(vi)	Insulating materials and				
	(vii)	Steel tank/core clamp structure.				
	Core/coil/insulation dimensions, clearances (internal and external) and stacking/coil winding sequence detail.					
	Drawing of nameplate to scale.					
	Dimensional drawing of bushings, tap-changer and					

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER 50kVA	100kVA	200kVA	315kVA
	clamps.					
	Legend for all technical engineering drawings with manufacturer name, logo, model number, revision/drawing number and key					
	Detailed drawing of arcing horns where applicable.					
	Detailed drawing of arcing horns where applicable.					
	All design drawings MUST BE stamped and signed by the manufacturer's authorised personnel.					
4.3.1	KVA, no-load voltage ratings and frequency					
4.3.2	Temperature Rise	Top Oil				
		Windings				
		Winding hot spot and of metallic part in contact with cellulose				
	Temperature Rise Test					
4.3.3	Fault level for 2 seconds					
4.3.4	Demonstration of thermal ability of offered transformer design to withstand short circuit (submit detailed calculation in accordance with clause 4.1.2 and 4.1.5 of IEC 60076-5)					
	Value of symmetrical short-circuit current I as per clause 4.1.2 of IEC 60076-5					
	Duration of the symmetrical short-circuit current as per clause 4.1.3 of IEC 60076-5					
	Maximum permissible values of the average temperature of each winding after short circuit as per clause 4.1.4 of IEC 60076-5					
	Short circuit current density (A/mm^2) HV winding					
	Short circuit current density (A/mm^2) LV winding					
	Average temperature θ_1 attained by each winding after short circuit (calculation of temperature as per clause 4.1.5 of IEC 60076-5)					
	Overload capacity for 2 hours after continuous full load run (indicate clause & standard)					
4.3.5	Calculation showing details and compliance with the requirements of clause 4.1.1 to 4.1.5 of IEC 60076-5					
4.3.6	Type test report for the ability of the offered transformer to withstand dynamic effects of short circuit					
4.4	Windings, insulation and connections		-	-	-	-
4.4.1.1	Vector group					
4.4.1.2	Voltage variations					

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER			
			50kVA	100kVA	200kVA	315kVA
4.4.1.3	Insulating material shall not soften, ooze, shrink or collapse during service. The material shall be non-catalytic & chemically inert in transformer oil					
4.4.2	Primary windings					
4.4.2.1	Secondary windings					
4.4.2.2	Current density, A/mm^2	HV winding				
		LV winding				
	Material of winding	HV winding				
		LV winding				
	Conductor area of winding mm^2	HV winding				
		LV winding				
	Resistance at 20^{0}C	HV winding				
		LV winding				
4.4.2.3	Characteristics of copper wire and aluminium wire					
	Copper	Standard of manufacture				
		Type designation or grade				
		Specific heat at 100 °C (J/kg· °C)				
		Density at 100 °C (kg/m^3)				
		Resistivity at 100 °C (μΩ·m)				
	Aluminium	Standard of manufacture				
		Type designation or grade				
		Specific heat at 100 °C (J/kg· °C)				
		Density at 100 °C (kg/m^3)				
		Resistivity at 100 °C (μΩ·m)				
	Characteristics of copper and aluminium foil/strip					
	Copper	Standard of manufacture				
		Type designation or grade				
		Ultimate tensile strength, N/mm^2				
		Density in 20^{0}C, kg/dm^3				
		Elongation, % , min				
		Maximum resistance at 20^{0}C, Ωmm^2/m				
	Aluminium	Standard of manufacture				
		Type designation or grade				
		Ultimate tensile strength, N/mm^2				
		Density in 20^{0}C, kg/dm^3				
		Elongation, % , min				
		Maximum resistance at 20^{0}C, Ωmm^2/m				
4.4.2.4	Stage inspection by Kenya Power					
	Insulating material		-	-	-	-

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*			BIDDER'S OFFER			
				50kVA	100kVA	200kVA	315kVA
4.4.3.1	Separation of windings for cooling and ease of repair						
	Insulation sleeves material						
	Interlayer insulation material						
4.4.3.2	Double layer insulation						
	Temperature class of insulation						
	Crepe paper	Standard of manufacture					
		Type designation or grade					
		Apparent density,					
		Grammage					
		Conductivity of aqueous extract					
		Electric strength in oil					
		Tensile strength	Machine direction				
			Cross machine direction				
	Presspaper – Grade type	Standard of manufacture					
		Type designation or grade					
		Apparent density,					
		Grammage					
		Conductivity of aqueous extract					
		Electric strength in oil					
		Tensile strength	Machine direction				
			Cross machine direction				
	Krapt paper/ Celullosic paper	Standard of manufacture					
		Type designation or grade					
		Apparent density					
		Conductivity					
		Air permeability					
	Radial spacer blocks	Standard of manufacture					
		Type designation or grade					
		Electrical and mechanical properties					
4.4.4	**Connections**						
4.4.4.1	Windings, joints & connections braced/brazed?						
4.4.4.2	Drying in vacuum & impregnating with hot oil						
4.5	**Tapping**			-	-	-	-
4.5.1	Tapping range						
4.5.2.	Tapping method and design						
4.5.2.1	Tap changer (ratio tap-switch)	Standard of manufacture					
		Type designation or grade					
		Mode of operation					

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER 50kVA	100kVA	200kVA	315kVA
		Shank diameter				
		Height of ratio tap-switch				
4.5.2.3	Gap between ratio tap-switch top to the inside of the tank					
4.5.2.4	Tap switch position number 1, orientation					
4.6	**Core and Flux Density**		-	-	-	-
4.6.1	**Core**					
	Standard of manufacture of core material					
4.6.1.1	Type designation or Grade of core steel					
	Insulating material for CRGO to prevent corrosion					
4.6.1.2	Thickness of each single lamination					
	Net core area, mm^2					
	Number of turns on LV, per phase					
	Stack factor/Building factor					
	Weight of core, kg					
	Specific loss in watts/kg (at 1.6T flux density)					
4.6.1.3	Static discharges & local heating					
4.6.1.4	Assembled core free from distortion					
4.6.1.5	Cooling for core					
4.6.1.6	Movement of core during transportation or in service					
4.6.1.7	Core clamping					
4.6.1.8	Lifting lugs for core, winding and complete transformer. Factor of safety at least 2.					
4.6.1.9	Oil pockets & trapping of air					
4.6.1.10	Insulation withstand of core to bolts and core to frame					
4.6.2	Flux density		-	-	-	-
4.6.2.1	Effect of primary voltage variations on flux density					
4.6.2.2	Maximum flux density					
	Lowest limit of flux density					
4.6.2.3	Allowable maximum flux density	1 min				
		5 s				
4.6.2.4	Flux density at which core saturates					
4.6.2.5	Magnetization curve and design calculations					
4.7	**Losses**		-	-	-	-
4.7.1	Short-circuit Impendence, %					
	Resistance at 75°C of HV Winding in ohms (at normal & extreme taps)					
	Resistance at 75°C of LV Winding in ohms					
	Minimum efficiency at 100% load (unity power factor), at 75°C					
	Total losses (no-load + load losses) at 100% load					

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER 50kVA	100kVA	200kVA	315kVA
	No-load Losses at 75°C					
	Load Losses at 50% load, 75°C					
	Load Losses at 75% load, 75°C					
	Load Losses at 100% load, 75°C					
	I^2R component of load losses at 100% load, 75°C					
	Load Losses at 125% load, 75°C					
	Stray Losses at 50% load, 75% load, 100% load and 120% load, all at 75°C					
	Total losses at maximum tap Total losses at Minimum tap all at 75°C					
4.7.2	Sound power level					
4.7.3	No-load and Load Losses shall be submitted in the tender					
4.7.4	Capitalization					
4.8	Bushings and clearances		-	-	-	-
4.8.1.1	Open, outdoor & weatherproof bushings to IEC 60137					
4.8.1.2	Bushings to be changed without opening transformer					
4.8.1.3	HV bushings to be polymeric or porcelain. Specify					
4.8.1.4	33kV Bushings complete with surge diverter bracket and arcing horns					
4.8.1.5	LV bushings shall be two part, bottom in toughened epoxy and top in porcelain, brown					
4.8.1.6	Neutral bushing identical to LV phase bushing					
4.8.1.7	Spacing & clearances					
4.8.1.8	Creepage distance of bushings: HV, LV, N					
	Coastal regions Creepage distance of bushings: HV, LV, N					
4.8.1.9	Clamp type bushing terminals for aluminum conductor					
	Materials, size and drawings for terminal connectors					
4.8.1.10	Marking and method of marking of terminals					
4.8.1.11	Continuous current rating of each bushing					
4.8.2	Clearances					
4.8.2.1	External air clearances					
4.8.2.1.1	Adequate to withstand impulse withstand test voltages					
4.8.2.1.2	Position of fittings & accessories not to interfere with external connection to bushing terminals					
4.8.2.1.3	Minimum external clearances & creepage					
	LV, mm (cable box)	Phase to phase				
		Phase to earth				
		Creepage distance				
	11kV, mm	Phase to phase				

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER			
			50kVA	100kVA	200kVA	315kVA
	(cable box)	Phase to earth				
		Creepage distance				
	33kV, mm (open)	Phase to phase				
		Phase to earth				
		Creepage distance				
4.8.2.2	Internal clearances					
	Minimum radial clearance of LV coil and core, mm					
	Minimum radial clearance of LV coil and earth, mm					
	Minimum radial clearance between LV and HV, mm					
	Minimum electrical clearance between the surface of the tank and tapping leads, mm					
	Minimum radial clearance between HV and HV windings, mm					
4.9	Insulation Levels (internal)					
	LV: Power frequency withstand voltage					
	11kV: Lightning impulse & power frequency withstand voltages					
	33kV: Lightning impulse & power frequency withstand voltages					
	External insulation level and altitude correction (indicate offered insulation and altitude correction applied)					
4.10	Transformer Tank & Tank Cover		-	-	-	-
4.10.1	Bolted top cover design					
	Minimum thickness of top cover, bottom and sides of offered transformer respectively					
4.10.2	Inside clearance					
4.10.3	Pressure test of tank and test report during delivery					
4.10.4	Lifting lugs and factor of safety					
4.10.5	Steel radiators					
4.10.6	Top cover design, non-accumulation of rain water, gasket & non-standard bolts and nuts					
4.10.7	4 non-standard bolts on top cover					
4.10.8	Removable jumper of 25mm x 1.2mm tinned copper &stainless steel bolt & nut					
4.11	Paint Work		-	-	-	-
4.11.1	Method of cleaning before painting					
4.11.2	Final colour of exterior surfaces and paint thickness					
4.11.3	Cleaning and painting of interior of tank and other oil filled chambers					
4.11.4	Degreasing & treatment of radiators with anti-rust inhibitor					

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER			
			50kVA	100kVA	200kVA	315kVA
4.11.5	Final colour of exterior of radiators & paint thickness &painting method					
4.12.1	Fittings and Accessories		-	-	-	-
4.12.1(a) i	Pressure at which pressure relief device operates					
ii	Pressure Relief Device & location					
4.12.1 (b)	Oil Level Gauge & location					
4.12.1 (c)	Earthing Terminals: location & to have stainless steel bolt, nut & washer and tinned copper terminal lug for 50mm^2 conductor					
4.12.1 (d)	Separate Lifting lugs for core, top cover, conservator & complete transformer					
4.12.1 (e)	Off-circuit tap changer & location					
4.12.1 (f)	Tinned copper jumper size and materials					
4.12.1 (g)	Rating and diagram plate					
4.12.1 (h)	Clamp connectors					
4.12.1 (i)	Jacking Lags					
4.12.1 (j)	Combined drain plug and sampling device					
4.12.1 (k)	Surge arrester mounting brackets	Mounting Brackets dimensions				
		Universal type				
		Galvanized to ISO 1461				
4.12.1 (l)	Arcing horns					
4.12.2	Features to deter oil vandalism					
4.12.3	Detailed drawings					
4.12.4	Transformer mounting rails at bottom					
4.13	Transformer Oil – technical particulars shall be as per KP1/6C.1/13/TSP/08/001					
4.14	Surge Arresters technical particulars shall be as per KP1/6C.1/13/TSP/11/32.					
4.15	Quality Management System		-	-	-	-
4.15.1	Quality Assurance Plan to be based on ISO 9001:2008					
4.15.2	Declaration of conformity to IEC 60076					
	Copy of ISO 9001:2008 certificate submitted					
4.15.3	Monthly & annual production capacity					
	List of previous customers					
	Reference letters from at least four previous customers					

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*		BIDDER'S OFFER			
			50kVA	100kVA	200kVA	315kVA
5.	Tests and Inspection		-	-	-	-
5.1	Test Standard					
	Responsibility of testing transformer & manufacturer's capability to carry out specified tests					
5.2	Copies of type test reports to IEC 60076		-	-	-	-
	Lightning impulse withstand test					
	Short circuit withstand test					
	Temperature rise test					
5.3	Acceptance tests at manufacturers premises					
5.3.1	Routine tests to IEC 60076					
5.3.2	Type tests to IEC 60076					
	Temperature rise test					
	Lightning impulse withstand test					
	No-load loss and current at:	90% rated voltage				
		110% rated voltage				
5.3.3	Additional tests (sample test)					
5.3.4	Sampling as per IEC 60410					
5.4	Contact details for testing authority					
5.5	Complete test reports for approval before shipment					
5.6	Inspection or test by KPLC during delivery before acceptance to stores					
6.	Marking, Labeling & Packing		-	-	-	-
6.1	Packing: mounted & bolted on wooden base blocks					
6.2	Dispatch fully assembled & oil filled					
6.3	Assemble & package of items suitably marked					
6.4	Permanent Rating & Diagram plate indelibly marked (by etching, engraving or stamping)					
6.5	Content of marking					
7.1	Tender submitted with all technical documents					
7.2	Successful bidder to submit documents/details for approval before manufacture					
Other details required with the tender	Weight of complete transformer, kg					
	Weight of tank, kg					
	Material of tank					
	Weight of oil, kg					
	Weight of core, kg					
	Weight of HV windings (without insulation), kg					
	Weight of LV windings (without insulation), kg					
	Weight of insulation, kg					
	Manufacturer's experience					
	Detailed list of all the required fittings and accessories indicating type/model number, manufacturer and					

Clause Number	Description *Indicate KVA & voltage ratings in columns on the right*	BIDDER'S OFFER			
		50kVA	100kVA	200kVA	315kVA
	quantities				
	List catalogues, brochures and technical data submitted to support offer				
	Deviations from tender specifications (indicate supporting documents submitted)				

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Manufacturer's Name, Signature, Stamp and Date

ANNEX C: DRAWINGS – 33kV Bushings Drawings

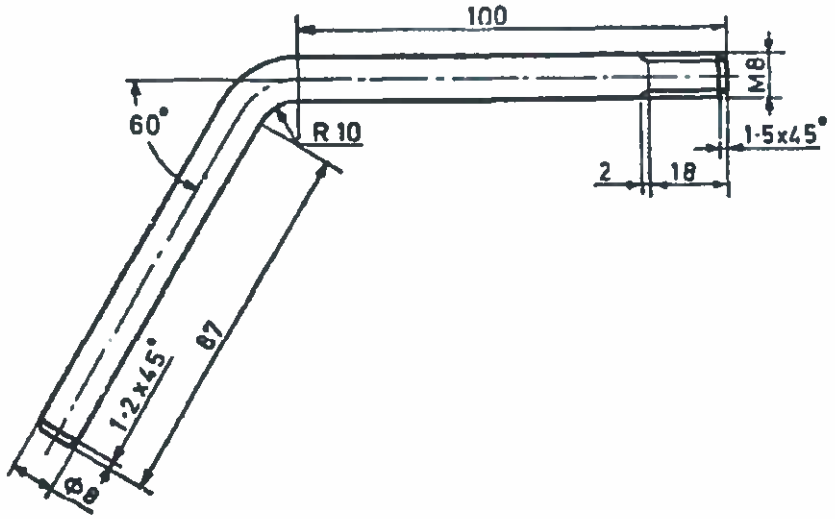


Fig. 1: Upper Spark Gap Horn (For 36 kV/250A Rating) as per DIN 42531-33

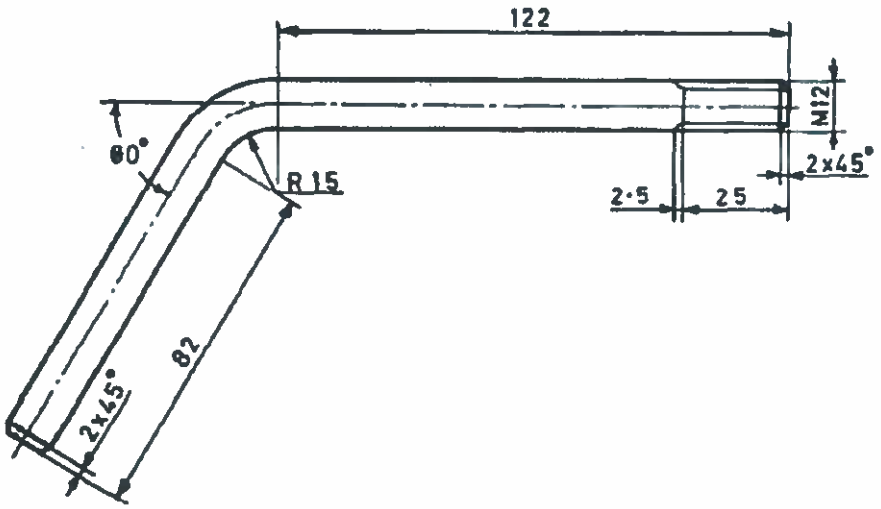


Fig. 2: Upper Spark Gap Horn (For 36 kV/630A Rating) as per DIN 42531-33

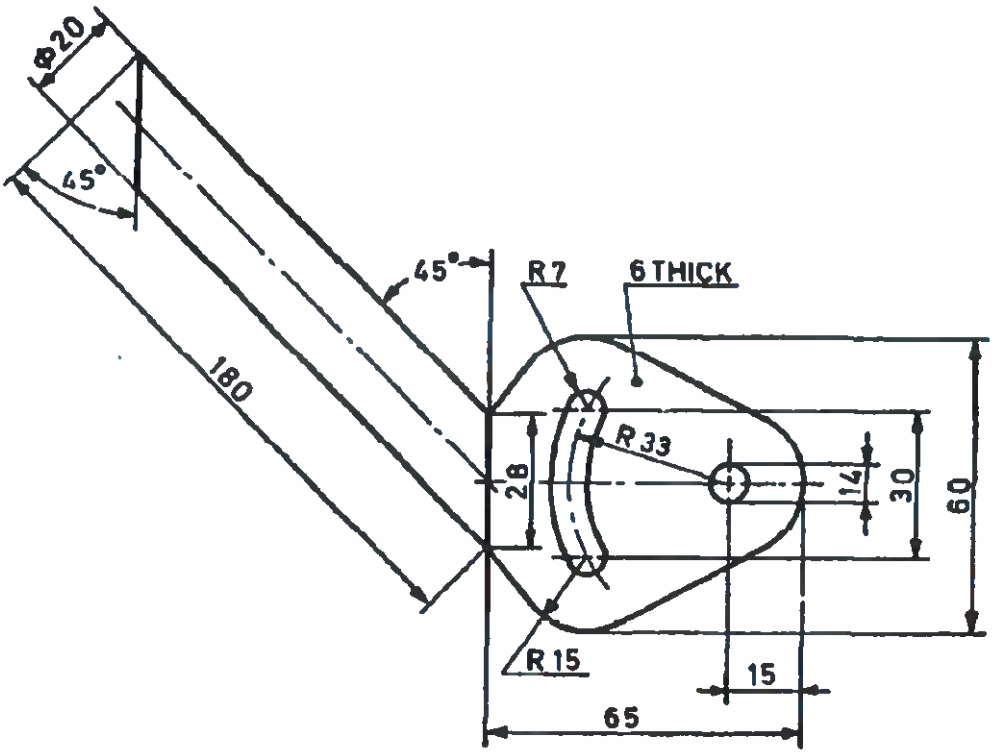


Fig. 4 Lower Spark Gap Horn (For 36 kV/ 250A - 630A Rating) as per DIN 42531-33

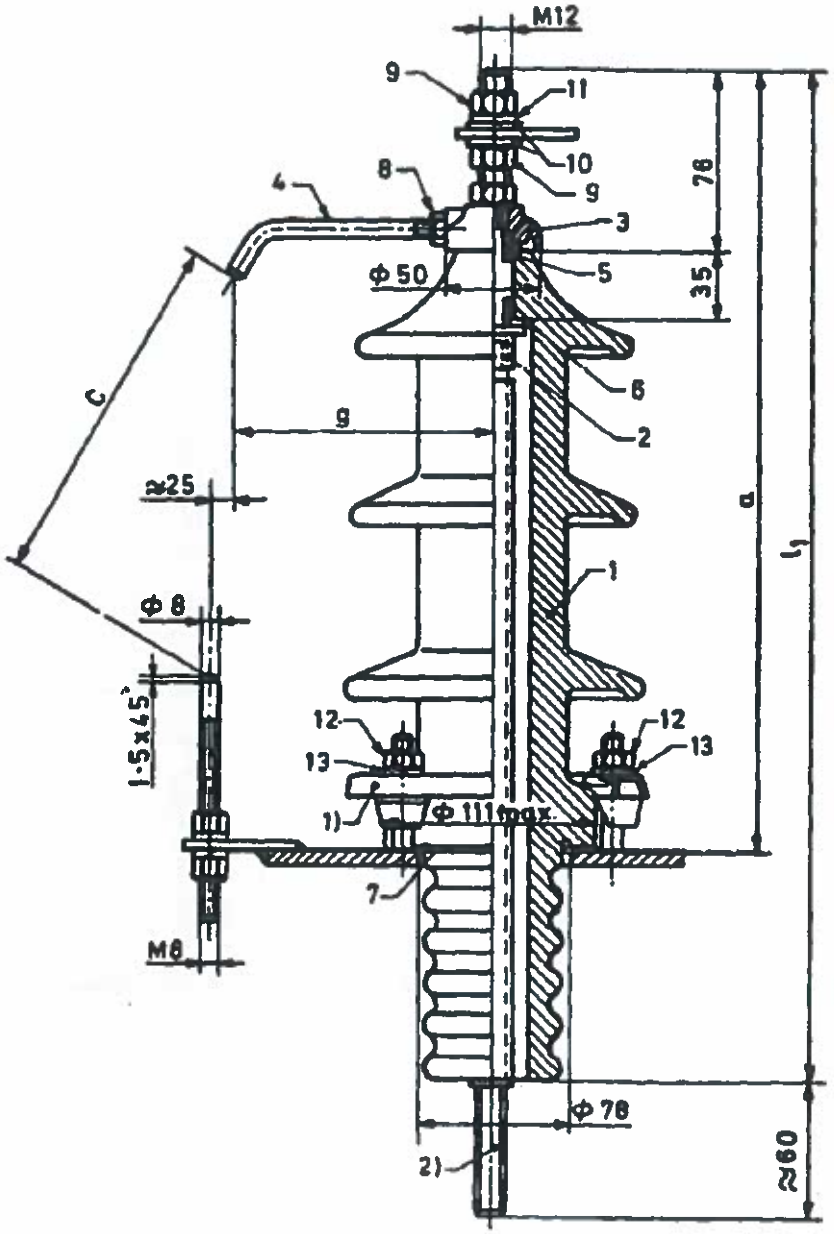


Table 14: Dimensions

Bushing rating	a	r	g	l_1
36 kV/250A	485	220	170	755

Fig. 6: Bushing Assembly for (For 36 kV/250A Rating) as per DIN 42531-33

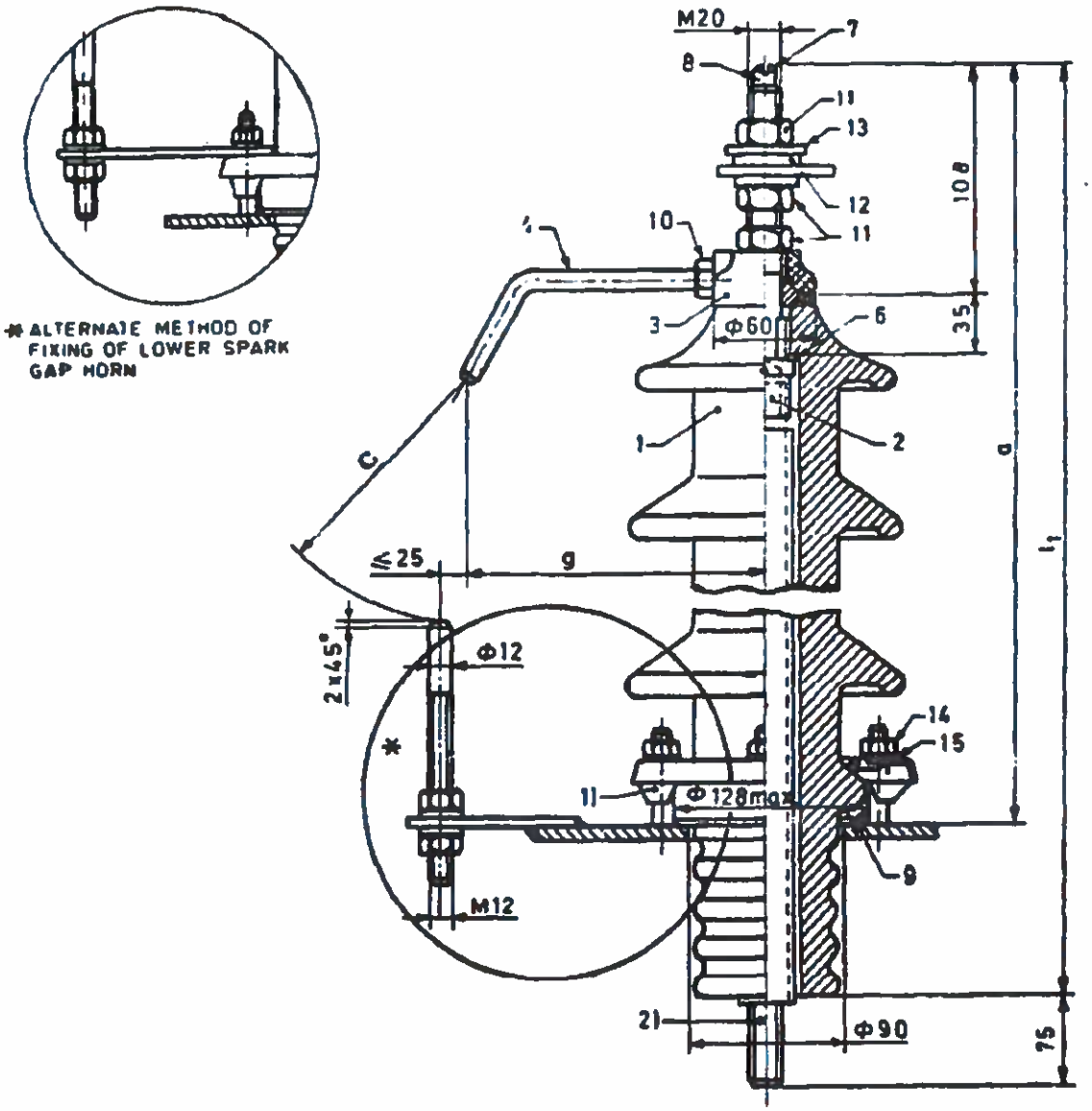


Table 15: Dimensions

Bushing rating	a	r	g	l_1
36 kV/630A	522	220	200	792

Fig. 6: Bushing Assembly for (For 36 kV/630A Rating) with copper stem as per DIN 42531-33

ANNEX C: LIST OF SUB CONTRACTOR

The supplier shall provide a list of critical raw materials and transformer accessories, names of sub-suppliers for the raw materials, their addresses, telephone numbers, email addresses, website addresses, and contact persons together with Type Test reports/certificates for individual materials including the test methods - international standards to which the materials and accessories are tested. The list shall be as per, but not limited to, Table 12.

Table 12: LIST OF SUB CONTRACTOR

S/N	Item		Type designation	Name of supplier	Place of manufacture	Place of testing inspection	Test method
1	Laminations/core material						
2	Winding materials	Aluminium wire					
		Enameled copper wire					
		Aluminium foil/strip					
		Copper foil/strip					
3	Insulated winding wires						
4	Mineral insulating oil						
5	Press boards						
6	Crepe paper						
7	Kraft paper						
8	MS plates, angles & channels						
9	Gaskets						
10	Bushings	HV					
		LV					
11	Paints						
12	Off load tap changer						
13	Lighting Arrestor						
14	Current transformer(where applicable)						
15	Pressure relief valve						
16	Oil level indicator						
17	Surge Arresters						
18	Surge Arresters mountings						

NOTE: *The successful bidder shall within thirty (30) days of placement of order submit the above information regarding list of materials as well as accessories, the names of sub –suppliers selected from those furnished along with the offer. Proof of purchase will ultimately be required.*