



Kenya Power

TITLE:

SPECIFICATION FOR:

66kV VOLTAGE TRANSFORMER:
Part 1: Inductive Voltage
Transformer

Doc. No.

KP1/3CB/TSP/10/009-1

Issue No.

2

Revision No.

0

Date of
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2013-02-19

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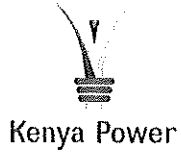
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0.1 Circulation List

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1	Research & Development Manager
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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 Rev 0	2013-02-19	Cancel and replaces Issue 1 Rev 0 dated 2006-10-23 and all previous issues	S. Kimiti 	G. Owuor

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FOREWORD

This specification has been prepared by the Research and Development Department in collaboration with the Technical Services Department both of The Kenya Power and Lighting Company Limited (abbreviated as KPLC) and it lays down requirements for 66kV Voltage Transformers. It is intended for use by KPLC in purchasing the equipment.

1. SCOPE

- 1.1 This specification is for newly manufactured voltage transformers for use with electrical measuring instruments and electrical protective devices on system highest voltage of 72.5kV at power frequency of 50Hz.
- 1.2 The specification also covers inspection and test of the voltage 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 66kV voltage transformers acceptable for use in the company and it shall be the responsibility of the supplier to ensure adequacy of the design, good engineering practice, adherence to the specification and applicable standards and regulations as well as ensuring good workmanship in the manufacture of the voltage transformers for The Kenya Power & Lighting Company.

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.

IEC 60044-2: Instrument Transformers – Part 2: Inductive Voltage Transformers

IEC 60815: Guide for the selection of insulators in respect of polluted conditions

3. TERMS AND DEFINITIONS

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For the purpose of this specification the definitions given in the reference standards shall apply.

4. REQUIREMENTS

4.1 SERVICE CONDITIONS

4.1.1 Site Conditions

The voltage transformer shall be suitable for continuous outdoor operation in tropical areas inland, cities and suburbs of cities, along the coast and with the following conditions:

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

4.1.2 System Conditions

The voltage transformer will be connected to overhead system operating at a nominal voltage of 66kV with maximum system voltage (highest voltage for equipment) of 72.5kV, 50Hz and exposed to over-voltages of atmospheric origin.

4.2 MATERIALS, DESIGN AND CONSTRUCTION

4.2.1 The voltage transformer shall be designed, manufactured and tested to IEC 60044-2 and the requirements of this specification.

4.2.2 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.

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- 4.2.3 The design shall 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.
- 4.2.4 All parts of the transformer, including insulators with their mountings, shall be designed so as to avoid pockets in which water can collect.
- 4.2.5 The voltage transformer shall be outdoor; oil insulated and hermetically sealed type. The insulator portion of the voltage transformer shall be made of high-grade brown-glazed porcelain.
- 4.2.6 The voltage transformer shall be suitable for vertical installation on a steel structure.
- 4.2.7 All parts and components of the voltage transformer shall be resistant to atmospheric corrosion.
- 4.2.8 The voltage transformer shall have primary, secondary and earth terminals.
- 4.2.9 Primary Terminal
- 4.2.9.1 The primary terminal shall be of high conductivity copper, tin-plated, suitable for connection of both copper and aluminium conductors.
- 4.2.9.2 It shall have palm clamp connectors suitable for both stranded conductor and tube connection. Conductor overall diameter shall be 18.3mm to 25mm and busbar tubes of 76.2mm diameter.
- 4.2.9.3 The voltage to be transformed shall be applied to the primary winding.
- 4.2.10 Secondary Terminals
- 4.2.10.1 The secondary terminals of the voltage transformer shall be wired to a terminal box.
- 4.2.10.2 The terminal box shall be weatherproof with a cable plate at the bottom and shall be covered with removable plate.
- 4.2.10.3 The secondary winding shall supply the voltage circuits of measuring instruments, meters, relays or similar apparatus.
- 4.2.10.4 The secondary terminal box of the voltage transformer shall be complete with protection fuses complete with fuse links.

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4.2.11 The voltage transformer shall be designed and constructed to withstand without damage, when energized at rated voltage, the mechanical and thermal effects of an external short-circuit for the duration of 1 s.

4.2.12 The voltage transformer shall have cores and ratings as per clause 4.3.

4.3 Ratings

The ratings of the voltage transformer shall be as indicated in Table 1.

Table 1: Ratings

Nominal primary voltage		66000/√3 volts		
Nominal secondary voltage		110/√3 volts		
Rated frequency		50 Hz		
Minimum creepage distance of insulator		2250mm		
Minimum lightning impulse withstand voltage, primary winding		325kV (peak)		
Minimum power frequency withstand voltage, primary winding, dry		140kV (r.m.s.)		
Minimum power frequency withstand voltage, secondary winding, r.m.s.		5kV (r.m.s.)		
Maximum temperature rise	Windings	65K		
	Oil (at top of tank)	55K		
Rated voltage factor		1.2 Continuous		
		1.5 for 30 sec.		
Permissible partial discharges (PD)	PD test voltage (r.m.s) = U_m	10pC		
	PD test voltage (r.m.s) = $1.2U_m/\sqrt{3}$	5pC		
Transmitted overvoltage limits {peak value of applied voltage(U_p) = $1.6 \times \sqrt{2} \times U_m / \sqrt{3}$, Wave-shape characteristics: conventional front time (T_1) = $0.5\mu s \pm 20\%$, time to half value (T_2) $\geq 50\mu s$; as per IEC 60044-2		1.6kV (peak value limits)		
Secondary windings core 1, core 2 and core 3				
	Terminal Markings	Voltage Output	Class	VA (pf 0.8 lagging)
Core 1	1a-1n	110/√3	0.5	75
Core 2	2a-2n	110/√3	3P	150
Core 3	da-dn	110/√3	3P	50

Notes:

(1) The voltage transformer shall be installed at altitude of 2200m asl and if tests will be carried out at altitudes below 1000m, the limits of temperature rise given in Table 1 above

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shall be reduced by 0.4% for each 100m that the altitude at the operating site exceeds 1000m (see clause 5.4 of IEC 60044-2.

(2) The voltage transformer shall be installed at altitude of 2200m asl, the arcing distance under the standardized reference atmospheric conditions shall be determined by multiplying the withstand voltages required at the service location by a factor k in accordance with Figure 1 and clause 4.2.1 of IEC 60044-2 ($k = e^{m(H-1000)/8150} = e^{(2200-1000)/8150} = 1.16$, with $m=1$ as per IEC 60044-2 and therefore arcing distance shall be $325kV_p * 1.16 = 377kV_p$, the nearest standard value is 450kV_p).

4.4 Quality Management System

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

4.4.2 The Manufacturer's Declaration of Conformity to applicable 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.

4.4.3 The bidder shall indicate the delivery time of the voltage transformers, manufacturer's monthly & annual production capacity and experience in the production of the type and size of items being offered. A detailed list & contact addresses (including e-mail) of the manufacturer's previous customers for similar type of voltage transformers sold in the last five years as well as reference letters from at least four of the customers shall be submitted with the tender for evaluation.

5. TESTS AND INSPECTION

5.1 The voltage transformer shall be inspected and tested in accordance with the requirements of this specification and IEC 60044-2. It shall be the responsibility of the supplier to perform or to have performed the tests specified.

5.2 Copies of previous Type Test Certificates and 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. The accreditation certificate for the third party testing laboratory shall also be submitted with the tender (all in English Language).

Copies of Type Test Reports to be submitted shall include the following tests as per IEC 60044-2:

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- 5.2.1 Temperature rise test;
- 5.2.2 Short-circuit withstand capability test;
- 5.2.3 Lightning impulse test (with both positive and negative polarity – fifteen consecutive impulses of each polarity);
- 5.2.4 Chopped impulse test on primary winding;
- 5.2.5 Mechanical tests;
- 5.2.6 Transmitted overvoltage measurement;
- 5.2.7 Wet test for outdoor type transformers;
- 5.2.8 Determination of errors;

- 5.3 Routine test reports for the voltage transformers to be supplied shall be submitted to KPLC for approval before shipment/delivery of the goods. KPLC Engineers (2) will witness tests at the factory before shipment.

Tests to be witnessed by KPLC Engineers at the factory shall be in accordance with IEC 60044-2 and shall include the following:

- 5.3.1 Verification of terminal markings;
 - 5.3.2 Power-frequency withstand test on primary windings;
 - 5.3.3 Partial discharge measurement;
 - 5.3.4 Power-frequency withstand tests on secondary winding;
 - 5.3.5 Power-frequency withstand tests between sections;
 - 5.3.6 Determination of errors;
 - 5.3.7 Accuracy of measuring voltage transformers at 80%, 100% and 120% of rated voltage, at rated frequency and at 25% and 100% of rated burden;
 - 5.3.8 Temperature-rise test for residual voltage transformer;
 - 5.3.9 Tests for accuracy of protective voltage transformers at 2%, 5% and at 100% of rated voltage and at rated voltage multiplied by the rated voltage factor, at 25% and at 100% of rated burden at a power factor of 0.8 lagging;
 - 5.3.10 Measurement of capacitance and dielectric dissipation factor;
 - 5.3.11 Chopped impulse test on primary winding;
 - 5.3.12 Transmitted overvoltage measurement;
 - 5.3.13 Visual inspection of complete voltage transformer.
- 5.4 Upon delivery of the voltage 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 extra or additional charge to KPLC, voltage transformers which upon examination, test or use fail to meet any of the requirements in the specification.

6. MARKING AND PACKING

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6.1 The voltage transformer shall be fitted with a permanent rating plate indicating the following:

- a) The manufacturer's name or identification mark;
- b) The type reference number and serial number;
- c) The rated primary and secondary voltage;
- d) The rated frequency (50Hz);
- e) The rated output and the corresponding accuracy class of each secondary winding;
- f) The highest voltage for equipment (72.5kV);
- g) The rated insulation level (140kV(rms)/325kV_p);
- h) The class of insulation;
- i) The short-time current ratings and time;
- j) The use of each secondary winding and its corresponding terminals;

All the marking shall be by engraving (or superior method) and shall be permanent and legible.

6.2 The terminals shall be marked clearly and indelibly and in accordance with IEC 60044-2. The terminal marking shall consist of letters followed by numbers.

6.3 Letters A, B, C denote fully insulated primary winding terminals and the lower-case letters a, b, c and n denote the corresponding secondary terminals. Letters da and dn denote the terminals of windings intended to supply a residual voltage.

6.4 Terminals having corresponding capital and lower-case markings shall have the same polarity at the same instant.

6.5 The voltage transformers shall be delivered packed in wooden crates firmly bound together to avoid damage during transportation and storage.

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 technical 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 for the last five years and at least four customer reference letters;
- d) Details of manufacturing capacity and the manufacturer's experience;

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- e) Copies of required type test reports by a third party testing laboratory accredited to ISO/IEC 17025;
- f) Copy of accreditation certificate for the testing laboratory.

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

- a) Guaranteed Technical Particulars,
- b) Design Drawings with details of voltage transformer to be manufactured for KPLC,
- 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) Detailed test program to be used during factory testing,
- e) Marking details and method to be used in marking the voltage transformers,
- f) Manufacturer's undertaking to ensure adequacy of the design, good engineering practice, adherence to the specification and applicable standards and regulations as well as ensuring good workmanship in the manufacture of the voltage transformers for The Kenya Power & Lighting Company
- g) Packaging details (including packaging materials and their dimensions).

7.3 A set of three (3) original hard cover installation and technical manuals for the voltage transformers shall be supplied with the equipment during delivery.

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ANNEX A: Guaranteed Technical Particulars (to be filled and signed by the Manufacturer and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records, four customer reference letters, details of manufacturing capacity, the manufacturer's experience and copies of complete type test certificates and type test reports for tender evaluation, all in English Language)

Tender No

Clause Number	Description	Bidder's Offer (indicate details of the voltage transformer offered)
-	Name of the Manufacturer, address and Country of manufacture	
	Name & address of Bidder	
	Type/Model Number offered	
Clause Number as per specification (please refer to the specification)		
1.	Scope It shall be the responsibility of the supplier to ensure adequacy of the design, good engineering practice, adherence to the specification and applicable standards and regulations as well as ensuring good workmanship in the manufacture of the voltage transformers for The Kenya Power & Lighting Company	
2	Applicable Standards	
3	Terms and Definitions	
4.1.1	Site Conditions	
4.1.2	System Conditions	
4.2.1	Design Standard	
4.2.2	Materials	
4.2.3	Variations of load & voltage	
4.2.4	Rain water	
4.2.5	Outdoor, oil insulated & hermetically sealed type Insulator portion of brown porcelain	
4.2.6	Vertical installation on a steel structure	
4.2.7	All parts & components to be corrosion resistant	
4.2.8	Primary, secondary and earth terminals	
4.2.9.1	Primary terminal to be high conductivity copper, tin plated	
4.2.9.2	Primary terminal to have palm clamp connector	

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Clause Number	Description	Bidder's Offer (indicate details of the voltage transformer offered)
	clamp suitable for conductor overall diameter of 18.3mm to 25mm and tubes of 76.2mm diameter	
4.2.9.3	The voltage to be transformed shall be applied to the primary winding	
4.2.10.1	Secondary terminals wired to terminal box	
4.2.10.2	Terminal box shall be weather-proof with cable plate at bottom	
4.2.10.3	The secondary winding shall supply the voltage circuits of measuring instruments, meters, relays or similar apparatus	
4.2.10.4	The secondary terminal box of the voltage transformer shall be complete with protection fuses complete with fuse links	
4.2.11	Short-circuit withstand, 1 s	
4.3	RATINGS	
a)	Nominal Primary Voltage	
b)	Nominal Secondary Voltage	
c)	Rated Frequency	
d)	Minimum Creepage Distance of Insulator	
e)	Lightning impulse withstand voltage, primary winding (kV _p)	
f)	Power frequency withstand voltage, primary winding, r.m.s, dry	
g)	Power frequency withstand voltage, secondary winding, r.m.s.	
h)	Rated Voltage Factor	Continuous 30 seconds
i)	Permissible partial discharges (PD)	PD test voltage (rms) = U _m PD test voltage (rms) = 1.2U _m /√3
j)	Transmitted overvoltage limits: peak value of applied voltage(U _p) = 1.6x√2xU _m /√3, Wave-shape characteristics: conventional front time (T ₁) = 0.5μs ±20%, time to half value (T ₂) ≥50μs; as per IEC 60044-2 (peak value limits)	

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Clause Number	Description	Bidder's Offer (Indicate details of the voltage transformer offered)
k)	Secondary Windings (indicate terminal markings, voltage output, class & VA rating at 0.8pf lagging)	Core 1
		Core 2
		Core 3
4.4.1	Quality Assurance Plan to be based on ISO 9001:2008	
4.4.2	Declaration of conformity to IEC 60044-2	
	Copy of ISO 9001:2008 certificate submitted	
4.4.3	Customer reference list for last five years and four customer reference letters	
	Manufacturer's experience	
	Manufacturer's capacity (number of units per month)	
5.1	Test Standard	
	Responsibility of testing of transformer & manufacturer's capability to test	
5.2	Copies of type test reports to IEC 60044-2 submitted with tender for evaluation:	
	5.2.1 Temperature rise test;	
	5.2.2 Short-circuit withstand capability test;	
	5.2.3 Lightning impulse test (with both positive and negative polarity – fifteen consecutive impulses of each polarity);	
	5.2.4 Chopped impulse test on primary winding;	
	5.2.5 Mechanical tests;	
	5.2.6 Transmitted overvoltage measurement;	
	5.2.7 Wet test for outdoor type transformers;	
	5.2.8 Determination of errors;	
5.3	Tests to IEC 60044-2 to be carried out during Factory Acceptance Testing:	
	5.3.1 Verification of terminal markings;	
	5.3.2 Power-frequency withstand test on primary windings;	
	5.3.3 Partial discharge measurement;	
	5.3.4 Power-frequency withstand tests on secondary winding;	

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	5.3.5 Power-frequency withstand tests between sections; 5.3.6 Determination of errors; 5.3.7 Accuracy of measuring voltage transformers at 80%, 100% and 120% of rated voltage, at rated frequency and at 25% and 100% of rated burden; 5.3.8 Temperature-rise test for residual voltage transformer; 5.3.9 Tests for accuracy of protective voltage transformers at 2%, 5% and at 100% of rated voltage and at rated voltage multiplied by the rated voltage factor, at 25% and at 100% of rated burden at a power factor of 0.8 lagging; 5.3.10 Measurement of capacitance and dielectric dissipation factor; 5.3.11 Chopped impulse test on primary winding; 5.3.12 Transmitted overvoltage measurement; 5.3.13 Visual inspection of complete voltage transformer.	
5.4	Inspection and test by KPLC during delivery by supplier before acceptance to stores	
6.1	Marking	Items to be marked to include those required by clause 6.1 of this specification
		Method of marking to ensure it is permanent and legible
6.2	The terminals shall be marked clearly and indelibly and in accordance with IEC 60044-2. The terminal marking shall consist of letters followed by numbers. The letters shall be in block capitals.	
6.3	Each voltage transformer shall be packed in wooden crate firmly bound together to avoid damage during transportation and storage	
7.1	List of documents submitted with tender for evaluation	
7.3	List of documents to be submitted by supplier to	

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	KPLC for approval before manufacture	
7.4	A set of three (3) original hard cover installation and technical manuals for the instrument transformers shall be supplied with the equipment during delivery	
Other details required with the tender	Weight of complete voltage transformer, kg	
	Material of tank (to suit stated service conditions)	
	Weight of oil, kg	
	Weight of insulator, kg	
	Manufacturer's warranty and guarantee for the complete voltage transformer	
	Manufacturer's Letter of Authorization	
	Deviations from tender specifications (indicate supporting documents submitted)	

Manufacturer's Name, Signature, Stamp and Date

Issued by: Head of Section, Tech Stds & Specs

Authorized by: Head of Department, R&D

Signed:

Signed:

Date: 2013-02-19

Date: 2013-02-19

