DOCUMENT NO: KP1/6C.1/13/TSP/10/001-03

Kenya Power

# Distribution Transformers-Part 3: Ground Mounted Three Phase Oil Type Distribution Transformer - Specification

## Table of Contents

## 0.1 Circulation List

| COPY NO. | COPY HOLDER |
|---|---|
| 1 | Standards Manager |
| 2 | Electronic copy (pdf) on KPLC server currently: http://172.16.1.40/dms/browse.php?fFolderId=23 |

## REVISION OF KPLC STANDARDS

To keep abreast of progress in the industry, KPLC Standards shall be regularly reviewed. Suggestions for improvements to approved Standards, addressed to the Manager, Standards department, are welcome.

## 0.2 Amendment Record

| Rev No. | Date (YYYY-MM-DD) | Description of Change | Prepared by (Name & Signature) | Approved by (Name & Signature) |
|---|---|---|---|---|
| Issue 3 Rev 1 | 2014-09-15 | Corrected arithmetic errors, parameters and reviewed component losses & Sound Power Levels as per BS EN 50464-1 | S. Kimitei | G. Owuor |
| Issue 4 Rev 0 | 2015-07-31 | -Cancels & replaces Issue 3, revision 1 and all previous issues | M. Apudo<br>N. Mungai<br>S. Nguli<br>S. Kimitei<br>J. Kinda<br>S. Machariah<br>G. Welimo<br>F. Omondi<br>H. Njenga<br>B. King'esi | Dr. Eng. Peter Kimemia |
| Issue 4 Rev 1 | 2015-09-02 | Cancels & replaces Issue 4, revision 0 and all previous issues | M. Apudo<br>J. Kinda<br>R. Ndolo<br>G. Korir<br>J. Kasimu<br>G. Welimo.<br>R. Siakama | Dr. Eng. Peter Kimemia |
| Issue 4 Rev 2 | 2019-11-25 | Cancels & replaces Issue 4, revision 1 and all previous issues | S. Nguli<br>N. Mungai<br>R. Ndolo<br>J.Kanampiu<br>S. Machariah<br>G. Welimo.<br>S. Theuri<br>B. Kinge'si<br>J. Ndirangu<br>M. Mwai | Dr. Eng. Peter Kimemia |
| | | | | |

## FOREWORD

This Specification has been prepared by the standard Department in collaboration with Network Management Division, both of The Kenya Power & Lighting Company Plc (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 distribution 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: 100 KVA, 200 KVA, 315 KVA, 630 KVA and 1000 KVA
- 33000/420V: 315 KVA, 630 KVA and 1000 KVA.

1.2. The Specification also covers inspection, tests and inspections 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 ground 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 use in KPLC distribution system.

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 |
| BS 381C: | Specification for colours 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 aluminium for electrical purposes. Wire

BS EN 755-6: Aluminium and aluminium 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; Final Rule.

Manual on Transformers – Publication No. 295 CBIP 2006.

## 3. TERMS AND DEFINITIONS

For the purpose of this Specification, 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 33kV volts
b) LV-Low Voltage at 420 volts

## 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 +30ºC with a minimum of -1ºC and max +40 ºC;

c) Humidity: up to 95%;

d) Pollution: Design pollution level to be taken as "*Very Heavy*" (Pollution level IV) 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). The rated fault current for 11,000 volts system is 31.5kA while for 33,000 volts system is 25kA.

4.1.2.2. The primary system is having a nominal voltage of 11,000 volts and 33,000 volts and system highest voltage of 12,000 volts and 36,000 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 transformer shall be outdoor, oil-immersed, of ONAN classification and core type windings designed, manufactured and tested in accordance with IEC 60076-1 and 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 a service(functional) life of at least twenty-five (25) years in line with the minimum insulation life of 180,000 h (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 either free breathing type or hermetically sealed type each with bolted top cover.

**a)** The hermetically sealed type completely filled system in which the expansion and contraction of the oil is taken up by movement of the permanently sealed, usually corrugated tank without exceeding the specified temperature rise as per clause 9.3 of IEC 60076-1:2011. All the active parts including tap-changer contacts and HV lead-outs completely

submerged in oil and a pressure relief device and oil gauge mounted on the LV side of the top cover without overextended pipe above the cover surface. 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.*

b) The free breathing type shall be provided with a conservator and cobalt free dehydrating breather. The conservator shall be in such a position as not to obstruct the electrical connections and shall constitute:

(i) Oil Level Indicator of the magnetic type fitted to the conservator tank to show the oil level at all temperatures likely to be experienced in service. It shall be marked with normal level at $30^0$C clearly visible from normal access level.

(ii) Feed valve and a moisture-removing breather fitted in the connection to the atmosphere. All valves shall be made of gunmetal and shall be of the sluice type having non-rising spindles and shall be closed by turning the hand wheel in a clock wise direction. Each valve shall be provided with an indicator to show clearly the position of the valve and also a name plate to indicate the purpose of the valve.

(iii) Oil seal type silica gel breather, mounted at a suitable height above ground level to ease maintenance.

4.2.5. The transformer and its component parts shall be able to carry loading beyond rated power under permissible loading given in 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 and shall be designed to facilitate operation, inspection, maintenance and repairs.

4.2.6. The transformer shall be designed to minimize the risk of accidental short-circuit caused by animals, birds or vermin. The manufacturer shall consider the safely 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 bushing insulators with their mountings, shall be designed to eliminate pockets of water. The top cover shall be inclined so that 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 including bushings 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 small 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 brass 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 noise 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 ground mounting on a concrete plinth. 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 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 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 a minimum of the following:

a) Overall dimensions of the transformer and relevant electrical clearances. This shall include all perspectives and respective
   (i) Weights 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
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, its mounting and constituent parts.
g) Detailed drawing of arcing horns where applicable.
h) Oil seal type silica gel breather.

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

### 4.3. Ratings

4.3.1. The transformers covered by this specification shall be of the following ratings:

(a) 11000/420V: 100 KVA, 200 KVA, 315 KVA, 630 KVA and 1000 KVA
(b) 33000/420V: 315 KVA, 630 KVA and 1000 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 hotspot 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 three (3) seconds. The design shall 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 600MVA and 1500MVA 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 three (3) 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, super enameled round copper wire as per IEC 60317-0-1 or shaped aluminium coil conforming to BS 2627 or superior quality. The winding 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 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. The winding shall be full coiling without segmenting.

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 confirmed through the relationship: Conductor area = Current per phase/Current density.

The characteristics of copper and aluminium required shall be as per IEC 60076-5 and Table 1:

**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 |
| Elongation, %, min | >30 | >25 |
| Density at 20 °C (kg/dm$^3$) | 8.91 | 2.703 |
| Maximum resistance at 20 °C (μΩ/m) | ≤0.01734 | ≤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 and IEC 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 (thermopox) 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 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.

**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.

**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 |

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 high 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 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 ration tap-switch shall be located at the transformer top cover with sufficient electrical clearance and well submerged in oil. The tap switch shaft shall be robust and sufficient height to enable the active linear contacts to be fully submerged in oil at all times. One transformer shall be opened to confirm compliance.

4.5.2.4. 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.

4.5.2.5. 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 and IEC 60512.

## 4.6. Core and Flux Density

### 4.6.1. Core

4.6.1.1. The core shall be made of 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.

**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 |
| **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 |

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

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 2.5kV, 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 1.7 Tesla at normal voltage, frequency & 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.

4.7.2. The sound power level as per NEMA TR-1, no-load losses and full load losses at 75°C (unity power factor) shall be as per Table 6:

**Table 5: Total Transformer Losses and short circuit impedance**

| | Rating KVA | TOTAL LOSSES (no-load + load losses) at 75°C, Watts | Short- circuit impedance % |
|---|---|---|---|
| 11/0.420kV Transformers | 100 | 1,395 | 4 |
| | 200 | 2,685 | |
| | 315 | 3,690 | |
| | 630 | 6,280 | |
| | 1000 | 9,940 | 6 |
| 33/0.420kV Transformers | 315 | 4,492 | 4 |
| | 630 | 7,800 | |
| | 1000 | 12,200 | 6 |

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

| | 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 | 100 | 51 | 145 | 1,250 | 1,395 |
| | 200 | 55 | 310 | 2,375 | 2,685 |
| | 315 | 56 | 440 | 3.250 | 3,690 |
| | 630 | 57 | 680 | 5,600 | 6,280 |
| | 1000 | 58 | 940 | 9,000 | 9,940 |
| 33/0.420kV Transformers | 315 | 56 | 672 | 3,820 | 4,492 |
| | 630 | 57 | 1,300 | 6,500 | 7,800 |
| | 1000 | 58 | 1,700 | 10,500 | 12,200 |

**NOTE:** *Tenderers 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 above 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.

**Table 7: Loss Capitalization**

| | |
|---|---|
| Total Load losses, ONAF 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 loss + dielectric loss) | US$ 4339 per kW for 25 years |

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

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. Cable box bushing design for 33kV class shall also be accepted. 11kV class bushing design shall be in a cable box as per clause 4.9.4. The bushings shall be manufactured and tested in accordance with IEC 60137 and DIN 42531. The 11kV and 33kV class HV bushing shall be fitted with adjustable arcing horns. The high voltage bushing shall be fitted with adjustable double-gap arcing horns set

at 2 X 25mm gaps for 11kV and 2 X 55mm gaps for 33kV set at the factory to withstand conditions stated in clause 4.1.

4.9.1.2. The HV bushings shall be made of either porcelain of grade C-110 ceramic material or equivalent complying to IEC 60627-3 or composite (polymeric) material made of high quality reinforced high temperature vulcanized (HTV) silicon rubber based on dimethyl siloxane, which exhibit hydrophobicity with the capability to transfer hydrophobicity to the layer of pollution.

4.9.1.3. 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. The top cover shall be designed such that the LV bushing base is raised to avoid any water seepage to the gasket.

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

4.9.1.5. 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 or cable box.

4.9.1.6. The specific creepage distance of bushings shall not be less than 31mm/kV based on the maximum phase to phase voltage.

4.9.1.7. Outdoor bushing terminal connectors shall be clamp type (bolted) connectors whereas cable box bushing terminal connectors shall be palm type of an approved design with M8 stainless steel bolts, nuts and washers (including a spring washer) and of the following sizes and materials as per Table 8.

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

4.9.1.9. The continuous current rating of each bushing shall not be less than 120% of the rated current of the transformer.

**Table 8: Terminal Connectors**

| Rating | HV Terminal Connector | | | |
|---|---|---|---|---|
| | Open/Outdoor design | | Closed/Cable box design | |
| | Connector type | Size of conductor | Connector type | Size of cable |
| 315 kVA<br>630 kVA<br>1000 kVA | Tinned brass (tin thickness of 150µm) - Groove bolted type | 50mm$^2$ All Aluminium Soft Drawn PVC conductor | Tinned brass (tin thickness of 25µm) - Four (4) hole bushing palms | 95mm$^2$ three (3) core XLPE cable for 11kV and 185mm$^2$ or 300mm$^2$ single core XLPE cables for 33kV complete with cable lugs |

## 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 in Table 9.

**Table 9: External Clearances in Air (As per IEC Standard 60076)**

| Nominal System Voltage between Phases Centers | | LV | 11kV | 33kV |
|---|---|---|---|---|
| *Minimum* clearance phase-to-earth and phase-to-neutral | mm | 80 | 150 | 380 |
| *Minimum* clearance phase-to-phase between phases of the same winding | mm | 80 | 150 | 380 |
| *Minimum* creepage distance | mm | 60 | 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 of intrusion of birds and other animals.*

4.10.2. **Internal air clearances**

4.10.2.1. Internal air clearances shall be as per Table 10:

**Table 10: Internal Air clearances**

| Description | | 11kV | 33kV |
|---|---|---|---|
| Minimum radial clearance of LV coil and core | mm | 3 | 3 |
| Minimum radial clearance of LV coil and earth | mm | 3 | 3 |
| Minimum radial clearance between LV and HV | mm | 8 | 20 |
| Minimum electrical clearance between the surface of the tank, tapping leads and edges of winding | mm | 15 | 30 |
| Minimum radial clearance between HV and HV windings | mm | 8 | 20 |

**4.11. Cable Boxes**

4.11.1. The 11/0.420kV class ground mounted distribution transformers shall have cables boxes on both HV and LV sides whereas 33/0.420kV class ground mounted distribution transformers shall have open-type bushing on HV side and cable box on LV side as per clause 4.8.1.

4.11.2. Requirements applicable to both LV and HV cable boxes:

a) The cable boxes shall be suitable for operating indoors or outdoors under conditions given in clause 4 of this specification. It shall be designed and tested in accordance with IEC 61439-3.
b) The medium voltage (11kV) and low voltage (0.42kV) cable boxes shall be mounted on opposite sides of the tank by bolting.
c) The design shall minimize the effects of eddy currents.
d) Cores of cables shall terminate within the cable box and shall be connected to terminals fixed therein.
e) The cable boxes shall be unfilled type.
f) The cable boxes shall be arranged for cables entering vertically from below.The bottom plate of the cable box shall have knock-outs for the size and number of cables specified.
g) Bushings shall be oil-tight.
h) Each HV and LV cable box shell shall be at least 3mm thick with minimum thickness of the cover plate and bushing plate of 3mm and 6mm respectively, and shall be made from the same steel grade as that of the transformer tank.

i) The minimum size of fixing studs or bolts for cable box shell, securing cover plate and for the hardwood cable cleat shall be M10. This shall be made of stainless steel

j) The cable boxes shall have gaskets of not less than 2mm thickness made of synthetic rubber or synthetic rubber bonded cork.

k) The construction shall be such that each cable box is effectively sealed against weather and insects. A 12mm diameter breathing hole covered with corrosion resistant stainless steel wire gauze shall be provided in the bottom of the cable box.

l) All internal surfaces of cable boxes shall be cleaned of all scale and rust by shot blasting or other approved method. The internal surfaces of the boxes and their covers shall, after cleaning, be given a priming coat and one coat of air drying anti-condensation paint.

### 4.11.3. LV (0.42kV) cable boxes

The cable box shall be designed, manufactured and tested in accordance with IEC 61439-3 and shall have the following characteristics:

a) The LV (0.420kV) cable boxes shall be in two sizes:

(i) For 100 – 315KVA transformers - LV cable box for four (4) cables – A four pole cable box for use with four (4) single core cables.

(ii) For 630KVA and 1000KVA transformers - LV cable box for seven (7) cables – A four (4) pole cable box for use with seven (7) single core cables.

**NOTE:** *The bushing stem (copper bar) shall have holes adequate for the number and size of cables specified.*

b) The LV cable box all be suitable for terminating:

(i) For 630 kVA and 1000KVA transformers - Up to seven (7) single core 630mm$^2$ aluminium PVC cables (two per phase and one for neutral);

(ii) For 100-315 kVA transformers – Up to four (4) single core 300mm$^2$ aluminium PVC cables (one per phase and neutral).

c) Bushing stems for LV (0.42kV) cable box shall be made from hard-drawn high conductivity copper bar. The copper bar shall be at least 63mm x12.5mm in dimensions with fully radiused corners. The entire outer ends of the bushing stem shall be hot dipped tinned with

a minimum tin thickness of 150µm. Both ends of the bushing stem shall be clean and free from resin (where resin is used) for the entire length from 3mm clear of the moulding.

d) The LV neutral bushing of the transformer shall be identical to the corresponding LV phase terminal bushings and bushing conductor (copper bar).

4.11.4. **HV (11kV) cable boxes.**

4.11.4.1. The HV cable box (11kV) shall conform to IEC 61439-3 requirements and shall be suitable for three (3) core HV cables up to 95mm$^2$ in size.

4.11.4.2. The HV cable box shall have the following additional features:

(i) It shall be suitable for heat/cold shrink terminations;
(ii) The bushing rod (conductor) shall be high conductivity copper alloy hot dip tinned with a minimum tin thickness of 150µm and at least 12mm hole diameter;
(iii)The termination shall be suitable for cable sockets (lugs) and three (3) core copper or aluminium XLPE insulated, armoured cables.

4.11.5. The 33kV bushings shall be either as per clause 4.8.1 or shall be designed in a cable box with clearances as per Table 9. The cable box shall have same requirements as per clause 4.9.1 and shall conform to IEC 61439-3 requirements.

4.11.6. Distances between centres of low voltage bushings shall be as follows:

a) For currents up to 250A: 80mm
b) For currents above 250A and up to 2000A: 175mm
c) For currents above 2000A: 190mm

**4.12. Insulation Levels**

4.12.1. 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) |
| 0.420 | 1.1 | - | 3 |
| 11 | 12 | 95 | 38 |
| 33 | 36 | 200 | 95 |

**NOTE**:

1) *The insulation levels specified are for the internal insulation as per IEC 60076 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.*

### 4.13. Transformer Tank and Tank Cover

4.13.1. The tank shall be bolted top cover type constructed of tested steel plates conforming to EN 10025 and shall have sufficient thickness and strength. The tank shall be complete with specified accessories and fittings. It shall be designed so as to allow the complete transformer when filled with oil to be lifted by means of lifting lugs, transported by road, rail or on water without overstraining any joints and without causing subsequent leakage of oil. The minimum thickness of the top cover, bottom and sides of the transformer tank shall be 5mm, 5mm and 3.15mm respectively.

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

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

4.13.3. 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.

4.13.4. 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 be heavy duty type made of suitable grade of steel plate of at 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).

4.13.5. 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.

4.13.6. 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.

4.13.7. The top cover bolts shall include at least four (4) non-standard bolts of dome shaped head with non-standard profile and that can't 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.

4.13.8. 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 strip 25mmx1.2mm and shall be secured by stainless steel bolt & nut.

## 4.14. Paint Work

4.14.1. 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.

4.14.2. 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.

4.14.3. 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 of the transformer tank and oil filled chambers. The manufacturer shall demonstrate this for inside of radiators and pipe connections.

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

4.14.5. 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.

### 4.15. Transformer Oil

4.15.1. 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.

4.15.2. 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 - KP1/3CB/08/001 (Shall be attached during tender).

### 4.16. Surge Arresters

4.16.1. Each transformer shall be complete with surge arresters mounted on brackets (one number per phase) fitted under the HV bushings with Galvanized iron earth strip of at least 50mm x 6mm connected to the body of the transformer with necessary fixing arrangements suitable to allow for physical disconnection of operated surge arrester.

4.16.2. The fixing arrangement for the surge arresters shall be 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.

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

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

### 4.17. Fittings and Accessories

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

a) **Pressure relief device**:

(i) An approved pressure relieve device of suitable size shall be mounted on the top cover steel tubing (with a skirt to protrude at least 2.5mm into 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 any internally generated pressure.

(iii) It shall not protrude too high from the top cover level.

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 of the transformer tank.

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**

There shall be 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 ±2x2.5%. The tapping method shall be as per clause 4.5.2.

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 HV bushings.

4.17.2. 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 fittings and accessories.

4.17.3. 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.

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

## 5. MARKING, LABELLING AND PACKING

5.1. 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.

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

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

5.4. 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.

5.5. 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 AND LIGHTING CO. PLC'** all marked indelibly and legibly as in 6.4.

## APPENDICES

### APPENDIX A: TESTS AND INSPECTION (NORMATIVE)

A.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.

A.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:

- Dielectric tests to IEC 60076-3 (Lightning Impulse Withstand Voltage Test).
- Short circuit withstand test to IEC 60076-5.
- Temperature rise test to IEC 60076-2.
- 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 ground 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 at least five (5) years.*

**NOTE:** *Temperature rise test to IEC 60076 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.*

**NOTE:** *Upon successful bid, the supplier shall conduct Type Test and routine test on one unit of each rating at independent Third Party Laboratory accredited to ISO 17025 and be witnessed by KPLC engineers. Upon successful tests, KPLC will issue clearance to manufacture.*

A.3. The supplier shall give advance intimation to Supply Chain Manager, Procurement to organize for stage inspections for raw materials, core assembly, winding, oil. Manufacturer shall furnish raw materials test certificates as well as documentary proof of purchase and payment of relevant taxes/duty. The inspection may be carried out at any stage of manufacture. The stage inspection shall not relieve the manufacturer from the responsibility of full compliance to the specification or rejection from non-compliance.

A.4. 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:

A.4.1. **Routine tests to IEC 60076 (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 test 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.

A.4.2 **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.

A.4.3 **Additional tests (to be done on samples during acceptance testing at factory)**

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

A.5. Acceptance criteria shall include untanking one unit of each size to verify compliance with specifications.

A.6. 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.

A.7. Complete Test Reports for each transformer (including its individual components) shall be submitted to KPLC for approval before shipment.

A.8. 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.

## APPENDIX B: QUALITY MANAGEMENT SYSTEM (NORMATIVE)

B.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: 2015.

B.2. The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2015 certificate shall be submitted with the tender for evaluation.

B.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 (4) customer reference letters shall be submitted with the tender for evaluation.

## APPENDIX C: TECHNICAL DOCUMENTATION (NORMATIVE)

C.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 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: 2015 certificate and other technical documents required in the tender.

C.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 fulfil the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfil the requirements of ISO 9001: 2015;
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 standards/specification, good workmanship and good engineering practice in the manufacture of the transformers for The Kenya Power and Lighting Company Plc;

g) Packaging details (including packaging materials and marking and identification of component packages).

C.3. The supplier/manufacturer shall submit a full list of all their vendors of critical raw materials (e.g. laminations, wires, insulation materials, tanks, surge diverters, oil, bushings, rods, connectors etc.) together with their associated type test certificates from accredited laboratories to be vetted during evaluation. The successful bidder shall submit the same for approval before manufacture.

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

----------***This Space is left blank***----------

## APPENDIX D: SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS (GTPS) (NORMATIVE)

*(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 testing laboratory for tender evaluation, all in English Language)*

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

| Clause Number | Description (*Indicate KVA and Voltage ratings in the columns on the right*) | BIDDER'S OFFER | | | | |
|---|---|---|---|---|---|---|
| | | 100 KVA | 200 KVA | 315 KVA | 630 KVA | 1000 KVA |
| - | Name and address of the Manufacturer | | | | | |
| | Country of manufacture | | | | | |
| | Manufacturer's Letter of Authorization | | | | | |
| | Model/Type Reference No. of the offered transformer | | | | | |
| | Manufacturer's warranty and guarantee for the offered transformer | | | | | |
| 1. | Scope: a) Design, manufacture, test, ship and deliver ground-mounted single phase distribution transformer to KPLC store/site as per specification and terms of contract.<br>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 The Kenya Power & Lighting Company Ltd | | | | | |
| 2 | Applicable Standards | | | | | |
| 3 | Terms and Definitions | | | | | |
| 4.1.1 | Operating Service Conditions *(Include altitude, temperature range, humidity, pollution and isokeraunic level)* | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4.1.2.1 to 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 | Type of transformer offered | | | | | |
| 4.2.4.1 | Hermetically sealed, with allowance 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 and 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 small openings that do not allow oil siphoning | | | | | |
| 4.2.10 | Test certificate 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 values of maximum noise level (NEMA TR.1) | | | | | |
| 4.2.14 | Transport to withstand 1g beyond gravitational acceleration | | | | | |
| 4.2.15 | Suitable for ground 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: | | | | | | |
| | a) Weight of oil | | | | | | |
| | b) Weight of LV winding conductor | | | | | | |
| | c) Weight of HV winding conductor | | | | | | |
| | d) Core material | | | | | | |
| | e) Copper/aluminium winding material | | | | | | |
| | f) Insulating material | | | | | | |
| | g) 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 drawings of bushings, tap-changer and clamps | | | | | | |
| | Legend tor all technical engineering drawings with manufacturers name, logo, model number, revision/drawing number and key | | | | | | |
| | Detailed drawing of arcing horns | | | | | | |
| | All design drawings MUST BE stamped and signed by the manufacturer's authorized personnel | | | | | | |
| 4.3 | Ratings | | | | | | |
| 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 $\theta_1$ 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) | | | | | |
| | Thermal time constant in hours | | | | | |
| 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 ability of 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 winding | | | | | | |
| 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$^0$C (J/kg.$^0$C) | | | | | |
| | | Density at 100$^0$C (kg/m$^3$) | | | | | |
| | | Resistivity at 100$^0$C ($\mu\Omega$.m) | | | | | |
| | Aluminium | Standard of manufacture | | | | | |
| | | Type designation or grade | | | | | |
| | | Specific heat at 100$^0$C (J/kg.$^0$C) | | | | | |
| | | Density at 100$^0$C (kg/m$^3$) | | | | | |
| | | Resistivity at 100$^0$C ($\mu\Omega$.m) | | | | | |
| | Characteristics of copper and aluminum foil/strip | | | | | | |
| | Copper | Standard of manufacture | | | | | |
| | | Type designation or grade | | | | | |
| | | Ultimate tensile strength, N/mm$^2$ | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Density at $20^0$C (kg/dm$^3$) | | | | | |
| | | Elongation, %, min | | | | | |
| | | Maximum resistance at 200CX, $\Omega mm^2/m$ | | | | | |
| | Aluminium | Standard of manufacture | | | | | |
| | | Type designation or grade | | | | | |
| | | Ultimate tensile strength, N/mm$^2$ | | | | | |
| | | Density at $20^0$C (kg/dm$^3$) | | | | | |
| | | Elongation, %, min | | | | | |
| | | Maximum resistance at $20^0$C, $\Omega mm^2/m$ | | | | | |
| 4.4.3 | **Insulating materials** | | | | | | |
| 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 | | | | |
| | Press paper-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 | | | | |
| | Kraft paper/Cellulosic 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 | | | | | | |
| | | LV winding | | | | | |
| 4.5 | **Tapping** | | | | | | |
| 4..5.1 | Tapping range | | | | | | |
| 4.5.2 | Tapping method and design | | | | | | |
| 4.5.2.1 | Tap changer (ration tap-switch) | Standard of manufacture | | | | | |
| | | Type designation or grade | | | | | |
| | | Mode of operation | | | | | |
| | | Shank diameter | | | | | |
| | | Height of ratio tap-switch | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4.5.2.3 | Tap switch position no. 1orientation | | | | | |
| 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 (indicate designed 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 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 | | | | | |
| 4.6.2.3 | Allowable maximum flux density for one minute and for five seconds | | | | | |
| 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 Voltage, % | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 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 50% load (unity power factor), at 75°C | | | | | |
| | Total losses (no-load + load losses) at 50% 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 at 75°C | | | | | |
| | Total losses at minimum tap at 75°C | | | | | |
| 4.7.2 | Sound power level | | | | | |
| 4.7.3 | No-load and Load Losses shall be submitted with 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 | HV bushings complete with surge diverters, brackets and arcing horns. Specify | | | | | |
| 4.8.1.5 | LV bushings shall be two part, bottom in toughened epoxy and top in porcelain, brown | | | | | |
| | HV & LV bushings on top cover | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4.8.1.6 | LV neutral identical to LV phase terminal bushing | | | | | | |
| 4.8.1.7 | Spacing & clearances | | | | | | |
| 4.8.1.8 | Creepage distance of bushings: HV, LV, N | | | | | | |
| 4.8.1.9 | Clamp type bushing terminals for aluminium 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 at each bushing | | | | | | |
| 4.8.2 | Clearances | | - | - | - | | - |
| 4.8.2.1 | External Air Clearances | | | | | | |
| 4.8.2.1.1 | Adequate to withstand impulse test voltages | | | | | | |
| 4.8.2.1.2 | Position of fittings and accessories not to interfere with external connections to bushing terminals | | | | | | |
| 4.8.2.1.3 | Minimum External clearances | | | | | | |
| | 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 (cable box) | Phase to phase | | | | | |
| | | Phase to earth | | | | | |
| | | Creepage distance | | | | | |
| 4.8.2.1.3 | 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 | | | | | | |
| 4.11 | Cable Boxes | | | | | | |
| 4.11.1 | Cable boxes | 11/0.42kV | | | | | |
| | | 33/0.42kV | | | | | |
| 4.11.2 | Requirements applicable to both HV and LV cable boxes | | | | | | |
| 4.11.3 | Requirements applicable to LV (0.42kV) cable boxes | | | | | | |
| 4.11.4 | Requirements applicable to HV (11kV) cable boxes | | | | | | |
| 4.11.5 | 33kV bushings shall be either open outdoor or cable box design | | | | | | |
| 4.11.6 | Distance between centers of low voltage bushings | | | | | | |
| | For currents up to 250A | | | | | | |
| | For currents above 250A and up to 2000A | | | | | | |
| | For currents above 2000A | | | | | | |
| 4.12 | Insulation Levels (internal) | | | | | | |
| | 11kV: Lightning impulse and power frequency withstand voltage | | | | | | |
| | 33kV: Lightning impulse and power frequency withstand voltage | | | | | | |
| | External insulation level and altitude correction (indicate offered insulation and altitude correction applied) | | | | | | |
| 4.13 | Transformer Tank & Tank Cover | | | | | | |
| 4.13.1 | Bolted top cover design | | | | | | |
| | Minimum thickness of top cover, bottom and sides of offered transformer respectively | | | | | | |
| 4.13.2 | Inside clearance | | | | | | |
| 4.13.3 | Pressure test of tank and test report during delivery | | | | | | |
| 4.13.4 | Lifting lugs and factor of safety | | | | | | |
| 4.13.5 | Steel radiators/corrugations | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4.13.6 | Top cover design, non-accumulation of water, gasket | | | | | | |
| 4.13.7 | Non-standard bolts and nuts | | | | | | |
| 4.14 | Paint Work | - | - | - | | - | |
| 4.14.1 | Method of cleaning before painting | | | | | | |
| 4.14.2 | Final colour of exterior surfaces and paint thickness | | | | | | |
| 4.14.3 | Cleaning and painting of interior of tank and other oil filled chambers | | | | | | |
| 4.14.4 | Degreasing & treatment of radiators with anti-rust inhibitor | | | | | | |
| 4.14.5 | Final colour of exterior of radiators & paint thickness | | | | | | |
| 4.15.1 | Fittings and Accessories | | | | | | |
| 4.15.1 (a) | Pressure at which pressure relieve device operates | | | | | | |
| 4.15.1 (b) | Pressure Relief Device & location | | | | | | |
| 4.15.1 (b) | Oil Level Gauge & location | | | | | | |
| 4.15.1 (c) | Earthing Terminals: location & to have stainless steel bolts, nuts and washers | | | | | | |
| 4.15.1 (d) | Separate Lifting lugs for core, top cover & complete transformer | | | | | | |
| 4.15.1 (e) | Off-circuit tap changer & location | | | | | | |
| 4.15.1 (f) | Tinned copper jumper size and materials | | | | | | |
| 4.15.1 (g) | Rating and diagram plate | | | | | | |
| 4.15.1 (h) | Clamp Connectors | | | | | | |
| 4.15.1 (i) | Jacking lugs | | | | | | |
| 4.15.1 (j) | Combined drain plug and sampling device | | | | | | |
| 4.15.1 ( k) | Surge arrester mounting brackets — Mounting brackets dimensions | | | | | | |
| | Surge arrester mounting brackets — Universal type | | | | | | |
| | Surge arrester mounting brackets — Galvanized to ISO 1461 | | | | | | |
| 4.15.1 ( l) | Arcing Horns provided on HV bushings | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4.15.2 | Features to deter oil vandalism | | | | | |
| 4.15.3 | Detailed drawings | | | | | |
| 4.15.4 | Transformer mounting rail at bottom | | | | | |
| 4.16 | Transformer Oil-Technical particulars shall be as per KP1/6C.1/13/TSP/08/001 | - | - | - | | - |
| 4.17 | Surge Arresters technical particulars shall be as per KP1/6C.1/13/TSP/11/32 | | | | | |
| 5 | Marking, Labeling & Packing | - | - | - | | - |
| 5.1 | Packing: mounted & bolted on wood base blocks | | | | | |
| 5.2 | Dispatch fully assembled and oil filled and complete with surge arrester mounting brackets | | | | | |
| 5.3 | Assemble & package of items suitably marked | | | | | |
| 5.4 | Permanent rating and Diagram plate indelibly marked (by etching, engraving or stamping) | | | | | |
| 5.5 | Content of marking | | | | | |
| Appendix A | Tests and Inspection | - | - | - | | - |
| A.1 | Test Standard | | | | | |
| | Responsibility of testing transformer & manufacturer's capability to carry out specified tests | | | | | |
| A.2 | Copies of type test reports to IEC 60076 | | | | | |
| | Lightning impulse withstand test | | | | | |
| | Short circuit withstand test | | | | | |
| | Temperature rise test | | | | | |
| A.3 | Acceptance tests at manufacturers premises | | | | | |
| A.3.1 | Routine tests to IEC 60076 | | | | | |
| A.3.2 | Copies of Type tests to IEC 60076 | | | | | |
| | Short circuit withstand test | | | | | |
| | Temperature rise test | | | | | |
| | Lightning impulse withstand test | | | | | |
| | No load loss and current at 90% and 110% rated voltage | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| A.3.3 | Additional tests (sample test) | | | | | |
| | Sampling as per IEC 60410 | | | | | |
| A.4 | Contact details for testing authority | | | | | |
| A.5 | Complete test reports for approval before shipment | | | | | |
| A.6 | Inspection or test by Kenya Power during delivery before acceptance to stores | | | | | |
| | Marking, Labeling & Packing | | | | | |
| Appendix B | Quality Management System | | | | | |
| B.1 | Quality Assurance Plan to be based on ISO 9001:2015 | | | | | |
| B.2 | Declaration of conformity to IEC 60076 | | | | | |
| | Copy of ISO 9001:2015 certificate submitted | | | | | |
| Appendix C | Documentation | | | | | |
| C.1 | Tender submitted with all technical documents | | | | | |
| C.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 windings (without insulation), kg | | | | | |
| | Weight of insulation, kg | | | | | |
| | Conductor area in $cm^2$, indicate for HV and LV windings | | | | | |
| | Current density in Amps/$cm^2$, indicate for HV and LV windings | | | | | |
| | Customer reference list and four reference letters | | | | | |
| | Manufacturer's experience | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Manufacturer's capacity (number of units per month) | | | | | |
| | Manufacturer's warranty and guarantee | | | | | |
| | 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) | | | | | |

.....

**Manufacturer's Name, Signature, Stamp and Date**