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Kenya Power

HARDNESS TESTING MACHINE — SPECIFICATION

A Document of the Kenya Power & Lighting Co. Ltd
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0.1 Circulation List

COPY NO.	COPY HOLDER
1	Manager, Standards
Electronic copy (pdf) on Kenya Power server (http://172.16.1.40/dms/browse.php?fFolderId=23)	

REVISION OF KPLC STANDARDS

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

0.2 Amendment Record

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
0	2017-02-03	New Issue	Rotich Benard	Dr. Eng. Peter Kimemia

FOREWORD

This specification has been prepared by the Standards Department in collaboration with Quality Control Section, Supply Chain department, both of the Kenya Power and Lighting Company Limited (KPLC) and it lays down requirements for Hardness Testing Machine herein called the 'Machine'.

The Hardness Testing Machine shall be used for measuring hardness in materials. The Machine shall measure Brinell, Vickers, Knoop, Rockwell and Super-Rockwell hardness numbers in order to provide useful information about metallic materials and other related items. This information shall be useful in quality control and mechanical property evaluations.

This is the first KPLC specification for the Hardness Testing Machine.

The Machine shall be supplied, installed and commissioned at the Quality Control Metrology Laboratory to be set up by the KPLC in their Nairobi South stores.

It is the responsibility of the manufacturer/supplier to ensure that the offered Machine is of the highest quality and guarantees excellent service to KPLC. The supplier shall submit information which confirms that the offered Machine carries out all the above tests and have all the above hardness scales.

The following are members of the team that developed this specification:

Name	Department
Eng. Simon Kimitei	Quality Control
Rotich Benard	Standards

1. SCOPE

1.1. This specification covers the supply, installation and commissioning of Hardness Testing Machine that shall be able to carry out the following hardness tests measurements, convert one measured hardness scale values into another hardness scale:

a) Brinell Tests
b) Vickers Hardness Tests
c) Knoop Tests
d) Rockwell tests &
e) Super-Rockwell tests

1.2. The specification stipulates the minimum requirements for a hardness testing Machine for carrying out the above-mentioned hardness tests on all metals — Iron, steel, tempered steel, cast iron, brass, aluminum, copper and metal alloys including those that have undergone heat treatment, hardening, nitriding, cementation and hardfacing— and other items such as ceramics (Knoop Test).

2. REFERENCES (NORMATIVE)

The following standards contain provisions which through reference in this text constitute provisions of this specification. For dated editions the cited edition shall apply; for undated editions the latest edition of the referenced document shall apply.

ISO 6506-1:2014:	Metallic materials - Brinell hardness test — Part 1: Test method
ISO 6507-1:2005:	Metallic materials - Vickers hardness test — Part 1: Test method
ISO 6508-1:2016:	Metallic materials - Rockwell hardness test — Part 1: Test method
ISO 6508-2:2015:	Metallic materials -Rockwell hardness test — Part 2: Verification and calibration of testing machines and indenters
ISO 6508-3:2015:	Metallic materials - Rockwell hardness test — Part 3: Calibration of reference blocks
ASTM E10:	Standard Test Method for Brinell Hardness of Metallic Materials
ASTM E18:	Standard Test Methods for Rockwell Hardness of Metallic Materials
ASTM E92:	Test Methods for Vickers Hardness and Knoop Hardness of Metallic Materials
ASTM E384:	Standard Test for Microhardness of Materials.
ASTM E140 – 12:	Standard Hardness Conversion Tables for Metals Relationship among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness.

3. DEFINITIONS AND ABREVIATION

3.1. Definitions

For the purpose of this specification the definitions given in the reference standards shall apply. The following shall also apply:

Hardness: a measure of a material's resistance to localized plastic deformation caused by indentation. It is not an intrinsic material property but a result of a defined measurement procedure.

Knoop test: Hardness test done for very brittle materials (such as ceramics) or thin sheets, where only a small indentation may be made for testing purposes. The Knoop hardness number is designated by HK.

Rockwell Test: Hardness test that consists of indenting the test material with a diamond cone or hardened steel ball indenter. Several different scales may be utilized from possible combinations of various indenters and different loads. The scale is designated by the symbol HR followed by the appropriate scale identification.

Super-Rockwell: Used to test materials too thin or small for the regular scales or outside the regular Rockwell scale ranges. Also called Rockwell superficial hardness test.

Brinell test: The method consists of indenting the test material with a 10 mm diameter hardened steel or carbide ball. The diameter of the indentation left in the test material is measured with a microscope. This method is the best for achieving the bulk or macro-hardness of a material, particularly those materials with heterogeneous structures.

Vickers test: Consists of indenting the test material with a diamond indenter, in the form of a right pyramid. Well suited for measuring the hardness of small, selected specimen regions.

3.2. Abbreviations

CCD: Charge-Coupled Device

UTS: Ultimate Tensile Strength

KPLC: Kenya Power and Lighting Company Limited

IEC: International Electrotechnical Commission

ISO: International Organization for Standardization.

LCD: Liquid Crystal Display

OS: Operating System

4. REQUIREMENTS

4.1. Service conditions

The Hardness Testing Machine shall be suitable for use indoors in tropical areas and harsh climatic conditions including areas exposed to:

a) Altitudes of up to 2200m above sea level and humidity of up to 95%,

b) Average ambient temperature of +30°C with a minimum of -1°C and a maximum of +40°C, in direct sunlight,

c) Pollution: Design pollution level to be taken as "*Heavy*" (Pollution level III) for inland and "*Very Heavy*" (Pollution level IV) for coastal applications in accordance with IEC 60815.

d) Isokeraunic levels of up to 180 thunderstorm days per year.

4.2. Design and Construction

4.2.1 Hardness Scales

The Machine shall have Brinell, Vickers, Knoop, Rockwell and Super-Rockwell hardness scales. The scales shall be convertible from one to another as per ASTM E140-12.

4.2.2 Optics

4.2.2.1 The Machine shall have two portable microscopes for measurement of Brinell, Knoop and Vickers indentations.

4.2.2.2 The Optical system shall be high precision optical path with mat screen diameter of at least 135 mm.

4.2.3 Objective lens

The Machine shall have interchangeable objective lenses of 20X, 44X, 70X, 140X magnification.

4.2.4 Scale resolution & Accuracy

The scale resolution (depth) shall be better than 1 micron and an accuracy of at least 0.5%.

4.2.5 Display & Touch Control Panel

4.2.5.1 The Machine shall have large LCD screen 15" (381 mm), with touch-provision or mouse, to show measured values, on-line statistics, memory overview, tester settings, integrated hardness calculator, statistic functions and data transfer functions etc.

4.2.5.2 The LCD screen shall act as Control Panel and shall have explanation of functions by icons such as

a. Hardness test method & indenter selector.

b. Load selection & display

c. Data editing capabilities (Data memory up to 999 reading).

d. Self-diagnostics (display troubles with motor & switches).

e. Hardness Conversion as per ASTM E140-12.

f. N/Kg load unit display/ change.

g. Continuous light volume adjustment.

h. Dwell time selector etc.

4.2.6 Test Load Type

4.2.6.1 The load forces shall be applied through load cells and controlled in "Closed Loop" with a frequency of 1 khz, assuring perfect linearity in every range.

4.2.6.2 The results shall not be affected by any structural deflection, misalignment, vibration or problems associated with dead weight systems on traditional testers.

4.2.7 Test Cycle

4.2.7.1 The Machine shall be fully motorized for fully automatic test cycles by the push of a start button.

4.2.7.2 At the press of one button, the hardness tester's head moves down to make contact with the sample's surface, clamps the piece, applies the force, makes the indentation and goes back upwards.

4.2.8 Test Loads

The Machine shall have a wide and superior range of test loads including 1, 2.5, 3, 5, 6.25, 10, 15, 15.625, 20, 30, 31.25, 50, 60, 62.5, 100, 125, 150, 187.5 and 250kgf.

4.2.9 Load duration

The speed of indentation shall be controlled to assure that the load duration (dwell) time is applied correctly. The load duration shall be 0.1– 250 secs.

4.2.10 Clamping system

4.2.10.1 Secure contact with the specimen or test piece shall always be maintained throughout the test cycle.

4.2.10.2 The clamping system shall have an automatic and motorized sliding X/Y table 100x100 mm with 25 x 25 mm X/Y stroke and 10μm step, for an easy and accurate positioning of the sample.

4.2.11 Auto indent reading

4.2.11.1 The indent reading process shall be automatic.

4.2.11.2 A ½" branded CCD high definition, colour camera and appropriate software shall be used to assure absolute accuracy even if the samples surface isn't perfect.

4.2.11.3 The Machine shall give measurements readings on a variety of sample surfaces — from perfectly polished to rough and etched samples.

4.2.12 Data Output, Image Viewing & Measurement Analysis

4.2.12.1 The Machine shall have RS-232, USB-2 and LAN connection interfaces to the latest PC and printer, with relevant software for data output. The software shall be compatible with Windows™ 7 and its newer versions.

4.2.12.2 The Machine shall have dedicated image processing software for the methods of testing (Brinell, Knoop & Vickers) working on latest OS (Windows™ 7 and its newer versions) for automatic hardness measurement.

4.2.12.3 The software shall have statistical data analysis, image enhancement, precise measurement of diagonal lengths, manual measurement of hardness, case depth measurement, automatically conversion of hardness values, length measurement, Report generation MS- Excel or MS Word format and (Desirable modules- grain size measurement module, percentage phase analysis etc.).

4.2.12.4 The supplier shall guarantee upgradation of the image processing software, free of charge, for at least next 5 years.

4.2.12.5 The Machine shall be supplied with branded computer with the following minimum configurations:

i. Intel i5 processor,
ii. 4GB RAM,
iii. 500 Gb HDD,
iv. DVD-RW,
v. I9 inch LED monitor,
vi. Keyboard and Mouse and
vii. Licensed copies of Window based current/latest Operating System & MS office).
viii. Image processing software installed

4.2.12.6 Branded Colour printer for A4 size printing having minimum resolution of 600Dpi

4.3. Specific Requirements

4.3.1 Rockwell Test

a. DISPLAY: Single line, dot matrix backlit LCD with alpha-numeric display i.e. 60.3 HRC in 8mm high characters.

b. DATA ENTRY: Via menu system on membrane keypad.

c. TEST LOADS: Pre-load - 10kgf (98.07N) &

: Total loads - 60 kgf (588.4), 100 kgf (980.7) and 150 kgf (1471N) total loads.

d. TEST SCALES: HRA, B, C, D, E, F, G, H, K, L, M, P, R, S & V.

e. HARDNESS RESOLUTION: 0.1 Rockwell Units.

f. INDENTERS: 120° Diamond Cone, Balls - 1/16 in, 1/8 in, 1/4 in & ½ in & 1/16" in Ø and 10 spare 1/16" balls.

g. TEST BLOCKS: HRC and HRB calibrated to ISO 6508-3:2015, UKAS accredited.

h. CALIBRATION: As per ISO 6508-2:2015 or ASTM E18.

i. SPECIMEN ACCESS: Tests external cylindrical surfaces down to 3mm diameter & internal surfaces from 20mm dia.

j. STANDARD FEATURES:

   i. Automatic test cycle with analogue bar sequence indication.

   ii. Screen display of hardness number and scale resolved to 0.1 i.e. 60.3 HRC.

   iii. Hardness tolerance setting.

   iv. Statistics (X and R).

   v. Conversions - Vickers, Brinell, Knoop, UTS.

   vi. Automatic curvature correction for rounds.

   vii. RS-232 and USB-2 output for printer or computer drive.

   viii. User programmable test sequence timing - dwell and recovery times 1-50 seconds.

4.3.2 Brinell Test

a. DISPLAY: Operator prompts via LCD screen.

b. DATA ENTRY: Via menu system on membrane keypad.

c. TEST LOADS: 62.5, 187.5 kgf.

d. TEST SCALES:

   i. HB2.5/62.5 (F/D^2) = 10).

ii. HB2.5/187.5 (F/D^2) = 30).

e. IMPRESSION MEASUREMENT: Via portable microscope, x 40 magnification.

f. INDENTER: 2.5mm diameter and five spare 2.5mm diameter balls.

g. TEST BLOCK: 300 HB 2.5/187.5 (nominal).

4.3.3 Vickers Test

a. DISPLAY: Operator prompts by LCD screen.

b. DATA ENTRY: Via menu system on membrane keypad.

c. TEST LOADS: 10 kgf (98.07) and 100 kgf (980.7N).

d. TEST SCALES: HV10 and HV100.

e. IMPRESSION MEASUREMENT: Via a portable microscope, x 40 magnification.

f. INDENTER: 136°-degree Diamond Pyramid.

g. TEST BLOCK:300 HV100 (nominal).

Table 1: Summary of Hardness Testing Machine Requirements

Item	Requirements
Optical Screen Diameter	At least 135mm
Objectives	20X, 44X, 70X, 140X magnification
Scale Resolution, Accuracy	1 micron, 0.5%
Display	LCD screen ≥ 15"
Test Loads	1, 2.5, 3, 5, 6.25, 10, 15, 15.625, 20, 30, 31.25, 50, 60, 62.5, 100, 125, 150, 187.5 and 250kgf.
Data Output Connectivity	RS-232, USB-2 and LAN
PC's minimum configuration	Intel i5 processor, 4GB RAM, 500 Gb HDD, DVD-RW, 19' LED monitor, Keyboard and Mouse and Licensed copies of Window based current/latest Operating System & MS office). Image processing software installed
Power Supply	single phase 230V 50Hz
UPS Rating	1 kVA, minimum of 30 minutes' power back up

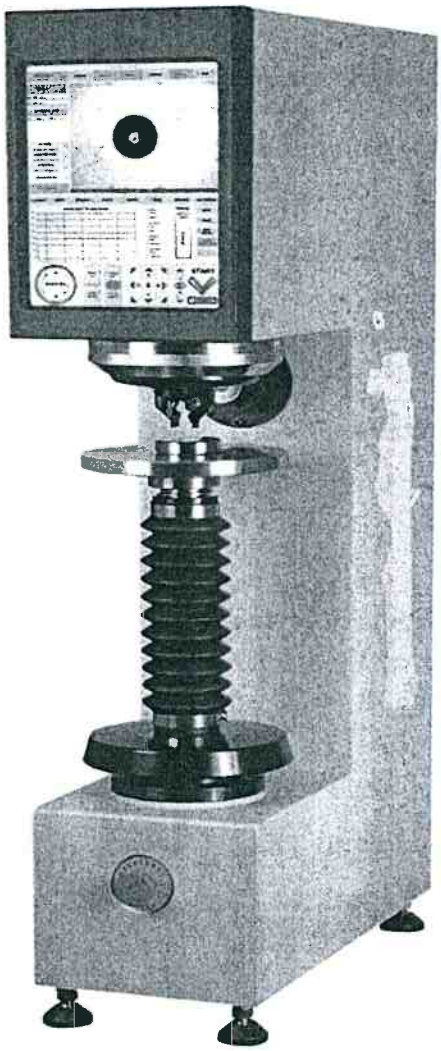

Figure 1: A typical Hardness Testing Machine

Note: The figures in the specification are for illustration purposes

4.4. Other Requirements

4.4.1 The Machine shall accommodate specimen sizes of vertical height of 600mm and width of 150mm (indenter center line to machine frame).

4.4.2 **Power Supply:** The Machine shall be supplied from a single phase 230V 50Hz wall outlet.

4.4.3 Branded Online 1 kVA UPS of minimum of 30 minutes' power back up (APC make or equivalent)

4.4.4 **Machine Dimensions:** The manufacturer/supplier shall provide the dimensions during tendering.

4.5. Standard Accessories:

The following accessories shall be supplied with the Machine:

a) Nose clamp protection
b) Indenter protection cover/cap when not in use.
c) Dust cover
d) set up tools and accessory box.
e) Operation Manual (English Language)
f) The objectives for 20X, 44X, 70X, 140X magnification.
g) Power cable, USB-2, RS-232 Connections
h) Test Certificate
i) Anti-vibration fixture/mount for Machine.

5. TEST AND ACCEPTANCE REQUIREMENTS

5.1. The Hardness Testing Machine shall be inspected and tested in accordance with the requirements of this specification and the applicable standards. It shall be the responsibility of the supplier to test or to have all the relevant tests performed.

5.2. After satisfactory installation and commissioning and training of KPLC personnel, performance evaluation & acceptance of the micro-hardness testing machine shall be done as per the procedure given in ASTM E384 standard.

5.3. The firm shall provide training to KPLC testing personnel for satisfactory operation of Machine, after duly commissioning.

6. MARKING AND PACKING

6.1 The following information shall be marked legibly and in a permanent manner on the measurement Machine and the standard accessories:

a) The manufacturer's identity;

b) Model Number;

c) Markings required by the applicable standard.

d) The words "**PROPERTY OF KENYA POWER & LIGHTING CO. LTD.**"

6.2 Each equipment for measurement of dimensions shall be packed in a manner so as to protect it from damage during transportation and storage.

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APPENDICES

APPENDIX A: TESTS AND INSPECTION (NORMATIVE)

A.1. Copies of test certificates by a third party testing laboratory accredited to ISO/IEC 17025 shall be submitted with the offer for evaluation. A copy of the accreditation certificate for the testing laboratory shall also be submitted with the tender (all in English Language). Any translations of certificates and test reports into English language shall be signed and stamped by the Testing Authority.

A.2. Test certificates and calibration certificates for the Machine to be supplied shall be submitted to KPLC for approval before shipment.

A.3. On receipt of the equipment, KPLC shall inspect them and may perform or have performed any of the relevant tests in order to verify compliance with the specification and applicable standards.

A.4. The supplier shall replace without charge to KPLC, Hardness Testing Machine which upon examination/inspection, test or use, fail to meet any of the requirements in the specification and applicable standards.

APPENDIX B: QUALITY MANAGEMENT SYSTEM (NORMATIVE)

B.1. The Supplier shall submit a quality assurance plan (QAP) that will be used to ensure that the 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 or 2015.

B.2. The Manufacturer's Declaration of Conformity to reference standards and copies of quality management certifications including copy of valid and relevant ISO 9001: 2008 or 2015 certificate shall be submitted with the tender for evaluation.

B.3. The bidder shall indicate the delivery time of the Hardness Testing Machine, manufacturer's monthly and annual production capacity and experience in the production of the Machine for KPLC.

APPENDIX C: TECHNICAL DOCUMENTATION (NORMATIVE)

C.1. The bidder shall submit its tender complete with technical documents for tender evaluation. The technical documents to be submitted (all in English language) for tender evaluation shall include the following:

a) Fully filled clause by clause Guaranteed Technical Particulars (GTPs — Appendix D) signed by the manufacturer;

b) Copies of the Manufacturer's catalogues, brochures, drawings and technical data;

c) An undertaking by the manufacturer to train KPLC staff on the operation and maintenance of the Machine after duly commissioning.

C.2. The successful bidder (supplier) shall submit the following documents/details to The Kenya Power & Lighting Company for approval before manufacture:

a) Fully filled clause by clause Guaranteed Technical Particulars (GTPs) stamped and signed by the manufacturer (**these are not the ones submitted with the tender**);

b) Authentic manufacturing drawings, stamped and signed by the manufacturer, with details of items including the standard accessories coming with the Machine.

c) Bidder's personnel demonstrating to KPLC Staff (in Nairobi) the use of the equipment and explain the features that guarantee excellent service.

d) Quality assurance plan (QAP) that will be used to ensure that the design, material; workmanship, tests, service capability, maintenance and documentation will fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008 or 2015.

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APPENDIX D: GUARANTEED TECHNICAL PARTICULARS (GTPS) — NORMATIVE

(to be filled and signed by the Supplier and submitted together with relevant copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records for previous five years, four customer reference letters, details of suppliers' capacity and experience; and copies of complete type test certificates and test reports for tender evaluation, all in English Language)

Tender No. .....

Bidder's name and Address.....

Description		**Bidder's offer**
1. Manufacturer's Name & Country of manufacture		State
2. Type Reference/Model Number of item		State
3. List of components to be supplied (for one installation)		Specify
Clause	**Description**	**Bidders offer***
1.1	Hardness Tests that the Machine carries out	State
1.2	Specimen materials covered	State
2	Applicable Standards	List
4.1	Service conditions	Specify
4.2.1	Hardness Scales and conversion & standard	State
4.2.2.1	Number of portable microscopes for Brinell and Vickers Indentation	Specify
4.2.2.2	Type and diameter of the optical screen	Specify
4.2.3	Interchangeable objectives' magnification	Specify
4.2.4	Scale resolution and accuracy of the Machine	Specify
4.2.5.1	The type and size of the display screen	State
4.2.5.2	Display control panel icons	State
4.2.6.1	Application of the load forces and the type of control system	Specify
4.2.6.2	Results not affected by problems associated with dead weight systems	Specify
4.2.7	Test cycle fully motorized and fully automatic	Specify
4.2.8	The Machine's test load range	Specify
4.2.9	Load duration	Specify
4.2.10.1	Secure contact maintained through the test cycle	Specify
4.2.10.2	Motorized clamping system's dimensions and X/Y stroke	State
4.1.11.1	Indent reading process type	State
4.2.11.2	Type and size of camera and software to ensure absolute accuracy	State

Description		**Bidder's offer**
4.2.11.3	Machine giving measurements regardless of the sample surfaces	Specify
4.2.12.1	Data Output connectivity interfaces	Specify
4.2.12.2	Image processing software working on latest OS	Specify
4.2.12.3	Image processing software functions	Specify
4.2.12.4	Period that upgradation of the software is free	Specify
4.2.12.5	Specifications of the branded computer coming with the testing Machine	Specify
4.2.12.6	Printer resolution and paper size	Specify
4.3	**Specific requirements**	
4.3.1	Rockwell Test	
	a. Display	Specify
	b. Data Entry	Specify
	c. Test Loads: Preload, Total Load	Specify
	d. Test Scales	Specify
	e. Hardness resolution	Specify
	f. Indenters	Specify
	g. Test Blocks	Specify
	h. Calibration standard(s)	Specify
	i. Specimen Access	Specify
	j. Standard Features	Specify
4.3.2	Brinell Test	
	a. Display	Specify
	b. Data Entry	Specify
	c. Test Loads	Specify
	d. Test Scales	Specify
	e. Impression Measurements	Specify
	f. Indenters	Specify
	g. Test Blocks	Specify
4.3.3	Vickers Test	
	a. Display	Specify
	b. Data Entry	Specify
	c. Test Loads	Specify
	d. Test Scales	Specify
	e. Impression Measurements	Specify
	f. Indenters	Specify
	g. Test Blocks	Specify
4.4.1	Workpiece accommodation	Specify
4.4.2	Power Supply requirements	Specify
4.4.3	UPS Make & Rating	Specify

Description		**Bidder's offer**
4.4.4	Machine dimensions and weight	Specify
4.5	Standard Accessories supplied with the Machine	Specify
5.1	Machine shall comply with the specification test requirements.	State
5.2	Testing and acceptance standards	Specify
6.1	Marking on the Machine	Specify
6.2	Packing to protect from damage during transport, handling & storage	Specify
A1	Copies of test certificates and routine test reports submitted with offer	State
A2	Test and calibration certificates to be submitted for approval before shipment	State
A4	Supplier shall replace without charge to KPLC items that don't meet specification	State
B1	QAP and ISO 9001:2008	State
B2	Copies of quality management certifications attached	State
B3	Delivery time, Production capacity & experience of the manufacturer	State
C1	Documents submitted with tender documents for evaluation	
	a. Fully filled GTPs	State
	b. Copies of manufacturer's catalogues, manufacturing drawings, technical data	State
C2	To be submitted for approval before manufacture	
	a. Fully Filled Clause by clause GTPs **(not the ones submitted with the tender)**	state
	b. Authentic manufacturing drawings, signed & stamped by the manufacturer	Specify
	c. Bidder's personnel demonstrating the Machine suitability to KPLC staff in Nairobi	State
	d. QAP Plan	State

** Words like 'agreed', 'confirmed', 'As per KPLC specifications', etc. shall not be tolerated and shall be considered non-responsive.*