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0.1 Circulation List

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0.2 Amendment Record

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)

FOREWORD

This specification has been prepared by the Standards Department in collaboration with The Design Optimization Committee both of The Kenya Power & Lighting Company Ltd (abbreviated as KPLC) and it lays down requirements for pole mounted single phase oil type distribution transformers for 19.1kV Single Wire Earth Return (SWER) system derived from 33kV & 11kV 50Hz systems. 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

This specification is for newly manufactured oil-immersed, air-cooled, outdoor type pole mounted distribution transformers for Single Wire Earth Return (SWER) system operated at 19.1kV 50 Hz, with dual phase LV.

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

Voltage Ratio: **19100V/240-0-240V**
KVA Ratings: **5KVA, 10KVA, 16KVA, 20KVA and 25KVA.**

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

The specification stipulates the minimum requirements (including features to deter vandalism) for pole mounted single phase distribution transformers acceptable for use in the company (KPLC) and it shall be the responsibility of the 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.

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: Power transformers, ***all parts***

IEC 60038: IEC Standard Voltages

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

BS 381C: Specification for colours for identification coding and special purposes

3. TERMS AND DEFINITIONS

The terms and definitions given in the reference standards shall apply.

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: upto 2,200 metres 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) according to IEC 815.

(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).

4.1.2.2 The 19.1kV single wire earth return system will be derived from 33kV 50Hz three phase system through isolating transformer (step down transformer) or from 11kV 50Hz three phase system through isolating transformer (step up transformer).

4.1.2.3 The primary system is single wire earth return and the secondary is dual phase 240-0-240 volts 2-wire system. The target voltage at the consumer terminals is 230V±6% 50Hz single phase and 460V±6% 50Hz dual phase.

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

4.2 General Requirements

4.2.1 The transformer shall be outdoor, oil-immersed, of ONAN classification and core type or shell type (lamination stackings / wound core). All offers shall comply with the requirements of IEC 60076. Any deviations /additional requirements shall be as stated in this specification.

4.2.2 The transformer shall be designed for a service life of twenty five years.

4.2.3 The transformer shall be a two winding integral unit with dual phase on LV.

4.2.4 The transformer shall be hermetically sealed type with gas cushion of 60mm filled with dry air and bolted top cover.

4.2.5 The transformer and accessories shall be designed to facilitate operation, inspection, maintenance and repairs. All apparatus shall be designed to ensure satisfactory operation under such sudden variations of load and voltage as may be met with under working conditions on the system, including those due to short circuits.

4.2.6 The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the equipment keeping in view the regulatory requirements in Kenya.

4.2.7 All materials used shall be new and of the best quality and of the class most suitable for working under the conditions specified and shall withstand the variations of

temperatures and atmospheric conditions arising under working conditions without undue distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.

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 small openings that do not allow for oil siphoning.

4.2.10 All parts of the transformer, including bushings insulators with their mountings, shall be designed so as to avoid pockets in which water can collect. Rain water shall not collect anywhere on the top cover and the gasket shall be concealed by overlap between top cover and the tank flange.

4.2.11 All connections and contacts shall be of ample section and surface for carrying continuously the specified currents without undue heating and fixed connections shall be secured by bolts or set screws of ample size, adequately locked. Lock nuts shall be used on stud connections carrying current. All leads from the winding to the terminals and bushings shall be adequately supported to prevent injury from vibration including a systematical pull under short circuit conditions.

4.2.12 The transformer shall be designed to minimize the risk or accidental short-circuit caused by animals, birds or vermin.

4.2.13 The design and all materials and processes used in the manufacture of the transformer, shall be such as to reduce to a minimum the risk of the development of acidity in the oil.

4.2.14 Every care shall be taken to ensure that the design and manufacture of the transformers shall be such as to have minimum noise and vibration levels following good modern manufacturing practices. The maximum noise levels shall be in accordance to NEMA Tr.1 standards and guaranteed values shall be stated in the bid.

4.2.15 Each transformer shall be suitable for single pole mounting. It shall be round tank design complete with pole mounting brackets for use on round concrete and wooden poles. It shall be supplied complete with pole mounting bracket, fasteners and accessories as per Drawing No. TSP/10/001-01.

4.2.16 Drawings and documentation for each size of transformer offered shall be submitted with the tender, clearly detailing important dimensions, 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 technical specifications 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 weights of oil, core steel, winding (copper/aluminium), paper and steel tank/core clamp structure.
b) Core/coil/insulation dimensions, clearances 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) All design drawings MUST BE stamped and signed by the manufacturer.

4.3 Ratings

4.3.1 The transformers shall be of the following ratings:

Voltage Ratio: **19100V/240-0-240V**
KVA Ratings: **5KVA, 10KVA, 16KVA, 20KVA and 25KVA.**

4.3.2 (a) The transformer shall be capable of carrying its full normal rating continuously at any tap under the conditions stated in clause 4.1 without undue stress, overheating, or the temperature rise in the hottest region exceeding 55°C and 60°C in oil and windings respectively.

(b) The loading capabilities shall be demonstrated by a temperature rise test. This test shall be done in the presence of KPLC 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 2 seconds. The design should cater for the expected lifetime of the transformer. As a minimum, the short-circuit apparent power of the SWER system shall be taken as 500MVA (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.

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. The duration of the current to be used for the calculation of the thermal ability to withstand short circuit shall be 2 seconds as per IEC 60076-5.

4.3.5 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 tender for evaluation.

4.4 Winding and Connections

4.4.1 The transformer shall be capable of operation without danger on any particular tapping at the rated KVA when the voltage may vary by + 15% and -5% of the voltage corresponding to the tapping.

4.4.2 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.

4.4.3 The primary windings shall be of full coil copper or aluminium wires as opposed to segmented winding and the secondary windings shall be coil or strip or foil of copper or strip/foil of aluminium. The wire shall be enameled /paper insulated (double layer insulation). The temperature class of insulation shall be >105°C.

4.4.4 The HV and LV windings shall be separated so as to allow for cooling and ease of repair. Insulating sleeves for the transformer tappings shall be in crepe paper and inter layer insulation shall be in kraft paper.

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

4.4.6 All windings after being wound and all fibrous hygroscopic materials used in the construction of the transformer shall be dried under vacuum and impregnated with hot oil.

4.4.7 The radial spacer blocks where used shall be made of pre-compressed pressboard material, which will not soften while in contact with oil or fray out into fibers or

edges. The slots should be so dimensioned that the blocks will not come out of the slots.

4.4.8 All joints shall be brazed/crimped considering the vibrations due to short circuits and load fluctuations.

4.4.9 The transformer core and all electrical parts inside the transformer shall be sufficiently submerged in oil by no less than 60mm from the minimum oil level mark.

4.4.10 KPLC may inspect built-up winding for its quality, weight of copper or aluminium, insulation 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.

4.4.11 The current density in LV and 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.

4.4.12 The characteristics of copper and aluminium required shall be as per IEC 60076-5 and the following table:

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

Note: the properties of the material to be declared in the Guaranteed Technical Particulars shall be at 100 °C as indicated in above Table as per IEC 60076-5. No other reference shall be accepted.

4.5 Tapping

4.5.1 Tapping Range

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

4.5.2. Tapping Method

Tapping shall be carried out by means of an off-load tap changer.

The switch shall be located at the transformer top cover with sufficient electrical clearance and well submerged in oil. Switch position No. 1 shall correspond to highest voltage on the HV side

Tap switch shall be designed in such a way oil will not come out after removal / forceful breakage of Tap switch handle.

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 & IEC 60512.

4.6 Core and Flux Density

4.6.1 Core

4.6.1.1 The core shall be constructed from high grade cold rolled non-aging, grain oriented silicon steel of maximum thickness of 0.27mm OR superior grade core steels of proven design suitable for transformer core. The grade/type of core material to be used in the manufacture of the transformers for The Kenya Power & Lighting Company shall be stated in the bid.

4.6.1.2 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.

4.6.1.3 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 finall assembled core is free from distortion.

4.6.1.4 Adequate cooling shall be provided for the core.

4.6.1.5 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.

4.6.1.6 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.

4.6.1.7 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.

4.6.1.8 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.

4.6.1.9 The insulation structure for the core to bolts and core to clamp plate shall be such as to withstand a voltage of at least 2kV 50Hz for one minute.

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 & ratio. 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 well as flux density at +15% over-voltages.

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 successful tenderer shall be required to furnish magnetization curve of the core material, design calculations and such other data/documents deemed fit by KPLC for being satisfied that flux density is as desired.

4.7 Short Circuit Impedance

The short circuit impedance measured at the principal tap shall not be less than the values indicated in the following table:

	Rating	Short Circuit Impedance, minimum
19100V/240-0-240V Distribution Transformers	5KVA	4%
	10KVA	4%
	16KVA	4%
	20KVA	4%
	25KVA	4%

4.8 Efficiency and Losses

4.8.1 The minimum efficiency at 50% and 100% of nameplate-rated load shall be stated by the manufacturer in the Guaranteed Technical Particulars.

4.8.2 The sum total of the transformer losses, measured at full load operation, unity power factor and rated voltage shall not exceed values indicated in the table below. Measured values of the no-load losses and full load losses shall be adjusted to 75 degree Celsius.

	Rating	TOTAL LOSSES (No-load + Load Losses) at 100% load, 75°C
19100V/240-0-240V Distribution Transformers	5KVA	135W
	10KVA	200W
	16KVA	310W
	20KVA	350W
	25KVA	436W

4.8.3 No-load, Load Losses and stray losses shall be submitted in the tender and shall be treated as maximum values. Any increase in these values after tender award, at the time of factory acceptance testing and during inspection and acceptance to stores shall not be accepted.

4.9 Bushings and Clearances

4.9.1 The windings shall be brought out separately through open type bushings of outdoor, weatherproof design in accordance with IEC 60137.

4.9.2 The bushings shall be constructed, arranged and fitted in such a manner as to be changed without opening the transformer.

4.9.3 All bushings HV & LV shall be of two part bushing type. The bottom portion shall be made with toughened epoxy insulator material and the top portion made of porcelain material, brown in colour.

4.9.4 The location of the bushings shall be as per the general arrangement drawings.

4.9.5 The LV neutral bushing of the transformer shall be identical to the corresponding LV phase terminal bushings. The connection to earth on both primary and secondary sides shall be marked in such a manner so as to be distinguishable from the phase bushings.

4.9.6 Spacing and air clearances shall be so co-ordinated that there shall be no flashover from the terminal of one winding to the terminal of another winding.

4.9.7 Creepage distance of bushings shall not be less than 25mm/kV, based on the maximum phase to phase voltage.

4.9.8 Bushing terminals shall be clamp type suitable for aluminium conductors.

The terminal connectors shall be clamp type connectors with M8 stainless steel fasteners/hardware of the following sizes and materials:

HV		LV	
Material	**Size of conductor**	**Material**	**Size of conductor**
Brass	25-50mm² ACSR	Aluminium Alloy electrotinned	1x50mm² AAC

4.9.9 The terminals shall be clearly marked on the transformer body so as to indicate the polarity on both HV and LV windings as HV1 and HV2 for high voltage side and LV1, 0 and LV2 for low voltage side.

4.9.10 Air Clearance

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

4.9.10.2 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.

4.9.10.3 Minimum external air clearances (with terminal clamps fitted) shall be as shown under.

Nominal System Voltage between Phases		LV	19.1kV
Minimum clearance phase-to-earth and phase-to-neutral	mm	80	270
Minimum clearance phase-to-phase between phases of the same winding	mm	80	270
Minimum clearance between a line terminal of the high voltage winding and a line terminal of a lower voltage winding	mm	N/A	270
Minimum Creepage distance	mm	60	520

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.

4.9.10 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 and shall be secured by stainless steel bolt & nut.

4.10 Insulation Levels

The complete transformer arranged for service, shall be capable of withstanding the following test voltages and shall comply fully with the requirements of IEC 60076-3.

Nominal system voltage **(kV, rms)**	Highest voltage for equipment **(kV, rms)**	Test Voltages		
		Full Wave Lightning Impulse withstand voltage, positive **(kV, peak)**	Chopped Wave Lightning Impulse withstand voltage **(kV, peak)**	Power frequency withstand voltage **(kV, rms)**
LV	1.1	-	-	3
19.1	24	145	160	50

4.11. Transformer Tank and Tank Cover

4.11.1 The tank shall be bolted top cover type constructed of tested mild steel plates of sufficient thickness and strength and 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 3mm.

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

4.11.2 The internal clearance of tank shall be such that it shall facilitate easy lifting of core with windings from the tank. Inside of the tank shall be painted with varnish/hot oil resistant paint.

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

4.11.4 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 of mild steel plate at least 6mm thick suitably reinforced with a factor of safety of at least 2 (based on weight of complete transformer filled with oil). Separate lifting lugs shall be provided for top cover and core assembly.

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

4.11.6 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.

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. The required key/tool for opening the special bolts shall be provided to KPLC during delivery.

4.11.7 The transformer tank shall incorporate pole mounting bracket complete with bolts, nuts and washers as per the general arrangement drawing number TSP/10/001-01. The bolts, nuts and washers shall be hot dip galvanized to ISO 1461.

4.12. Paint Work

4.12.1 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.

4.12.2 The exterior shall be thoroughly cleaned by shot blasting or other approved method and given priming coat 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 at least 100 microns.

4.12.3 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.

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

4.12.5 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.

4.13. Fittings and Accessories

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

a) Pressure relief device: The pressure relief device shall be accommodated in protection cover to prevent rain water entering into the transformer and shall be mounted on top cover. It shall not protrude higher than the height of the transformer bushings above the top cover.
b) Oil level gauge; 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 centre of the range. The oil level gauge MUST be mounted on the side of the transformer.
c) Two earthing terminals (lugs) on the body of the transformer at the bottom 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) Separate lifting lugs for core, top cover and complete transformer (as per requirements given in this specification).

e) Off-circuit tap-changer; mounted on top cover. The tap changer shall be spring loaded rotary/linear and shall not allow water ingress or oil leakage and have mechanical interlock at each tap corresponding to each tap position.

f) Tinned copper jumper of 25x1mm fixed between tank and top cover with stainless steel bolt.

g) Pole mounting brackets complete with fasteners and accessories as per the general arrangement drawing number TSP/10/001-01 (subject to KPLC approval).

h) Rating and diagram plate (as per IEC 60076 and this specification)

i) Clamp connectors (as per requirements given in this specification).

j) Surge arrester mounting brackets as per clause 4.15 (subject to KPLC approval).

k) Thermometer pocket for use during temperature rise test.

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. No other fittings including oil drain valve, oil filling plug are allowed.

Detailed drawings for the transformer (including internal details), fittings and accessories and 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 Kenya Power for approval before manufacture.

4.14. Transformer Oil

4.14.1 Cooling of the transformer shall be by natural circulation of oil and natural circulation of air (ONAN).

4.14.2 The transformer shall be supplied filled with new oil.

4.14.3 The oil shall be new, unused and shall comply with all the requirements of IEC 60296 (class 1: un-inhibited oil) and as per KPLC Specification No. KP1/3CB/08/001 Issue 2 Rev 0 dated 2014-04-28.

4.15. Surge Arresters Mounting Brackets

4.15.1 Each transformer shall be complete with surge arresters mounting bracket (one number per phase) fitted under the HV bushings with steel earth strip of at least 50mm x 6mm 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 the hot dip galvanizing to ISO 1461.

Note: The surge arresters (to IEC 60099-4) shall be procured separately by KPLC:

4.16. Quality Management System

4.16.1 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 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 9001:2008.

4.16.2 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.

4.16.3 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 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.

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:

- Dielectric tests to IEC 60076 (Lightning Impulse Withstand Voltage Test).
- Short circuit withstand test to IEC 60076.
- Temperature rise test to IEC 60076.

Type Test Reports for a transformer of identical or higher voltage and identical or higher KVA rating and within the range of **19/0.242kV – 36/0.242kV** or **19/0.420kV – 36/0.420kV** and **25KVA – 500KVA** shall be accepted as representative for any of the pole mounted single phase distribution transformers on tender. The type test reports shall be for a transformer of the same design and construction as the transformer being offered.

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.*

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 (to be done during acceptance testing at factory)**

- Measurement of winding resistance
- Ratio test
- Vector group
- Separate source voltage withstand test
- Induced over-voltage
- Insulation resistance
- Oil leakage test on fully assembled transformer for 12 hours
- Measurement of impedance voltage
- Measurement of no-load loss and current
- Measurement of load loss (at normal & extreme taps)
- Tests on off-load tap-changer
- 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)**

- Temperature rise test – To be performed on one unit during acceptance testing.
- Lightning impulse withstand test – To be performed on one unit during acceptance testing.

5.3.3 **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
- Paint thickness
- Tank pressure test

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 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 IEC 60076. The entries on the plate shall be indelibly marked (either by etching, engraving or stamping) and shall be legible and permanent.

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

6.5 The type of transformer core steel shall be marked indelibly on one side of the transformer and the letters KPLC marked on the opposite side of the tank. The marking used shall be permanent type and shall be subject to approval by KPLC before manufacture.

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 testing laboratory;
g) Manufacturer's warranty and guarantee;
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 4.2.16;
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 standards/specification, 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).

The drawings to be submitted by the supplier to KPLC for approval before manufacture shall be in standard format clearly indication drawing number, parts list with material details & quantities, standard of manufacture, ratings, approval details and identify 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 testing laboratory for tender evaluation, all in English Language)

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

Clause Number	Description *Indicate the rating offered →*	BIDDER'S OFFER			
-	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 oil-immersed, air-cooled, outdoor type pole mounted distribution transformers for Single Wire Earth Return (SWER) system operated at 19.1kV 50 Hz, with dual LV to KPLC store/site as per specification				

Clause Number	Description *Indicate the rating offered →*	BIDDER'S OFFER			
	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 The Kenya Power & Lighting Company Ltd				
2	Applicable Standards				
3	Terms and Definitions				
4.1.1	Operating Service Conditions				
4.1.2.1 to 4.1.2.3	System Characteristics				
4.2	General Requirements				
4.2.1	Outdoor, oil type, ONAN, core or shell type				
4.2.2	Design Service Life				
4.2.3	Two winding, single phase integral unit				
4.2.4	Hermetically sealed, 60mm gas cushion, bolted top cover				
4.2.5	Design to facilitate operation, inspection, maintenance & repairs				
4.2.6	Safety & Regulatory Requirements				
4.2.7	All materials shall be new and of best quality and class				
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	No water pockets, rain water does not collect on top cover, gasket concealed by overlap				

Clause Number	Description *Indicate the rating offered →*		BIDDER'S OFFER			
	between top cover & tank flange					
4.2.11	All connections & contacts of ample section and surface for required currents					
4.2.12	Designed to minimize short circuits by birds & vermin					
4.2.13	Materials do not lead to acidity in oil					
4.2.14	State value of maximum noise level (NEMA TR.1)					
4.2.15	Brackets for single pole mounting, on concrete & wooden poles					
4.2.16	Drawings of offered transformer					
	Overall dimensions of offered transformer (length, width & height) in mm					
4.2.17 a) to g)	Design drawings for approval before manufacture					
4.3	Ratings		-	-	-	-
4.3.1	KVA, no-load voltage ratings and frequency					
4.3.2 (a)	Temperature Rise at 2200m asl	Top Oil				
		Windings				
4.3.2 (b)	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					

Clause Number	Description *Indicate the rating offered →*	BIDDER'S OFFER			
	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 of standard)				
	Thermal time constant in hours				
4.3.5	Type test report for ability of offered transformer to withstand dynamic effects of short circuit				
4.4	Windings and connections	-	-	-	-
4.4.1	Voltage variations				
4.4.2	Windings & connections				
4.4.3	Required details for primary & secondary windings				
4.4.4	Separation of windings for cooling and ease of repair				
4.4.5	Windings & connections braced?				
4.4.6	Drying in vacuum & impregnating with hot oil				
4.4.7	Material of spacer blocks				
4.4.8	All joints to be brazed/ crimped				
4.4.9	Active parts submerged in oil				

Clause Number	Description *Indicate the rating offered →*		BIDDER'S OFFER			
	by at least 60mm from minimum oil level mark					
4.4.10	Stage inspection by KPLC					
4.4.11	Current density, A/mm^2	HV winding				
		LV winding				
	Material of winding	HV winding				
		LV winding				
	Conductor area mm^2	HV winding				
		LV winding				
	Resistance at 20^{0}C	HV winding				
		LV winding				
4.4.12	Specific heat at **100 °C (J/kg· °C)**	Copper				
		Aluminium				
	Density at **100 °C (kg/m^3)**	Copper				
		Aluminium				
	Resistivity at **100°C (μΩ·m)**	Copper				
		Aluminium				
4.5	Tapping		-	-	-	-
4..5.1	Tapping range					
4.5.2	Tapping method and design					
4.6	Core and Flux Density		-	-	-	-
4.6.1	Grade of core steel					
	Thickness of lamination					
	Stack factor/Building factor					
	Specific loss in watts/kg (indicate designed flux density)					
4.6.2	Static discharges & local heating					
4.6.3	Assembled core free from distortion					
4.6.4	Cooling for core					
4.6.5	Movement of core during transportation or service					
4.6.6	Core clamping					
4.6.7	Lifting lugs for core, winding and complete transformer.					

Clause Number	Description *Indicate the rating offered →*	BIDDER'S OFFER			
	Factor of safety at least 2.				
4.6.8	Oil pockets & trapping of air				
4.6.9	Insulation withstand of core to bolts and core to frame				
4.6.10	Effect of primary voltage variations on flux density				
4.6.11	Maximum flux density				
	Number of turns on LV				
	Net core area m^2				
4.6.12	Allowable maximum flux density for one minute and for five seconds				
4.6.13	Flux density at which core saturates				
4.6.14	To furnish magnetization curve and design calculations				
4.7	Short Circuit Impedance, %				
	Resistance at 75°C of HV Winding in ohms (at normal & extreme taps)				
	Resistance at 75°C of LV Winding in ohms				
4.8.1	Minimum efficiency at full load (unity power factor), at 75°C,%				
	Minimum efficiency at 50% load (unity power factor), at 75°C, %				
4.8.2	Total losses (no-load + load losses) at full load at 75°C & unity power factor, W				
	Total losses (no-load + load losses) at 50% load at 75°C & unity power factor, W				
4.8.3	No-load Losses at 75°C, W				
	Load Losses at 50% load, 75°C, W				
	Load Losses at 75% load, 75°C, W				
	Load Losses at 100% load, 75°C, W				

Clause Number	Description	BIDDER'S OFFER			
	Indicate the rating offered →				
	I^2R component of load losses at 100% load, 75°C, W				
	Load Losses at 125% load, 75°C, W				
	Stray Losses at 50% load, 75% load, 100% load and 120% load, all at 75°C, W				
	No increase in no-load and load losses after award, during factory acceptance testing and during inspection and acceptance to stores				
4.9	Bushings and Clearances	-	-	-	-
4.9.1	Open, outdoor & weatherproof bushings to IEC 60137				
4.9.2	Bushings to be changed without opening transformer				
4.9.3	HV & LV bushings shall be two part, bottom in toughened epoxy and top in porcelain, brown				
	HV & LV bushings on top cover				
4.9.4	LV neutral identical to LV phase terminal bushing				
4.9.5	Spacing & clearances				
4.9.6	Creepage distance of bushings: HV, LV, N				
4.9.7	Clamp type bushing terminals for aluminium conductor				
	Materials, size and drawings for terminal connectors				
4.9.8	Marking and method of marking of terminals				
4.9.9	Air Clearances	-	-	-	-
4.9.9.1	Lightening impulse and power frequency withstand voltage rating of bushings offered (indicate for HV, LV & LV-N)				
4.9.9.2	Positioning & external				

Clause Number	Description *Indicate the rating offered →*	BIDDER'S OFFER			
	connections				
4.9.9.3	Minimum external air clearances: LV – phase to phase, phase to neutral, phase to earth, mm				
	Minimum external air clearances: 19.1kV –phase to LV and phase to earth, mm				
4.9.10	Size and material of removable jumper between top cover & tank				
4.10	Test Voltages				
	19.1kV Full wave LI				
	Chopped wave LI				
	AC withstand				
	LV: power frequency withstand voltage, kVrms,60s				
4.11	Transformer Tank & Tank Cover				
4.11.1	Bolted top cover design				
	Minimum thickness of top cover, bottom and sides of offered transformer				
4.11.2	Inside clearance and painting				
4.11.3	Pressure test of tank and test report				
4.11.4	Lifting lugs and factor of safety				
4.11.5	Steel radiators/corrugations				
4.11.6	Top cover design, gasket & non-standard bolts and nuts				
4.12	Paint Work	-	-	-	-
4.12.1	Method of cleaning before painting				
4.12.2	Final colour of exterior surfaces and paint thickness				
4.12.3	Cleaning and painting of interior of tank and other oil filled chambers				
4.12.4	Degreasing & treatment of radiators with anti-rust inhibitor				

Clause Number	Description *Indicate the rating offered →*	BIDDER'S OFFER			
4.12.5	Final colour of exterior of radiators & paint thickness				
4.13	Fittings and Accessories	-	-	-	-
4.13 (a)	Pressure Relief Device & location				
4.13 (b)	Oil Level Gauge & location				
4.13 (c)	Earthing Terminals: location & to be stainless steel				
4.13 (d)	Separate Lifting lugs for core, top cover & complete transformer				
4.13 (e)	Off-circuit tap changer & location				
4.13 (f)	Tinned copper jumper size and materials				
4.13 (g)	Pole mounting brackets and drawings				
4.13 (h)	Rating and diagram plate				
4.13 (i)	Clamp Connectors				
4.13 (j)	Surge arrester mounting brackets and drawing				
4.14	Transformer Oil	-	-	-	-
4.14.1	ONAN				
4.14.2	Transformer to be supplied filled with new oil				
4.14.3	Class and standard of oil				
	Quantity of oil in liters				
4.15	Surge Arresters Mounting Brackets				
4.15.1	Drawing				
4.15.2	Universal type				
4.15.3	Galvanized to ISO 1461				
4.16	Quality Management System	-	-	-	-
4.16.1	Quality Assurance Plan to be based on ISO 9001:2008				
4.16.2	Declaration of conformity to IEC 60076				
	Copy of ISO 9001:2008 certificate submitted				
5.	Tests and Inspection	-	-	-	-

Clause Number	Description *Indicate the rating offered →*	BIDDER'S OFFER			
5.1	Test Standard				
	Responsibility of testing transformer & manufacturer's capability				
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				
5.3.3	Additional tests (sample test)				
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, Labelling & Packing				
6.1	Packing				
6.2	Dispatch fully assembled, oil filled and complete with surge arrester mounting brackets				
6.3	Method of marking to ensure it is permanent and legible				
6.4	Content of marking				
6.5	Marking of Type of core steel & letters KPLC on opposite sides of tank				
7	Documents with tender				
	Documents for approval before manufacture				
Other	Weight of complete				

Clause Number	Description *Indicate the rating offered →*	BIDDER'S OFFER			
details required with the tender	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				
	Customer reference list and 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)				

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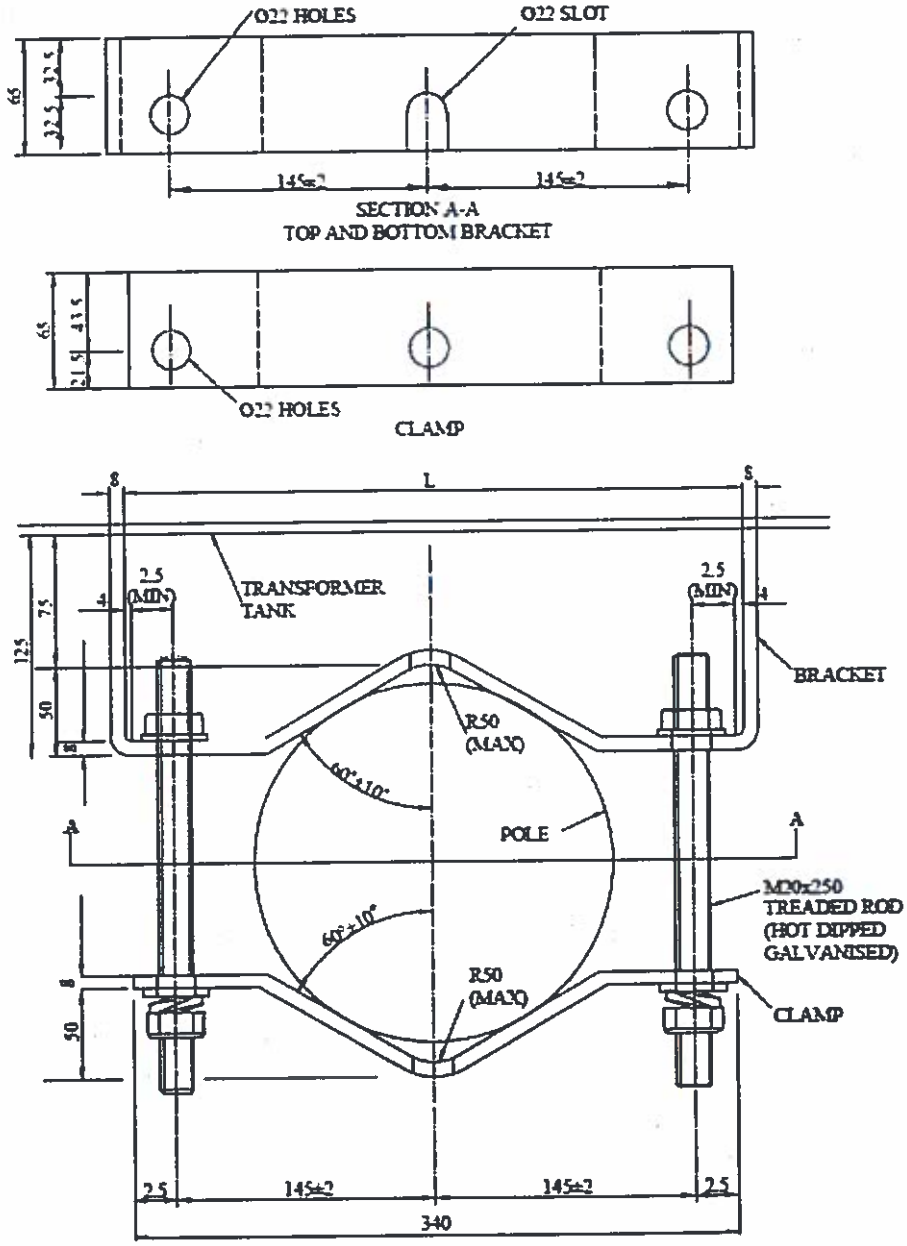
Manufacturer's Name, Signature, Stamp and Date

ANNEX B: Item Descriptions

CODE	ITEM DESCRIPTION
	TX 5KVA 19.1kV/240-0-240V SWER
	TX 10KVA 19.1kV/240-0-240V SWER
	TX 16KVA 19.1kV/240-0-240V SWER
	TX 20KVA 19.1kV/240-0-240V SWER
	TX 25KVA 19.1kV/240-0-240V SWER

ANNEX C: General Arrangement Drawings *(attached)*



NOTE
1. DIMENSIONS ARE SUBJECT TO A TOLERANCE OF ±mm UNLESS OTHERWISE STATED
2. MATERIAL ROD HOT DIPPED GALVANISED MILD STEEL

Drawing No. TSP/10/001-01: General Arrangement – Pole Mounting Bracket