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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)
Issue 3 Rev 1	2014-09-15	Corrected arithmetic errors, parameters and reviewed component losses & sound power levels as per BS EN 50464-1		

FOREWORD

This specification has been prepared by the Standards Department of The Kenya Power & Lighting Company Ltd (abbreviated as KPLC) and it lays down requirements for ground mounted three phase oil type distribution transformers. The specification is intended for use by KPLC in purchasing the transformers.

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

1. SCOPE

This specification is for newly manufactured oil-immersed, air-cooled, outdoor type ground 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: 100-1000 KVA
- 33000/420V: 315 KVA, 630 KVA, 1000 KVA.

The specification also covers inspection and test of the transformer 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 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 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 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 60137: Insulated Bushings for alternating voltages above 1000V

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

BS 2562: Cable boxes for transformers and reactors

BS EN 50464-1: Three-phase oil-immersed distribution transformers 50Hz, from 50KVA to 2500KVA with highest voltage for equipment not exceeding 36kV – Part 1: General requirements

Manual on Transformers – Publication No. 295 CBIP 2006

ESI 35-1: Distribution Transformers (from 16KVA to 1000KVA)

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 service conditions

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

(a) Altitude: up to 2,200m above sea level;

(b) Temperature: average of +30°C with a minimum of -1°C and max +40 °C;

(c) Humidity: up to 95%;

(d) Pollution: Design pollution level to be taken as "*Heavy*" (Pollution level III) 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 primary system is having a nominal voltage of 11000 volts and 33000 volts and system highest voltage of 12000 volts and 36000 volts respectively. The primary system is three phase 3-wire 50 Hz and the secondary is 420 volts three phase 4-wire. The target three phase voltage at the consumer terminals is 400V±6% 50Hz.

4.1.2.3 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 service life of twenty five years.

4.2.3 The transformer shall be a two winding type three-phase integral unit.

4.2.4 The transformer shall be either free breathing type or hermetically sealed type each with bolted top cover.

4.2.4.1 The hermetically sealed type shall have a gas cushion of 100mm filled with dry air and bolted top cover. The gas cushion of 100mm dry air shall be under the bolted top cover.

4.2.4.2 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. The oil gauge shall be provided at one end of the conservator marked with oil levels. The conservator shall have feed valve.

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 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 gaskets shall be concealed by an overlap between the top cover and tank flange of 10mm.

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 BS EN 50464-1 and guaranteed values shall be stated in the bid.

4.2.15 Each transformer shall be suitable for ground mounting. It shall be complete with two steel channel underbase.

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

4.2.17 Design drawings (by the manufacturer) complete with manufacturer's 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, 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) 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:

(a) 11000/420V: 100KVA, 200KVA, 315KVA, 630KVA and 1000KVA.
(b) 33000/420V: 315KVA, 630KVA and 1000KVA.

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 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 11kV and 33kV systems shall be taken as 500MVA and 1000MVA respectively (as per IEC 60076-5) in order to obtain the value of the symmetrical short circuit current to be used for the design and tests.

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

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 bid for tender evaluation.

4.4 Winding and Connections

4.4.1 The transformer shall be wound **Dyn11** with respect to the 11kV windings (or 33kV as appropriate) and low voltage winding (420V) as per IEC 60076. The star point of the low voltage winding shall be brought out to a neutral bushing of the same size as the phase bushing and rod.

4.4.2 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.

4.4.3 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.

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

4.4.5 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.

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

4.4.7 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.

4.4.8 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.

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

4.4.10 The transformer core and all electrical parts inside the transformer shall be sufficiently submerged in oil by no less than 80mm from the minimum oil level mark.

4.4.11 KPLC will 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.

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

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**

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

4.5.2.2 The tap changer shall be located on the side of the transformer with sufficient electrical clearance and well submerged in oil. The tap switch shall be rotary type with provision for padlock of 8mm shank diameter and 50mm height.

4.5.2.3 Switch position No. 1 shall correspond to highest voltage on the HV side.

4.5.2.4 The tap changer shall be designed in such a way that oil will not come out of it even after the removal / forceful breakage of the tap switch handle.

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 & IEC 60512.

4.6 Core and Flux Density

a) Core

4.6.1 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 and of thinner laminations 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.

4.6.2 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.

4.6.3 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 finally assembled core is free from distortion.

4.6.4 Adequate cooling shall be provided for the core.

4.6.5 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.

4.6.6 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.

4.6.7 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.

4.6.8 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.

4.6.9 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.

b) Flux Density

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

4.6.11 The transformer shall be so designed that the working flux density shall not exceed 1.6 Tesla at normal voltage, frequency & ratio. Tenders 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.

4.6.12 Tenderers shall indicate in their bid the continuous allowable maximum flux density for one minute and five seconds.

4.6.13 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.

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

4.7 Short-circuit Impedance

The short-circuit impedance measured at the principal tap at 75°C shall be as per Table 1.

Table 1: Short-circuit Impedance

	Rating KVA	Short-circuit Impedance %, at 75°C
11/0.420kV Transformers	100	4
	200	4
	315	4
	630	6
	1000	6
33/0.420kV Transformers	315	4
	630	6
	1000	6

4.8 Losses

4.8.1 The maximum sum total of the transformer losses, measured at full load operation, unity power factor and rated voltage shall not exceed values indicated in Table 2. Measured values of full load losses shall be corrected to 75 degree Celsius.

Table 2: Total Transformer Losses

	Rating KVA	**TOTAL LOSSES (no-load + load losses) at 75°C (100% loading, unity power factor) Watts**
11/0.420kV Transformers	100	1395
	200	2685
	315	3690
	630	6280
	1000	9940
33/0.420kV Transformers	315	4990
	630	7800
	1000	12200

4.8.2 The sound power level, no-load losses and full load losses at 75°C (unity power factor) shall be as per Table 3:

Table 3: Sound Power Level, No-load and Load Losses at 75°C

	Rating KVA	Sound Power Level (L_{WA}), dB(A)	No-load Losses, Watts	Load losses at 75°C (100% loading, unity power factor), Watts
11/0.420kV Transformers	100	41	145	1250
	200	49	310	2375
	315	52	440	3250
	630	55	680	5600
	1000	58	940	9000
33/0.420kV Transformers	315	63	790	4200
	630	67	1300	6500
	1000	68	1700	10500

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

4.9 Cable Boxes, Bushings and Clearances

4.9.1 The windings shall be brought out separately through bushings to IEC 60137.

11/0.420kV ground mounted distribution transformers shall have cables boxes on both HV and LV sides while 33/0.420kV transformers shall have open bushing on HV side and cable box on LV side.

4.9.2 Cable Boxes

4.9.2.1 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.
b) The high 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 4mm thick with minimum thickness of the cover plate and bushing plate of 5mm and 6mm respectively, all in mild steel.
i) Each HV & LV cable box shall have a treated hard wood cable cleat/box-base drilled to accommodate specified cables.
j) The minimum size of fixing studs or bolts for cable box shell, securing cover plate and for the hardwood cable cleat shall be M10.
k) The cable boxes shall have gaskets of not less than 5mm thickness made of synthetic rubber or synthetic rubber bonded cork.
l) 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 wire gauze shall be provided in the bottom of the cable box.
m) 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.
n) The HV bushings shall be made of porcelain while LV bushings may be made of porcelain material or toughened epoxy insulator material all brown in colour.
o) The continuous current rating of each bushing shall not be less than 120% of the rated current of the transformer.
p) 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.
q) Creepage distance of bushings shall not be less than 25mm/kV, based on the maximum phase to phase voltage.
r) Terminal arrangement and marking on the HV and LV sides shall be A, B, C and n, a, b, c respectively.
s) The HV and LV cable boxes shall be nested within the radiators.

4.9.2.2 LV (0.42kV) cable boxes

a) Bushing stems/conductor for LV (0.42kV) cable box shall be made from hard-drawn high conductivity copper bar. The copper bar shall be at least 63x12.5mm in dimensions and have fully radiused corners. The whole of the outer ends of the bushing conductors shall be hot dipped tinned. Both ends of the bushing conductor shall be clean and free from resin (where resin is used) for the whole of their length from 3mm clear of the moulding.
b) The LV (0.420kV) cable boxes shall be in two sizes:
    i. LV cable box for four cables – A four pole cable box for use with four single core cables on 100 – 315KVA transformers.
    ii. LV cable box for seven cables – A four pole cable box for use with seven single core cables on 630KVA and 1000KVA transformers.

iii. The bushing conductor (copper bar) shall have holes adequate for the number and size of cables specified.

c) The LV cable box for 630KVA and 1000KVA transformers shall be suitable for terminating up to 7No single core 630mm^2 PVC cables and 4No single core 630mm^2 PVC cables for 100-315KVA transformers.
d) The LV neutral bushing of the transformer shall be identical to the corresponding LV phase terminal bushings and bushing conductor (copper bar).

4.9.2.3 HV (11kV) cable boxes

a) The HV cable box (11kV) shall be suitable for three core cables up to 185mm^2 in size.
b) The HV cable box shall have the following additional features:
   i. It shall be suitable for heat/cold terminations.
   ii. The bushing shall be made of porcelain material.
   iii. The bushing rod (conductor) shall be high conductivity copper alloy hot dip tinned and at least 12mm diameter.
   iv. The termination shall be suitable for cable sockets (lugs) and three core copper/aluminium XLPE insulated SWA armoured cables.

4.9.3 The 33kV bushings shall be open type and shall have outdoor two part bushing with bottom portion made with toughened epoxy insulator and top portion made with porcelain material, brown colour, glazed weather proof bushings. Each bushing shall be complete with clamp bolted type connector suitable for ACSR conductor sizes from 7.8mm to 18.2mm diameter. The 33kV bushings shall be mounted on the tank top cover.

4.9.4 Air Clearance (applicable to all ratings of ground mounted distribution transformers)

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

4.9.4.2 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.

4.9.4.3 Minimum external air clearances (with terminal clamps fitted) shall be as shown in Table 5 for HV.

Table 5: External Clearances in Air

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

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

4.9.4.4 Distance 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

4.10 Insulation Levels

The complete transformer arranged for service, shall be capable of withstanding the voltages indicated in Table 6 and shall comply fully with the requirements of IEC 60076 Part 3.

Table 6: Insulation Levels

Nominal system voltage **(kV, rms)**	Highest system voltage **(kV, rms)**	Internal Insulation	
		Lightning Impulse withstand voltage, positive **(kV, peak)**	Power frequency withstand voltage **(kV, rms)**
0.42	1.1kV	-	5
11	12	75	28
33	36	170	70

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

3) Surge arresters shall be fitted by KPLC on the HV bushings for overvoltage protection of the transformer.

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 5mm, 5mm and 3.15mm respectively.

All joints of tank & 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/signed by an 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 8mm thick suitably reinforced with a factor of safety of at least 2 (based on weight of complete transformer filled with oil).

4.11.5 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.

4.11.6 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 Qty 4 non-standard bolts of dome shaped head with non-standard profile and that cannot 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 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 25mmx1.2mm and shall be secured by stainless steel bolt & nut.

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 between 100 and 130 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 complete with the following fittings and accessories:

a) Pressure relief device:
   i. Hermetically sealed transformers shall be equipped with a pressure relief device preset such that when a pressure exceeding design pressure occurs inside the transformer, the pressure relief device opens to evacuate the pressure.
   ii. The pressure relief device shall be mounted on top cover and its design shall prevent rain water entering into the transformer. It shall not protrude