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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 2 Revision 0	2014-03-24	Cancels and replaces Issue 1 Rev 0 dated 2009-04-27	S. Kimitei	G. Owuor

FOREWORD

This specification has been prepared by the Research and Development Department in collaboration with the Technical Services Department both of the Kenya Power & Lighting Company Ltd (abbreviated as KPLC) and it lays down requirements for 23MVA 66/33kV Power Transformer. The specification is intended for use by KPLC in purchasing the transformer.

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 outdoor oil type power transformer as described below:

23MVA, 66000/33000 volts, 50 Hz, ONAN/ONAF three phase power transformer.

The **Vector Group** shall be stated on the schedule of requirements in the tender and shall either be YNyn0d1, YNyn0d11 or Dyn1/Dyn11. Power transformer intended for Dy connection shall have facility to change over from Dyn1 to Dyn11 and vice versa.

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 for 23MVA 66kV/33kV power transformer acceptable for use in the company 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 transformer 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.

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IEC 60512: Connectors for electronic equipment

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

3. TERMS AND DEFINITIONS

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

3.2 The term similar rating where used in this specification shall be for transformer ratings within the range 23MVA – 100MVA and primary voltage rating of 66kV – 220kV and secondary voltage of 33kV – 66kV 50Hz with vector group YNyn0d11, Dyn1 or Dyn11.

4. REQUIREMENTS

4.1 Service Conditions

4.1.1 Operating conditions

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

(a) Altitude: Up to 2200 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 "Very *Heavy*" (Pollution level IV) according to IEC 815.

(e) Isokeraunic level: upto 180 thunderstorm days per year

4.1.2 System characteristics

a) The primary system is 66,000 volts, 3 phase, 3 wire, 50Hz. The system is mostly overhead and exposed i.e. without continuous aerial earth wire.

b) The secondary system is 33,000 volts, 3 phase, 3 wire, 50Hz, with neutral point solidly earthed. The system is mostly overhead and exposed i.e. without continuous aerial earth wire.

c) The Transformer shall be operated at a high loading factor.

4.2 General Requirements

4.2.1 The transformer shall be outdoor, oil-immersed, of ONAN/ONAF classification and core type (lamination stackings). 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 a three-phase integral unit.

4.2.3 The transformer shall be of the free breathing type. A dehydrating cobalt free breather of approved design shall be provided.

4.2.4 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.

4.2.5 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.

4.2.6 All material used shall be new and of the best quality and of the class most suitable for working under the conditions specified in clause 4.1 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.

4.2.7 Corresponding parts liable to be replaced shall be interchangeable.

4.2.8 All outdoor apparatus, including bushings insulators with their mountings, shall be designed so as to avoid pockets in which water can collect.

4.2.9 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.

4.2.10 All apparatus shall be designed to minimize the risk or accidental short-circuit caused by animals, birds or vermin.

4.2.11 In tank on-load-tap changers shall be located such that the space above the diverter switch chamber will be free of inter-connecting pipes etc. for lifting the diverter switch unit for inspection and maintenance purposes.

4.2.12 Galvanizing shall be applied by the hot-dipped process to ISO 1461 and for all parts other than steel wires shall consist of a thickness of zinc coating equivalent to not less than 610g of zinc per square meter of surface. The zinc coating shall be smooth, clean and of uniform thickness and free from defects. The preparation of galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated material. The quality will be established by tests as per ISO 1461.

4.2.13 All bolts, nuts, and washers exposed to atmosphere and in contact with non-ferrous parts which carry current shall be of phosphor bronze.

4.2.14 If bolts and nuts are placed so that they are inaccessible by means of ordinary spanners, suitable special spanners shall be provided by the supplier.

4.2.15 Except for protective hardware, which may have to be removed at site, all external surfaces shall receive at least four coats of paint. The total dry film thickness shall be at least 100 microns.

4.2.16 Descriptive labels for mounting indoors or inside cubicles and kiosks shall be of material that will ensure permanence of the lettering. A matt or satin finish shall be provided to avoid dazzle from reflected light. Labels mounted on dark surface shall have white lettering on a black background. Danger notices shall have red lettering on a white background.

4.2.17 All interior surfaces of chambers or kiosks that are in contact with air shall receive at least three coats of paint, of which the topcoat shall be of a light shade.

4.2.18 The design and all materials and processes use
transformer, shall be such as to reduce to a mir
acidity in the oil.

4.2.19 Every care shall be taken to ensure that the des
transformers and auxiliary plant shall be such t
levels following good modern manufacturing pra
shall be stated in the bid.

4.3 **Ratings**

4.3.1 (a) The windings of the transformer shall be rat
ONAN rating of 18 MVA. These ratings shall be
clause 4.1.

(b) The rating specified in this clause shall be t
ambient temperature and altitude given in claus

4.3.2 (a) The transformer shall be capable of carrying
any tap under the conditions stated in clause 4.
or the temperature rise in the hottest region exc
windings respectively.

(b) The loading capabilities shall be demonstra
test shall be done in the presence of KPLC Rep
(altitude correction shall be as per clause 4.3.1

4.3.3 The transformer shall be capable of withstandin
voltage and impedance for 2 seconds. The de
lifetime of the transformer.

4.3.4 The thermal ability of the offered transformer de
demonstrated by calculation carried out in acco
4.1.1 to 4.1.5 of IEC 60076-5.

The calculation showing details and compliance
to 4.1.5 of IEC 60076-5 shall be submitted with
be used for the calculation of the thermal ability
seconds as per IEC 60076-5.

4.3.5 The ability of the transformer to withstand the d

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sign to withstand short circuit shall be
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with the requirements of clause 4.1.1
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withstand short circuit shall be 2

amic 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 for tender evaluation.

4.4 Winding and Connections

4.4.1 The **Vector Group** shall be stated on the schedule of requirements in the tender and shall either be YNyn0d1, YNyn0d11 or Dyn1/Dyn11.

Power transformer intended for Dy connection shall have facility to change over from Dyn1 to Dyn11 and vice versa. The links for changing over from one mode to another shall be accessible through an inspection cover and shall be clearly marked. The marking used shall be permanent and indelible.

4.4.2 The transformer shall be capable of operation without danger on any particular tapping at the rated MVA when the voltage may vary by + 20% 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 windings and connections shall be properly braced to withstand shocks during transportation or due to short circuit and other transient conditions during service.

4.4.5 Adequate pre-shrinkage of the coil assembly using pre-compressed press board material having low moisture content for the radial spacer blocks shall be ensured by the manufacturer so that there is no displacement of the radial spacer blocks due to frequent short circuits on the transformers.

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 coil clamping rings wherever used shall preferably be of flat insulated steel laminations.

4.4.8 The radial spacer blocks must 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 KPLC will inspect built-up winding for its quality, weight of copper, 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 transformer shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth, so as to eliminate wave-form distortion and from any possibility of high frequency disturbances, inductive effects or of circulating currents between the neutral points at different transforming stations reaching such a magnitude as to cause interference with communication circuits.

4.4.12 The windings shall be designed to reduce to a minimum the out-of-balance forces in the transformer at all voltage ratios.

4.5 Tapping

4.5.1 Tapping Range

The transformer shall be provided with tapping on the 66kV winding for a variation of no load primary voltage for parallel operation, with Tap No. 1 having the highest voltage assignment, as follows:

66,000 volts	+ 8 × 1.67%
	- 8 × 1.67%

4.5.2. Tapping Method

Tapping shall be carried out by means of an on-load tap changer as described in clause 4.12 below.

4.6 Core and Flux Density

a) Core

4.6.1 The core shall be constructed from the laminations of high grade cold rolled non-aging, grain oriented silicon steel of maximum 0.27mm lamination thickness. The grade of CRGO 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 is practicable, the laminations are flat and the finally assembled core is free from distortion.

4.6.4 Adequate oil ducts shall be provided in the core for cooling. Tinned copper strip bridging pieces shall be used for maintaining electrical continuity wherever the magnetic circuit is provided into pockets by such ducts or insulating material thicker than 0.25mm.

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 All steel sections used for supporting the core shall be thoroughly sand blasted or shot blasted after cutting, drilling and welding. Any non-magnetic or high resistance alloy shall be of established quality.

4.6.7 Adequate lifting lugs shall be provided to enable core and winding to be lifted.

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 through the drain valve, 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 AC 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.

4.6.12 Tenderers shall indicate the continuous allowable maximum flux 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 the purchaser for being satisfied that flux density is as desired.

4.6.15 The flux density/design shall meet the over fluxing of the core due to temporary over voltage of the orders of 25% for one minute and 40% for five seconds that may appear in abnormal conditions such as the one obtained following sudden loss of large loads.

4.7 Losses, Regulation and Impendence

4.7.1 Losses of the transformer shall be stated and shall be regarded as the maximum allowed not subject to plus tolerances (due to capitalization). The fixed losses shall be as low as is consistent with good design, reliability and economical use of materials.

4.7.2 Voltage regulation from no-load to continuous rated output at unity power factor, at 0.8 lagging and 0.8 leading power factor with constant voltage across the higher voltage windings shall be stated in the bid.

4.7.3 The impedance voltage at extreme tappings and at principal tapping shall be stated and shall be subject to tolerances in accordance with IEC 60076. Typical values for existing 23MVA transformers in Kenya Power at principal (nominal) tap are 9.8% - 10.1%. The minimum as per IEC 60076-5 for this size of transformer is 8.0%).

4.7.4 As per IEC 60076-5, the short-circuit apparent power of 66kV & 33kV systems shall be taken as 3,000MVA & 1,000MVA respectively in order to obtain the value of the symmetrical short circuit current to be used for the design and tests.

4.8 Terminals: Arrangement & Bushings

4.8.1 The 66kV and 33kV windings shall be brought out separately through open bushings of outdoor, weatherproof design and to IEC 60137.

4.8.2 66kV bushings shall be of oil-filled condenser type construction, draw-out type and shall each have a capacitance test point.

4.8.3 To satisfy insulation requirements, 33kV bushings may be of oil-filled condenser type construction, draw-out type, each to have a capacitance test point. Otherwise solid porcelain type bushings for 33kV will be accepted.

4.8.4 The neutral bushing of the transformer shall be identical to the corresponding phase terminal bushings.

4.8.5 Spacing and air clearances shall be so co-ordinated as to render the probability of a flashover from the terminal of one winding to the terminal of another winding negligible.

4.8.6 Creepage distance of bushings shall not be less than 31mm/kV, based on operating phase to phase voltage.

4.8.7 Bushing terminals shall be clamp type suitable for both copper and aluminium busbars of sizes up to 76mm diameter.

4.8.8 Each bushe 66kV windings shall be mounted on a turret. Each turret shall be suitable fo modating at least two sets of current transformers.

4.8.9 Each bushe 33kV windings shall be mounted on a turret. Each turret shall be suitable fo modating at least three sets of current transformers.

4.8.10 Terminal a nent on the HV (66kV) and LV (33kV) sides shall be **N, A, B, C** and **n, a, b, c** r ely. The phase markings shall be visible from ground level.

Note: Neut n primary applicable only to YNyn transformers

4.9 Current tra ers to be fitted by the Manufacturer

4.9.1. Current tra rs shall be installed in the bushing turrets and shall be of the following qu , ratios, ratings and class:

PHASE	CORE	BURDEN	RATIO	CLASS
HV-side (66				
A		15VA	200/1A	cl. 5P10
		15VA	200/1A	cl. PX
B		15VA	200/1A	cl. 5P10
		15VA	200/1A	cl. PX
		10VA	200/?	cl. 1
C		15VA	200/1A	cl. 5P10
		15VA	200/1A	cl. PX
LV-side (33				
a		15VA	400/1A	cl. 0.5
		15VA	400/1A	cl. 5P10
		15VA	400/1A	cl. PX
b		15VA	400/1A	cl. 0.5
		15VA	400/1A	cl. 5P10
		15VA	400/1A	cl. PX
		15VA	400/1A	cl 0.5
c		15VA	400/1A	cl. 0.5
		15VA	400/1A	cl. 5P10
		15VA	400/1A	cl. PX
		10VA	400/?	cl 1.0
n		15VA	400/1A	cl. PX
		15VA	400/1A	cl. 5P10

4.9.2 Current transfrs of suitable rating and class for winding temperature indicators shall be instal adequately cover the transformer (HV & LV) as indicated above (as 200/? and?) for guidance.

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4.2.2 The transformer shall be a three-phase integral unit.

4.2.3 The transformer shall be of the free breathing type. A dehydrating cobalt free breather of approved design shall be provided.

4.2.4 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.

4.2.5 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.

4.2.6 All material used shall be new and of the best quality and of the class most suitable for working under the conditions specified in clause 4.1 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.

4.2.7 Corresponding parts liable to be replaced shall be interchangeable.

4.2.8 All outdoor apparatus, including bushings insulators with their mountings, shall be designed so as to avoid pockets in which water can collect.

4.2.9 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.

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4.2.17 All interior surfaces of chambers or kiosks that are in contact with air shall receive at least three coats of paint, of which the topcoat shall be of a light shade.

4.2.18 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.

4.2.19 Every care shall be taken to ensure that the design and manufacture of the transformers and auxiliary plant shall be such to have minimum noise and vibration levels following good modern manufacturing practices. The maximum noise levels shall be stated in the bid.

4.3 Ratings

4.3.1 (a) The windings of the transformer shall be rated at 23MVA (ONAF), with a minimum ONAN rating of 18 MVA. These ratings shall be for the operating conditions stated in clause 4.1.

(b) The rating specified in this clause shall be the continuous rating at the maximum ambient temperature and altitude given in clause 4.1.

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 4.3.1 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 visit (altitude correction shall be as per clause 4.3.1 of IEC 60076-2).

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.

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

Connections

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TITLE: SPECIFICATION FOR 23MVA 66/33kV POWER TRANSFORMER	Doc. No.	KP1/3CB/TSP/10/039
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ted by tests and complete test reports (including oscillograms and
condition of the transformer before and after the short-circuit test) shall
for tender evaluation.

4.4.10 KPLC will inspect built-up winding for its quality, weight of copper, 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 transformer shall be designed with particular attention to the suppression of harmonic voltage, especially the third and fifth, so as to eliminate wave-form distortion and from any possibility of high frequency disturbances, inductive effects or of circulating currents between the neutral points at different transforming stations reaching such a magnitude as to cause interference with communication circuits.

4.4.12 The windings shall be designed to reduce to a minimum the out-of-balance forces in the transformer at all voltage ratios.

4.5 Tapping

4.5.1 Tapping Range

The transformer shall be provided with tapping on the 66kV winding for a variation of no load primary voltage for parallel operation, with Tap No. 1 having the highest voltage assignment, as follows:

66,000 volts	+ 8 × 1.67%
	- 8 × 1.67%

4.5.2. Tapping Method

Tapping shall be carried out by means of an on-load tap changer as described in clause 4.12 below.

4.6 Core and Flux Density

a) Core

4.6.1 The core shall be constructed from the laminations of high grade cold rolled non-aging, grain oriented silicon steel of maximum 0.27mm lamination thickness. The grade of CRGO 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 is practicable, the laminations are flat and the finally assembled core is free from distortion.

4.6.4 Adequate oil ducts shall be provided in the core for cooling. Tinned copper strip bridging pieces shall be used for maintaining electrical continuity wherever the magnetic circuit is provided into pockets by such ducts or insulating material thicker than 0.25mm.

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 All steel sections used for supporting the core shall be thoroughly sand blasted or shot blasted after cutting, drilling and welding. Any non-magnetic or high resistance alloy shall be of established quality.

4.6.7 Adequate lifting lugs shall be provided to enable core and winding to be lifted.

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 through the drain valve, 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 AC 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.

4.6.12 Tenderers shall indicate the continuous allowable maximum flux 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 the purchaser for being satisfied that flux density is as desired.

4.6.15 The flux density/design shall meet the over fluxing of the core due to temporary over voltage of the orders of 25% for one minute and 40% for five seconds that may appear in abnormal conditions such as the one obtained following sudden loss of large loads.

4.7 Losses, Regulation and Impendence

4.7.1 Losses of the transformer shall be stated and shall be regarded as the maximum allowed not subject to plus tolerances (due to capitalization). The fixed losses shall be as low as is consistent with good design, reliability and economical use of materials.

4.7.2 Voltage regulation from no-load to continuous rated output at unity power factor, at 0.8 lagging and 0.8 leading power factor with constant voltage across the higher voltage windings shall be stated in the bid.

4.7.3 The impedance voltage at extreme tappings and at principal tapping shall be stated and shall be subject to tolerances in accordance with IEC 60076. Typical values for existing 23MVA transformers in Kenya Power at principal (nominal) tap are 9.8% - 10.1%. The minimum as per IEC 60076-5 for this size of transformer is 8.0%).

4.7.4 As per IEC 60076-5, the short-circuit apparent power of 66kV & 33kV systems shall be taken as 3,000MVA & 1,000MVA respectively in order to obtain the value of the symmetrical short circuit current to be used for the design and tests.

4.8 Terminals: Arrangement & Bushings

4.8.1 The 66kV and 33kV windings shall be brought out separately through open bushings of outdoor, weatherproof design and to IEC 60137.

4.8.2 66kV bushings shall be of oil-filled condenser type construction, draw-out type and shall each have a capacitance test point.

4.8.3 To satisfy insulation requirements, 33kV bushings may be of oil-filled condenser type construction, draw-out type, each to have a capacitance test point. Otherwise solid porcelain type bushings for 33kV will be accepted.

4.8.4 The neutral bushing of the transformer shall be identical to the corresponding phase terminal bushings.

4.8.5 Spacing and air clearances shall be so co-ordinated as to render the probability of a flashover from the terminal of one winding to the terminal of another winding negligible.

4.8.6 Creepage distance of bushings shall not be less than 31mm/kV, based on operating phase to phase voltage.

4.8.7 Bushing terminals shall be clamp type suitable for both copper and aluminium busbars of sizes up to 76mm diameter.

4.8.8 Each bushing of the 66kV windings shall be mounted on a turret. Each turret shall be suitable for accommodating at least two sets of current transformers.

4.8.9 Each bushing of the 33kV windings shall be mounted on a turret. Each turret shall be suitable for accommodating at least three sets of current transformers.

4.8.10 Terminal arrangement on the HV (66kV) and LV (33kV) sides shall be **N, A, B, C** and **n, a, b, c** respectively. The phase markings shall be visible from ground level.

Note: Neutral (N) on primary applicable only to YNyn transformers

4.9 Current transformers to be fitted by the Manufacturer

4.9.1. Current transformers shall be installed in the bushing turrets and shall be of the following quantities, ratios, ratings and class:

PHASE	CORE	BURDEN	RATIO	CLASS
HV-side (66kV)				
A	1	15VA	200/1A	cl. 5P10
	2	15VA	200/1A	cl. PX
B	1	15VA	200/1A	cl. 5P10
	2	15VA	200/1A	cl. PX
	3	10VA	200/?	cl. 1
C	1	15VA	200/1A	cl. 5P10
	2	15VA	200/1A	cl. PX
LV-side (33kV)				
a	1	15VA	400/1A	cl. 0.5
	2	15VA	400/1A	cl. 5P10
	3	15VA	400/1A	cl. PX
b	1	15VA	400/1A	cl. 0.5
	2	15VA	400/1A	cl. 5P10
	3	15VA	400/1A	cl. PX
	4	15VA	400/1A	cl 0.5
c	1	15VA	400/1A	cl. 0.5
	2	15VA	400/1A	cl. 5P10
	3	15VA	400/1A	cl. PX
	4	10VA	400/?	cl 1.0
n	1	15VA	400/1A	cl. PX
	2	15VA	400/1A	cl. 5P10

4.9.2 Current transformers of suitable rating and class for winding temperature indicators shall be installed to adequately cover the transformer (HV & LV) as indicated above (as 200/? and 400/?) for guidance.

4.9.3 Current transformers shall also comply with the requirements of IEC 60044.

4.9.4 Full technical particulars of current transformers offered, including type test re from a third party testing laboratory that is accredited to ISO/IEC 17025 shall b submitted with tender.

4.10 AIR CLEARANCE

4.10.1 When totally assembled, as in service, electrical clearances in air shall be ade withstand the assigned impulse withstand test voltages.

4.10.2 Care shall be taken to ensure that all fittings are suitably positioned so as not interfere with the external connection to the bushing terminals.

4.10.3 Minimum external air clearances shall be as shown under.

Nominal System Voltage between Phases		66kV	33
Minimum clearance phase-to-earth and phase-to-neutral	mm	830	4
Minimum clearance phase-to-phase between phases of the same winding	mm	830	4
Minimum clearance between a line terminal of the high voltage winding and a line terminal of a lower voltage winding	mm	830	4
Minimum clearance from live metal to oil pipe-work including conservator and pressure relief device	mm	830	4

4.11. INSULATION LEVELS

The complete transformer arranged for service, shall be capable of withstandin following voltages and shall comply fully with the requirements of IEC 60076 Pa

Nominal system voltage (kV, rms)	Highest system voltage (kV, rms)	Lightning Impulse withstand voltage, 1.2/50µs, dry, +ve (kV, peak)	Power frequency withstand voltage 50Hz, 60s, wet, (kV, rms)
66	72.5	325	140
33	36	200	95

4.12. ON LOAD TAP CHANGER AND MECHANISM BOX

4.12.1 The transformer shall be complete with vacuum type on-load, electrically driven tap changing mechanism of the high-speed resistor transition type, and shall comply with the requirements of IEC 60214, 60512 and this specification. The equipment shall be suitable for remote operation from a remote control panel supplied with the transformer as well as for local operation from the Motor Drive Unit (MDU) mounted on the transformer body.

4.12.2 The mechanism shall be so designed as to ensure that when a tap change operation is in progress, it shall be able to complete the task independently irrespective of operation of any relays or switches.

4.12.3 Adequate means shall be provided to safeguard the transformer and its auxiliary circuits from damage should a failure of the auxiliary supply or any other mal-operation occur during the progress of tap changing that may prevent it from completing its task.

4.12.4 Means shall be provided in the marshalling kiosk for mechanical isolation of the supply to the Motor Drive Unit, and a suitable thermal overload device (details to be submitted with tender) shall be provided in the MDU for the protection of the motor. The possibility of over-running the mechanism at each end of the voltage range shall be prevented by means of limit switches and mechanical stops. Other techniques used to prevent tap changer runaway shall be indicated.

4.12.5 A mechanically operated device shall be provided to indicate the tap position locally, and a suitable tap position transmitter shall be provided for the remote tap position indication.

4.12.6 A counter shall be provided on the tap changing mechanism box to indicate the total number of operations completed by the equipment.

4.12.7 Contactors and associated equipment for the control circuit for local/remote and manual operations of the tap changer mechanism shall be housed in the mechanism box.

4.12.8 The tap changer shall be housed in a **separate compartment** and shall be **Vacuum Type**. Sufficient documentation for the vacuum switch in form of manuals, instructions, drawings, technical characteristics, copies of type test certificates and type test reports, manufacturing and export experience of the supplier shall be submitted with the tender for technical evaluation. The tap changer shall be of a design & make approved by KPLC.

4.12.9 The Motor Drive Unit shall have the following in addition to what has been stated above:

(a) Isolating switch in the transformer marshalling box for the supply to the tap changer Motor Drive Unit,

(b) Raise/lower contactors for tap changer motor operation, and associated single-phase protection/overload relay,

(c) Switch for selection of local/remote tap changer control,

(d) Switch or switches for local tap changer operation,

(e) Provisions shall be made available for hand operation in the mechanism box,

(f) Provide glanding plate.

4.12.10 The tap changer shall be complete with remote tap changer control panel, automatic voltage regulating relay and parallel operation scheme detailed in clauses 4.12.11, 4.12.12 and 4.12.13 and shall be of design and type approved by KPLC.

4.12.11 Remote Tap Changer Control Panel

The remote tap changer control panel shall as a minimum, contain the following devices:

- Automatic Voltage Regulating Relay.
- Off/Manual/Automatic switch for the Relay.
- Raise /Lower control switch.
- Raise , Lower, 'out of step' and tap change in progress indication lamps
- Dial type Tap position indicator (technical details to be submitted with the tender).
- Master/Follower/Independent Scheme and selector switch. The Tap Changer shall employ, negative reactance or circulating current principle scheme for parallel operation with other three similar transformers but of different rating.
- Local /Remote switch
- KV meter (technical details to be submitted with the tender)
- Door operated lamp and anti-condensation heater.
- Heater switch ON/OFF to control anti-condensation heater
- Various control circuits controlled by Miniature Circuit Breakers

4.12.12 AUTOMATIC VOLTAGE REGULATING RELAY

The automatic voltage regulating relay shall, as a minimum, incorporate the following features:

- Rated voltage 110V AC.
- Rated Current 1 Amp.
- Initial time delay range 5-100 seconds, and ability to select Integrated delay or Definite time delay.
- Inter-tap delay 1-80 seconds
- Relay voltage setting, adjustable in steps of 1V from 85 - 130V
- Line drop compensation 0-20 V at rated current for both reactive and resistive setting
- Under voltage inhibit range 70%-90% & over current inhibit range 150%-250%
- Bandwidth range 0.5-5 % of voltage level
- Over voltage inhibit
- The AVR should have a selector switch with OFF/Manual/Auto
- Should be of Numeric Design.
- The Relay shall be Designed to employ both Circulating Current Compensation or Negative(Reverse) Reactance compounding to minimize circulating current for Parallel Transformer Operation.
- Tap changer Maintenance, by maintaining Tap Operation count.
- Tap Changer Mechanism Failure.

13. PARALLEL OPERATION

4.13.1 A scheme for operating this transformer in parallel with other similar units of different rating shall be provided and wired in the marshalling kiosk (box) by the manufacturer ready for interphasing.

4.13.2 The scheme shall maintain the transformers in stable parallel operation and limit circulating current to a minimum.

4.13.3 In the event of this transformer being disconnected from the system, its reconnection shall not result in its tap changer failing to operate automatically because of tapping discrepancy.

4.13.4 Suitable selector switch shall be provided, so that any one transformer of the group can at a time be selected as "Master", "Follower" or "Independent".

4.13.5 Necessary interlock blocking independent control when the units are in parallel shall be provided.

4.13.6 The scheme shall be such that only one transformer of a group can be selected as "Master".

4.13.7 An out –of- step device shall be provided for each transformer which shall be arranged to prevent further tapchanging when transformers in a group operating in "Parallel control" are one tap out-of-step.

4.14. MARSHALLING KIOSK (Box)

4.14.1 The transformer shall be complete with a marshaling kiosk (box).

The marshalling kiosk shall be of outdoor, IP 55, weatherproof, vermin-proof type with a hinged, lockable door fitted with a glass panel to facilitate reading of oil and winding temperature gauges without opening the door. The kiosk shall be mounted so that its window is approximately 1600mm above ground level; and shall accommodate at least the following items:-

a) Winding temperature indicator for both 66kV and 33kV with a maximum pointer drag hand type with a resetting knob and three separately adjustable mercury contacts for alarm, trip and operation of cooler control circuits as required.

b) Oil temperature indicator with a maximum pointer drag hand type with a resetting knob and two separately adjustable mercury contacts for alarm and trip.

c) Mechanical isolating switch for the incoming 3 phase, 4 wire, 400V±6% 50Hz supply to the marshalling kiosk. 400 volts and 230 volts socket outlets (British Standard design) shall also be provided in the kiosk.

d) A mechanical isolating switch for the outgoing 3 phase 4-wire 400V±6% 50Hz supply to the OLTC Motor drive unit.

e) Suitable starters for the cooling fan motors complete with thermal overload/single phase protection relay and normally-closed electrical auxiliary contacts for motor failure alarm/trip circuits.

f) A selector switch with 'OFF', 'HAND' and AUTO positions for cooling fan motors

g) An internal standard screw type illumination lamp and heater for the kiosk with respective switches. The lamp shall be door-switch operated.

h) Wiring, fuses, links, terminal boards and cable glands for bottom entry of multicore cables.

i) Anti-condensation heater with a switch.

j) Thermostat for anti-condensation heater control.

k) Hygrostat for anti-condensation heater control.

l) MCB control for each of the circuits.

m) Phase sequence relay for detection of wrong phase rotation for the supply to the fans and the OLTC Motor Drive Unit.

Detailed technical details, drawings, and schematics shall be submitted with the tender documents for evaluation.

4.15. AUXILIARY SUPPLIES, ALARMS & INDICATIONS

4.15.1 Equipment shall be rated for the following auxiliary power supplies:

(a)	Cooler control circuits:	230V±6%, single phase, 50Hz
(b)	Tap changer control:	230V±6%, single phase, 50Hz
(c)	Cooling fan motors:	400V±6%, three phase, 50Hz
(d)	Tap changer motor:	400V±6%, three phase, 50Hz

4.15.2 Alarms and Indications

The transformer shall be complete with standard alarms, signals and indications. These will include the following and the detailed list shall be submitted to KPLC for approval before manufacture:

- Tap changer not operating, alarm
- Tap changers out of step, alarm
- Voltage transformer failure
- Fan failure, alarm
- Oil/gas flow transformer, alarm
- Oil/gas flow transformer, trip
- On load tap changer protective relay operated, trip
- Oil gauge low level, alarm
- Oil gauge low level, trip
- Tap changer oil gauge level low, alarm
- Tap changer oil gauge level critical, trip
- Top oil temperature high, alarm
- Top oil temperature critical, trip
- Winding temperature high, alarm
- Winding temperature critical, trip

- Cooling fans automatically operated from the winding temperature indicat

4.16. TRANSFORMER TANK AND TANK COVER

4.16.1 The tank shall be of top cover design and shall be constructed of mild steel plate sufficient thickness and strength and shall be complete with all required accesso It shall be designed so as to allow the complete transformer when filled with oil t lifted by crane or jacks, transported by road, rail or on water without overstrainin joints and without causing subsequent leakage of oil. The minimum thickness fo sides, bottom and top cover shall be 8mm, 12mm and 12mm respectively.

4.16.2 The base of the tank shall be so designed that it shall be possible to move the complete transformer unit in any direction without injury when using rollers, and/c plates.

4.16.3 The tank and its accessories shall be so designed as to prevent collecting or tra of gases. Where this cannot be avoided, pipes shall be provided to vent the gas the main expansion pipe. The vent shall have a minimum outside diameter of 1 except for short pipes which may be 6.35mm minimum inside diameter.

4.16.4 All joints, other than those that may have to be broken shall be welded. Caulking unsatisfactorily welded joints is forbidden.

4.16.5. The main tank body shall be pressure tested and a certificate issued by the nati standards and testing laboratory ascertaining the soundness of all welded joints certified copy of previous certificate shall be submitted with the tender for evalua

4.16.6 Tank shall be provided with lifting lugs suitable for lifting the complete transform oil. Furthermore, a minimum of four accessible jacking positions shall be provide enable the complete transformer to be raised or lowered using jacks.

4.16.7 The transformer tank and all attachments normally under oil shall be capable of withstanding full vacuum. The oil conservator shall withstand at least 35% full Vacuum.

4.16.8 Tank cover shall be of such a design and construction as to prevent accumulatio water and shall be bolted to the flange on the tank top to form a weatherproof joi

4.16.9 Inspection openings shall be provided to give easy access to bushings, tapping s and for testing or general inspection.

4.16.10 Tank cover and inspection covers shall be provided with suitable lifting arrangements. Inspection covers shall not weigh more than 25 kg apiece.

4.16.11 The tank cover shall be fitted with isolated pockets for oil and winding temperature instrument bulbs. Protection shall be provided for each capillary tube. The pocket shall be fitted with a captive screwed cap to prevent the ingress of water. Detailed drawings shall be provided.

4.16.12 The pocket shall be located in a position of maximum oil temperature at continuous maximum rating and it shall be possible to insert and remove the instrument bulbs without lowering the oil in the tank.

4.16.13 Gaskets for weather and oil-tight joint faces shall be of synthetic rubber-and-cork composition and shall have a minimum thickness of 5mm, except that where jointing faces are precision-machined thinner gaskets may be used.

4.16.14 A tinned copper jumper of at least 40mmx1.2mm in dimensions shall be fixed between tank and top cover using bolt, washers and nut all in stainless steel.

4.17. PAINT WORK

Cleaning and painting shall be in accordance with the following requirements. Any deviations in methodology shall be stated and may only be those that will produce demonstrably superior results.

A test report for the paintwork issued by the national standards and testing laboratory shall be produced at the time of acceptance testing of the transformer.

4.17.1 Tanks and Accessories

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

(b) 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 coat shall be high gloss of shade No. 632 (Admiralty Grey) according to BS 381C. The total paint thickness shall not be less than 100µm at any point.

(c) 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 on white synthetic enamel paint is to be used for painting the inside of all

oil filled chambers, including transformer tanks and CT chambers & covers. The final coat shall be of a light-coloured anti-condensation finish.

4.17.2 **Radiators**

(a) Radiators shall be thoroughly degreased and treated externally by phospating and/or other rust-inhibiting process.

(b) 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.

4.18. COOLING SYSTEM

4.18.1 Radiators shall be supplied in banks as suitable. Each bank shall be fitted with gate valves with legible labelling for OPEN/CLOSED positions and used for full isolation from the main tank. Each radiator shall have a top and bottom isolating butterfly valve. The radiator design shall exclude accumulation of rainwater.

4.18.2 Radiator banks shall be mounted directly to the transformer main tank for best use of space. Adequate oil seals shall be provided for each radiator.

4.18.3 Each radiator shall have a bleeding facility (to allow escape of air) on top.

4.18.4 Separately mounted ac motor driven fans fitted with wire mesh guards shall be provided for the radiators. The fan motors shall be totally enclosed, weatherproof, outdoor type suitable for continuous operation and shall be fitted with terminal boxes and glands to accommodate multicore electric supply cables. Technical details of the fan motor shall be submitted with the tender.

4.18.5 Suitable starters, protection/warning devices, contactors and switches for the motors shall be provided as stipulated in clause 4.14 above.

4.18.6 Suitable lifting lugs shall be provided for removal and assembly of radiators.

4.18.7 The complete cooling system and the fittings shall be fully co-ordinated. Where necessary, the cooling fan motors shall be fired in designed groups and in such sequence as to achieve the desired control at maximum efficiency and safety.

4.19. FITTINGS AND ACCESSORIES

(All fittings & accessories including Gas & Oil Actuated Relays shall be of a design & make approved by KPLC*)*

4.19.1 Conservator

The transformer shall be complete with a conservator having a filling orifice, an isolating valve, a drain valve and a cobalt free dehydrating breather (with oil seal) which shall be accessible from ground level. The drain pipe shall be located at the lowest point in the conservator in its final installed position and welded such that it can drain all the sludge in the conservator.

The conservator shall be partitioned proportionately to separate the main tank oil and the tapchanger oil. Each compartment to be fitted with a breather and an oil level indicator with electrical contacts for alarms. The main tank conservator shall be fitted with aircell. The conservator complete with drain valve shall be in such a position as not to obstruct the electrical connections to the transformer. An oil gauge shall be provided at one end of the conservator marked with oil levels that can be read by a person standing on the ground. Expansion joints may be provided in the inlet and outlet pipes to the transformer as necessary.

4.19.2 Gas and Oil Actuated Relay (Transformer main tank)

The transformer shall be complete with a gas and oil actuated relay (Buchholz relay) of double float type with tripping contacts to detect accumulation of gas and sudden changes of oil pressure. Shut off valves and flange couplings shall be provided to facilitate easy removal of the relay without lowering oil level in the main tank. A bleed valve for gas venting, a test valve and a terminal box suitably wired to the marshalling kiosk shall also be provided. The gas venting pipe shall be brought down to a height reachable from ground level and shall be fitted with a gas sampling device at the end. Provision should be made on the relay for simulation of gas and oil surge for testing purposes.

4.19.3 Gas and Oil Actuated Relay (Tap changer compartment)

Tap changer compartment shall be complete with an oil surge relay with tripping contacts to detect sudden changes of oil pressure. Shut off valves and flange couplings shall be provided to facilitate easy removal of the relay without lowering oil level in the tap changer compartment. A bleed valve for gas venting, a test valve and a terminal box suitably wired to the marshalling kiosk shall also be provided. The gas venting pipe shall be brought down to a height reachable from ground level and shall be fitted with a gas sampling device at the end. Provision should be made on the relay for simulation of gas and oil surge for testing purposes.

4.19.3 Pressure Relief Device

A pressure relief device shall be provided for the main tank, complete with trip contacts suitably wired to the marshalling kiosk. The device shall be resettable after an operation. Details of the device shall be submitted with the offer.

4.19.4 **Winding Temperature Indicator**

(a) The transformer shall be provided with winding temperature indicator, maximum indicator and associated current transformers. The temperature indicator shall have a scale ranging from 20°C to 150°C, preferably uniformly divided and its type to be stated in the bid. The indicator shall have two sets of independently adjustable contacts as follows:

(i) **Alarm** Adjustable setting: 70°C to 150°C
Fixed differential: Not more than 10°C

(ii) **Trip** Adjustable setting: 70° to 150°C
Fixed differential: Not more than 10°C

(b) All contacts shall be adjustable to a scale and shall be accessible on removal of the cover for dial type devices. For purposes of (i) and (ii) above, the contacts shall be suitable for making or breaking 150VA between the limits of 30 and 250 V a.c. or d.c., and making 500 VA between the limits of the 110 and 250 V d.c.

(c) Isolating and test links shall be provided in a control cubicle to allow for measuring the oil temperature and testing the heater coil.

(d) The current transformer providing winding temperature indication shall be located at the discretion of the manufacturer, in the best position for the duty.

(e) Calibration of indicator shall be related to the winding having the maximum temperature rise.

(f) If the value on the winding temperature indicator varies by more than 3°C from the values derived from the tests specified in clause 5, then adjustments shall be made to the equipment to achieve these limits.

4.19.5 **Oil Temperature Indicator**

The transformer shall be complete with an oil temperature indicator with a maximum pointer and contacts for alarm and trip signals, similar to winding temperature indicator above.

4.20. ACCESSORIES

The following shall be provided:

4.20.1 Valves with blank flanges fitted at the top and bottom for oil filtration purposes, having the following features:

(a) The valve located at the bottom of the tank shall also be suitable for draining oil from the transformer tank.

(b) All valves shall close with a clockwise rotation. The main inlet and outlet valves shall be provided with "open" and "closed" position indicators, visible from ground level.

(c) All valves shall have provision for padlocking in the open and closed position for operation purposes. The hole for the padlock shall have a clearance of not less than 8mm and not more than 10mm. Locking pin shall be of anti-rattle design to limit noise emissions. The locking padlocks shall be provided.

(d) Closed/Open positions of all valves must be clearly marked.

4.20.2 Oil sampling device appropriately located to obtain samples of transformer oil from the top and bottom of the tank.

4.20.3 Two earthing terminals located at diagonally opposite corners of the tank.

4.20.4 Air release valves or plugs for the main tank, suitably located.

4.20.5 Non-deteriorating detailed diagram and rating plates.

4.20.6 Other Fittings/accessories

Diagram plate
Plate of valves and oil piping.
Motor drive electrical and protection diagram.
Cooling control electrical and protection diagram.
Electrical scheme for operating this transformer in parallel with other similar units.
Detailed list of the transformer equipment & fittings including their drawings, brochures & instruction manuals.
Shipping data
Detailed erection, installation, operation and maintenance manuals in English language.
Testing Plan.
Impact recorder for the whole duration of transit and a report provided afterwards.

2 Sets of keys for padlocking devices.
(all control boxes as well as valves to be padlocked)

4.21. TRANSFORMER OIL

The transformer and all associated oil immersed equipment shall be supplied oil filled. The oil shall comply with all the requirements of IEC 60296 (class 1: un-inhibited oil). Tenderer shall provide the chemical composition and properties of the oil and the replacement cycle over the expected life of the transformer.

4.22. CAPITALIZATION

4.22.1 Transformer losses shall be capitalized at the following rates to facilitate evaluation and comparison of tenders.

Total load losses, ONAF rating (copper loss + stray loss) at rated current at 75^0 C in KW, including auxiliary losses	US$ 2577 per kW for 35 years
Total no load losses in KW (core loss + dielectric loss)	US$ 4339 per kW for 35 years

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 35 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, including auxiliary losses} + US$ 4339 X {Total no load losses in KW (core loss + dielectric loss)}.

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

4.23. QUALITY MANAGEMENT SYSTEM

4.23.1 The bidder 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.

4.23.2 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.

4.23.3 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 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.

1) Copies of type test certificates and type test reports for similar rating transformer to be submitted for tender evaluation shall include:

a) Dielectric tests to IEC 60076 (Lightning Impulse Test).
b) Short circuit withstand test to IEC 60076.
   - thermal ability of the transformer to withstand short circuit,
   - ability of the transformer to withstand the dynamic effects of short circuit
c) Temperature rise test to IEC 60076.

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

2) Copies of type test certificates and type test reports for the on load tap changer to be submitted for tender evaluation shall include:

a) Dielectric tests (Lightning Impulse and Power Frequency Withstand Tests).
b) Short circuit withstand test.
c) Temperature rise test.
d) Switching tests.
e) Transition impedance test.
f) Mechanical tests.

5.3 The transformer shall be subject to acceptance tests at the manufactures' works before dispatch. Acceptance tests shall be witnessed by Engineers appointed by The Kenya Power and Lighting Company Limited 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,
- Magnetic balance,
- Measurement of no-load loss and current,
- Measurement of load loss (at normal & extreme taps),
- Tests on on-load tap-changer,
- Tests on on-load tap-changer remote control panel,
- Efficiency at 50%, 75%, 100% loading at unity p.f and rated terminal voltage (Corrected to 75°C),

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

- Temperature rise test.
- Lightning impulse withstand test.

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

- Visual Inspection (verification of auxiliaries, fittings & accessories, markings & nameplates, paintwork, workmanship and finish),
- Measurement of power taken by the fans,
- Insulation dissipation factor,
- Condenser bushing capacitance and tan delta,
- DGA (dissolved gas analysis) of the insulating oil.- To be performed before and after temperature rise test,
- Acoustic and sound level,
- Insulation tests on the auxiliary wiring in the marshalling box and remote tap changer control panel,
- Measurement of zero sequence impedance,
- Measurement of harmonics no-load current,
- CT ratio and polarity,
- Measurement of zero phase sequence impedance,
- Paint thickness,
- Tank pressure test,
- Sweep frequency response analysis.

5.4 Testing Facility

5.4.1 The bidder shall provide current e-mail address, fax and telephone numbers and contact person at the Testing Authority where Type Tests and Special Tests to IEC 60076 were carried out.

5.4.2 All test and measuring equipment to be used during acceptance testing shall have been calibrated and copies of valid calibration certificates shall be provided to Kenya Power Engineers. A detailed list of workshop tools, test/measuring equipment and list of tests to IEC 60076 that can be carried out by the manufacturer shall be submitted with the tender for evaluation.

5.5 Test reports for each transformer (including its individual components) shall be submitted to The Kenya Power and Lighting Company for approval before shipment.

5.6 During delivery of the transformers, KPLC will inspect them and may perform or have performed any of the relevant tests in order to verify compliance with the specification. The supplier shall replace/rectify without charge to KPLC, transformers which upon examination, test or use fail to meet any or all 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 it from any damage in transportation and handling. It shall be dispatched oil-filled and fully wired. All piping shall follow the contour of the transformer as closely as possible to avoid damage during transportation and handling. Auxiliary equipment and accessories/fittings shall be protected against mechanical damage and oil vandalism.

6.2 Each assembly and package of items associated with the transformer shall be suitably marked for ease of identification. Parts detached for shipping including oil chambers shall be protected against moisture and dust ingress. Sufficient number and sizes of oil seals, gaskets and other necessary parts shall be provided.

6.3 In addition to markings and labels required elsewhere in the tender & specification, each equipment and component shall be marked in accordance with the relevant IEC standard. Each transformer shall be provided with a rating 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 durable.

6.4 In addition, the name 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.' all marked indelibly and legibly as in 6.3.

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;
b) Copies of the Manufacturer's catalogues, brochures, drawings and technical data;
c) Sales records and at least four customer reference letters;
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.

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;
b) Design drawings & construction details of the transformer including 3-D views;

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 9001:2008;
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).

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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, 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 NO.	DESCRIPTION	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 23MVA 66/33kV power transformer to KPLC store/site as per 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 transformer for The Kenya Power & Lighting Company Ltd	
2	Applicable standards	
3	Terms and definitions	
4.1	Service conditions: clauses 4.1.1 to 4.1.2	
4.2	General requirements: clauses 4.2.1 to 4.2.19	
4.3	Ratings	
	a) 1. With ONAN cooling, MVA	
	2. With ONAF cooling, MVA	
	b) Rated no load voltage	
	HV-kV	
	LV-kV	
	c) Temperature rise of top oil (deg.C), 2200m asl	
	d) Temperature rise of winding measured by	

	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)	66kV winding
	Short circuit current density (A/mm^2)	33kV 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	
4.4.1	Vector group	
4.4.2	Voltage variations	
4.4.3	Windings and connections: clauses 4.4.3 to 4.4.12	
	a) Conductor area in mm^2	
	i) HV	
	ii) LV	
	iii) Tertiary (where applicable)	
	b) Current density in A/mm^2, ONAF	

d by: Head of Section, Tech Stds & Specs	Authorized by: Head of Department , R & D
d:	Signed:
2014-03-24	Date: 2014-03-24

CLAUSE NO.	DESCRIPTION	BIDDER'S OFFER
	resistance.	
	i) With ONAN cooling (deg. C), 2200m asl	
	ii) With ONAF cooling (deg. C), 2200m asl	
	iii) Period of operation of transformer at full load without calculated winding hot spot temperature exceeding 140°C and with - 50% coolers off - 100% coolers off	
	e) Rated frequency (Hz)	
	f) Noise level when energized at normal voltage and normal frequency at no load	
4.3.4	Demonstration of thermal ability of offered	

CLAUSE NO.	DESCRIPTION	BIDDER'S OFFER
	i) HV	
	ii) LV	
	iii) Tertiary (where applicable)	
	c) Type of windings	
	i) HV	
	ii) LV	
	iii) Tertiary (where applicable)	
	d) Winding insulation type and class, graded or ungraded	
	i) HV	
	ii) LV	
	e) Insulating material	
	i) Turn insulation; HV side	
	ii) Turn insulation; LV side	
	iii) Turn insulation; Tertiary (where applicable)	
	iv) Between HV and LV	
	v) For core bolts, washers and end plates	
	f) Tapping connection	
	g) Type of axial support	
	i) HV winding	
	ii) LV winding	
	h) Type of Radial Coil support	
	i) HV winding	
	ii) LV winding	
4.5	Tapping	
	i) Tap step (percent)	
	ii) Total tap ranges - (+) % to (-) %	
	iii) Tapping provided at HV	
4.6	Core and flux density: clauses 4.6.1 to 4.6.15	
	a) Type of transformer (stacked core type required)	
	b) Material of Laminations	
	i) Grade of CRGO & manufacturer	
	ii) Thickness of single lamination	
	iii) Stack-factor	
	iv) Specific weight/m^3	
	v) Specific loss watts/kg.	

CLAUSE NO.	DESCRIPTION	BIDDER'S OFFER
	vi) Net core area in sq. meters	
	c) Maximum flux density at rated voltage and frequency in Tesla	
	d) Allowable maximum flux density for one minute and for five seconds	
	e) Flux density at which core saturates	
	f) Magnetization curve and design calculations	
4.7	Losses, regulation and impedance: clauses 4.7.1 to 4.7.4	
	a) Magnetization data at no load, at 90% rating, at 100% rating and at 110% rated voltage and load and frequency	
	i) No-load current in Amps	
	ii) Power factor	
	iii) Total no load losses in KW (core loss + dielectric loss)	
	b) Total load losses (copper loss + stray loss) at rated current at 75^0 C in KW	
	i) For ONAN Rating	
	ii) For ONAF Rating (including auxiliary losses)	
	iii) Auxiliary Losses	
	c) Impedance voltage at rated current and frequency at 75^0 C (%)	
	i) Positive sequence at normal tap in %	
	ii) Positive sequence at Max. Voltage tap in %	
	iii) Positive sequence at Min. voltage tap in %	
	d) Minimum short-circuit apparent power for HV & LV system	
	e) symmetrical short circuit current	
	f)Reactance per phase at rated frequency at normal tap on rated MVA base: - HV to LV - %	
	g) Resistance at 75^0 C of:	
	i) HV Winding in ohms (at principle & extreme taps)	
	ii) LV Winding in ohms	
	h) Efficiency at 75^0 C taking into account input of cooling plant loss:	

CLAUSE NO.	DESCRIPTION	BIDDER'S OFFER
	At Unity Power Factor and at 0.8 Power Factor Lagging:	
	i) At 125% full load	
	ii) At 100% full load	
	iii) At 75% full load	
	iv) At 50% full load	
	I)Regulation at full load & at 75^0 C	
	i) At unity p.f. in %	
	ii) At 0.8 p.f. (lag) in %	
4.8	Terminals arrangement & bushings: clauses 4.8.1 to 4.8.9	
	a) Details of Bushings (indicate details for HV, LV & N)	HV LV N
	i)Type	
	ii)One minute power frequency withstand voltage kV (rms), dry	
	iii)One minute power frequency withstand voltage kV (rms), wet	
	iv)1.2/50μs lightning impulse voltage, dry (kVp)	
	v) Total creepage distance in Air (mm)	
	vi) Weight of bushings (kg)	
	vii) Maximum current rating of each bushing	
	viii) Quantity of oil in the bushings in liters	
4.9	Current transformers: clauses 4.9.1 to 4.9.4	
	a) HV side	
	i) Phase A	
	ii) Phase B	
	iii) Phase C	
	b) LV side	
	i) Phase a	
	ii) Phase b	
	iii) Phase c	
	iv) Neutral n	
	c) Tertiary, where applicable	
4.10	Air clearance: clauses 4.10.1 to 4.10.3	

CLAUSE NO.	DESCRIPTION	BIDDER'S OFFER
	i) HV - HV	
	ii) HV - LV	
	iii) HV - Earth	
	iv) LV - LV	
	v) LV - Earth	
	vi) Where applicable: HV – Tertiary, LV – Tertiary, Tertiary – Tertiary phase to phase & phase to earth	
4.11	Insulation levels at 22000m above sea level: indicate for HV, LV, N & Tertiary where applicable	HV LV N Tertiary
	a) Nominal system voltage, kV	
	b) Highest system voltage, kV	
	c) Lightning Impulse withstand voltage, 1.2/50µs, dry, +ve (kV, peak)	
	d) Power frequency withstand voltage, 50Hz, 60s, wet, (kV, rms)	
	e) Test voltages to be used at factory during acceptance testing	
	f) Altitude of factory	
4.12	On load tap changer: clauses 4.12.1 to 4.12.12	
	i) Manufacturer and Type & Model No. of OLTC (must be of a Type & make approved by KPLC)	
	ii) Rating	
	iii)Rated voltage kV	
	iv) Rated current Amps	
	v)Step voltage kV	
	vi) No. of steps No.	
	vii) Approximate over all dimensions (Width x Breadth x Depth) in mm	
	viii) Approximate overall weight in kg.	
	ix) Time to complete one tap change step in seconds	
	x) Technical documents required for the OLTC offered:	

CLAUSE NO.	DESCRIPTION	BIDDER'S OFFER
	-type test certificates and type test reports, -manufacturing experience, -sales records, -installation instructions and manuals and -manufacturer's authorization.	
	xi) Automatic Voltage Regulating Relay (to be of KPLC approved design & make and technical details shall be submitted with the tender)	
4.13	Parallel operation: clauses 4.13.1 to 4.13.7	
4.14	Marshalling box: clauses 4.14.1 a) to m)	
4.15	Auxilliary supplies, alarms & indications: clauses 4.15.1 to 4.15.2	
4.16	Transformer tank and tank cover: clauses 4.16.1 to 4.16.14	
	a) Bolted top cover design	
	b) Approximate weights	
	i) Core (kg)	
	ii) Windings (kg) (Copper & Insulation separately)	
	iii) Tank & Fittings (kg)	
	iv) Oil (kg)	
	v) Total weight of complete transformer (kg)	
	c) Details of Tank	
	i) Material for tank	
	ii) Type of the tank	
	iii) Thickness of sides in mm	
	iv) Thickness of Bottom in mm	
	v) Thickness of Cover in mm	
	vi) Thickness of Radiators in mm	
4.17	Paint work: clauses 4.17.1 to 4.17.2	
4.18	Cooling system: clauses 4.18.1 to 4.18.7	
	a) Radiators	
	i) Type and make of material used for radiators	
	ii) Total radiating surface in m^2	
	iii) Total weight of Radiators in kg	
	b) Fan motor	

CLAUSE NO.	DESCRIPTION	BIDDER'S OFFER
	i) Make and Type (Details)	
	ii) Number connected	
	iii) Number in standby	
	iv) Rated power & efficiency of each motor --- (kW, %)	
	v) Rated Voltage	
	vi) Temperature at which control is adjustable	
	vii) Capacity in Litres/Minute	
4.19 to 4.20	Fittings and accessories: clauses 4.19.1 to 4.20.6	
	a)Capacity of conservator vessel (Litres)	
	b)Type of oil preservative installed	
	c)Valve sizes and Numbers to be fitted	
	i) drain valves -mm- No.	
	ii) filter valves -mm- No.	
	iii) sampling valves -mm- No.	
4.21	Transformer oil	
	a) Transformer to be supplied oil filled	
	b) Chemical composition and properties of oil	
	c) Replacement cycle	
	d) Applicable standard and class of oil	
	e) Quantity of oil in liters	
4.22	Capitalization: clauses 4.22.1 to 4.22.2	
4.23	Quality management system: clauses 4.23.1 to 4.23.3	
	Copy of ISO 9001: 2008 certificate submitted	
5.1	Test Standard	
	Responsibility of testing transformer & manufacturer's capability	
5.2	Copies of type test reports to IEC 60076 submitted with tender	
	Lightning impulse withstand test	
	Short circuit withstand test	
	Temperature rise test *Note: Temperature rise test to IEC 60076 if conducted at the manufacturer's premises (factory) shall be in the presence of representatives of third party Testing Laboratory that is accredited as per ISO/IEC 17025. The representatives shall countersign the test reports.*	

CLAUSE NO.	DESCRIPTION	BIDDER'S OFFER
5.3	Acceptance tests at manufacturers premises – provide list of all tests that will be carried out in 5.3.1 to 5.3.3	
5.3.1	Routine tests to IEC 60076 – to be done during factory acceptance testing	
5.3.2	Type tests to IEC 60076 – to be done during factory acceptance testing	
	Temperature rise test	
	Lightning impulse withstand test	
5.3.3	Additional tests – to be done during factory acceptance testing	
5.4	Contact details for testing authority	
	Calibration of test and measuring equipment	
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: clauses 6.1 to 6.4	6.
	a) Contents of name plate	
	b) Method of marking to ensure it is permanent, legible and durable	
7	Documentation: clauses 7.1 to 7.2	
	Other details required with the tender	
	Overall dimensions of offered transformer including cooling gear, tap changing gear etc.	
	-Length mm	
	-Breadth mm	
	-Height mm	
	-General arrangement drawing Number	
	Customer reference list and four customer reference letters for exact or similar rating of transformers sold in the last five years	
	Manufacturer's experience	
	Manufacturer's capacity (number of units per month)	
	Detailed list of all the required fittings and accessories indicating type/model number, manufacturer and quantities	
	List catalogues, brochures and technical data	

CLAUSE NO.	DESCRIPTION	BIDDER'S OFFER
	submitted to support offer	
	Manufacturer's Declaration of Conformity to IEC 60076 (all parts)	
	Copy of accreditation certificate to ISO/IEC 17025 for the testing laboratory used to carry out type tests of similar transformer	
	Shipping details – List parts normally detached for transport and indicate protection against mechanical damage and oil vandals for entire transformer and components	
	Deviations from tender specifications (indicate supporting documents submitted)	

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Manufacturer's Name, Signature, Stamp and Date