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0.1 Circulation List

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0.2 Amendment Record

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0	2014-01-07	New Issue	Michael Apudo	Simon Kimitei

FOREWORD

This specification has been prepared by the Electrical Plant Section (Mt Kenya Region) in collaboration with the Research and Development Department both of the Kenya Power & Lighting Company Ltd (abbreviated as KPLC) and it lays down requirements for Hipot Megohmmeter. The specification is intended for use by KPLC in purchasing the equipment.

The supplier shall submit information which confirms satisfactory service experience with products which fall within the scope of this specification.

1. SCOPE

This specification is for Hipot Megohmmeter to be used as a High Voltage DC Proof/Hipot Tester (Di-electric strength testers) and as a High Voltage Megohmmeter.

The specification also covers inspection and test of the Hipot Megohmmeter 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 Hipot Megohmmeter acceptable for use in the company (KPLC) and it shall be the responsibility of the supplier to ensure adequacy of the design, good workmanship, good engineering practice and adherence to applicable standards in the manufacture of the test equipment for KPLC.

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 edition of the referenced documents (including any amendments) applies:

IEC 61010-1:	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements
IEC 60664-1& 3:	Insulation Coordination for Equipment within Low-Voltage Systems - Part 1: Principles, Requirements and Tests; Part 3: Use of coatings to achieve insulation coordination of printed board assemblies.

IEC 62680-1:	Universal serial bus interfaces for data and power - Part 1: Universal serial bus specification
IEC 60112:	Method for the determination of the proof and the comparative tracking indices of solid insulating materials
IEC 61326:	Electrical Equipment for Measurement, Control and Laboratory Use - EMC Requirements
IEC 60529:	Degrees of protection provided by enclosures (IP Code)

3. TERMS AND DEFINITIONS

3.1 For the purpose of this specification, the definitions given in the reference standards shall apply together with the following abbreviations.

3.2 **Abbreviations**

IEC: International Electro-technical Commission
IEEE: Institute of Electrical and Electronics Engineers
DUT: Device under Test
GC: Ground continuity
GFI: Ground Fault Interrupter
CTI: Comparative Tracking Index
PLC: Performance Level Category

4. REQUIREMENTS

4.1 Service Conditions

The Hipot Megohmmeter shall be suitable for

(i) Continuous operation outdoors in tropical areas at altitudes of up to 2200m above sea level,
(ii) Humidity of up to 90%,
(iii) Average ambient temperature of +30°C with a minimum of -1°C and a maximum of +40°C and
(iv) Heavy saline conditions along the coast.

4.2 Design And Construction

4.2.1 The Hipot Megohmmeter Tester shall be designed, manufactured and tested to meet IEC 61010-1, IEC 60664-1 & 3 and IEC 62680-1 industry standards.

4.2.2 The equipment shall be designed for use as a Di-electric strength tester and as a High Voltage Megohmmeter.

4.2.3 It shall be used to proof test or megohm cable insulation, switchgear, motors, transformers, insulators, and other electrical apparatus used in Kenya Power systems operated at 50Hz.

4.2.4 The tester shall have IPX5 protection as per the requirements of IEC 60529 standard for protection of enclosures.

4.2.5 The equipment shall conform to the EMC requirements for electrical equipment; control and laboratory use as per IEC 61326 requirement.

4.2.6 The tester design performance and rating shall be as shown in the tables 1 & 2. The tolerances shall be as per clause 4.2.7.5 of this specification.

Table 1: Technical Requirements of the Hipot Megohmeter

No	DESCRIPTION		REQUIREMENT
1	Input 50/60 Hz		220-250V, 5A
2	Output		0-100kV, 10mA
3	Polarity		Negative Output, Positive ground
4	Duty		Continuous, capacitive charging
5	Ripple		Less than 2.5% RMS resistive load
6	Regulation		No Ferro-resonant regulator
7	Kilovolt meter		0-50/100 kV dc
8	Current meter		0-1.0 dc µA, w/x1,x10,x100,x1k,x10k
9	Megohm Scale (Megohm readings at any output voltage)		100-1 MΩ, w/x0.1x1,x10,x100,x1k
10	Control dimensions (Approx.)		359 mm-w x 279 mm-d x 356 mm-h
12	H.V Tank dimensions (Approx.)		241 mm-w x 298 mm-d x 368 mm-h
13	Approx. control weight		14 kg
14	Approx. tank weight		31 kg
15	Output Termination		Shielded output cable with clip and boot, 6 m
16	Other features	a	Automatic transit protected meters
		b	Glass front meters eliminate static buildup

Table 2: Tester Design Insulation Coordination as per IEC 60664-1

Sr. No	Particulars	Test Performance
1	Operating Voltage, AC $_{r.m.s}$ or DC , volts	220-250 V
2	Rated Impulse Voltage for equipment - 1.2/50µs	6000 V as per IEC 60664-1, table 1
3	Overvoltage category	Class IV as per IEC 61010-1
4	Pollution category	Class 2 as per IEC 61010-1
5	Insulation material group as per IEC 60112	Group II - 400≤CTI<600 (PLC=1)
6	Minimum clearances for equipment to withstand steady state voltages, temporary over-voltages and to avoid partial discharge	5.5 mm
7	Creepage distance for equipment subject to long term stresses, min	1.8 mm
8	Minimum acceptable creepage distances on printed circuit boards	1.0 mm
9	Maximum recurring peak voltage related to creepage distance on printed wiring boards	913 V
10	Width of grooves by pollution degree on printed circuit boards	1.0 mm
11	Partial discharge requirements	As per IEC 60664-1 Annex C
12	Solid insulation design	Shall withstand short term and long term stresses as per IEC 60664-1 clause 3.3
13	EMC category	Class B emission limits as per IEC 61326-1

4.2.7 General Tester Design Features

4.2.7.1 Range of Test Voltage and Current

The tester shall be capable of providing all voltages and currents needed for the range of tests to be performed.

For dielectric testing: Voltage and Current
For ground bond: Current and Resistance
For insulation resistance: Voltage and Resistance

4.2.7.2 **Range of Insulation Levels**

The tester shall handle insulation resistance measurements at any rated output voltage up to 7,500 GΩ at commonly used voltages (from 0V to 100kV DC).

4.2.7.3 **Flexibility**

The tester shall be easily adaptable to different test requirements through programmability plus an ability to recall previously stored test setups on demand.

4.2.7.4 **Line and Load Regulation**

The tester shall be designed so that normal variations in line voltage and connected loads do not cause the output voltage and current measured at the Device Under Test (DUT) to rise above or fall below the levels required for the test. This improves test repeatability and greatly reduces inconsistencies in measurements.

4.2.7.5 **Accuracy**

The tester accuracy shall meet the following specifications:

DC High Voltage: ±1% of reading +5V
Regulation: <1% +5V
Insulation Resistance: +/-2% for V/R >10nA, +/-5% for V/R < 10nA
Leakage Current: +/-(0.5% of set high limit +1μA)
Breakdown: ±1% of limit + 50mA
GC Output Current: ±1% of setting +0.3A
GC Resistance: ±1% of reading +20mΩ

4.2.7.6 **Easy to Use**

4.2.7.6.1 The tester shall have a well-designed front panel with easily read digital displays of measurements, settings, and pass/fail indicators.

4.2.7.6.2 Audible alarms with acknowledgment shall be inbuilt. An ability to hold an alarm condition after operator acknowledgment shall also be provided for later analysis of the fault.

4.2.7.6.3 All panel items shall be clearly marked so that the function of each is readily apparent to anyone looking at the device for the first time.

4.2.7.6.4 The **START TEST** button shall be large, well-marked, and protected in a way that prevents accidental activation of a test. The **STOP TEST** button shall also be easily identified (preferably bright red) and placed so as to be found quickly in an emergency.

4.2.7.6.5 Pushbuttons for setting, storing, or recalling test values, alarm limits, and test sequences shall be clearly marked and easily operated by typical test personnel.

4.2.7.7 Operator Safety

4.2.7.7.1 The tester should be designed so that the test operator cannot be accidentally subjected to hazardous voltages such as those used for a hipot test, a line voltage leakage test, or an insulation resistance test as per IEC 61010-1 requirements. The use of safety interlocks shall provide this protection by automatically shutting down the high voltage output whenever a safety switch on the Device Under Test (DUT) is opened.

4.2.7.7.2 In addition, the tester shall be designed so that output current cannot exceed a value that would be harmful to a human (GFI circuit). Cables used for high voltage output and ground clips shall be flexible, well insulated (EPR jacketed) , and designed to be repeatedly plugged into and removed from the front panel over a long period of time without becoming frayed, worn, or ineffective.

4.2.8 Production/Laboratory Tester Design Features

4.2.8.1 Programmability

4.2.8.1.1 The tester shall be fully programmable, permitting a user to enter a complete sequence of test steps, test parameters, and pass/fail limits. This shall permit the tester to automatically execute a complete test or series of tests on a Device Under Test (DUT).

4.2.8.1.2 Store/Recall of Test Programs

There shall be an ability to enter a test program and store it for later retrieval. A user shall then recall any of the several stored test programs at any time, saving valuable setup and test time. This feature shall ensure that tests are always performed the same way.

4.2.8.1.3 The operation shall be manual and automatic mode, in addition, there shall be a provision for future PC based operation wherein all the test parameters such as withstand voltage and leakage current, insulation resistance, etc. can be input from the PC software and the tests shall be run till the test is carried out all by itself (all tests are carried out one by one sequentially as programmed) and the results of each test shall be displayed on PC screen as well as the front panel.

4.2.8.1.4 The software for the PC shall be customized to fit the exact requirements of the customer. The results shall then be recorded or sent to a remote location via email. Fixtures shall be designed and provided for High Voltage testing.

4.2.8.2 Minimum Current Detection

The tester shall have the ability to detect minimum current in a hipot test guards against a false positive indication when the ground circuit is open to avoid a fault in the ground circuit which may be missed and cause an accident to the operator.

4.2.8.3 Displays and Alarms

The tester shall use digital displays for indications of measurement values, test limits, and pass/fail results which can easily be read by an operator.

4.2.8.4 Data Communication Interface

4.2.8.4.1 The tester shall be equipped with a standard data communication interface for connection to remote data processing such as computer, or control equipment.

4.2.8.4.2 The interfaces shall use IEC 62680-1, USB 3.0, device class DCh or FEh with a signaling speed of 5 Gbit/s and a usable data rate of up to 4 Gbit/s (500 MB/s) and RS232 serial communication line, with the length of the connection not exceeding 20 meters. The tester shall be capable of being remotely controlled by such equipment.

4.2.8.5 **Front Panel Lockout**

To prevent unauthorized operation or setup of the tester, a lockout feature (with password protection) shall be provided. This feature shall ensure that changes to test limits or any tester functions are made only by a competent, authorized person.

4.2.8.6 **Ramping**

The tester shall provide this feature without introducing spikes or distortion to the AC waveform. It shall also provide easily programmable ramp and hold times for each test step so as to avoid damage to components in the Device Under Test (DUT), since the high voltage output of the tester shall be increased smoothly over the test range rather as an abrupt step change.

4.2.8.7 **Automatic Range Sensing**

The tester shall have the ability to automatically sense and select the correct range for an insulation resistance test which is a very useful feature in an insulation tester. This shall save on time and ensures maximum accuracy of every measurement.

4.2.8.8 **Automatic Shutdown on Alarm**

When a Device Under Test (DUT) fails a test, the tester shall automatically save the test result and interrupt the test immediately to avoid potential damage to the Device Under Test (DUT).

4.2.8.9 **Automatic Offset**

The tester shall also have the ability to subtract leakage current due to test leads and test fixtures automatically from the instrument reading for convenience. A Four (4)-Terminal Kelvin connections shall ensure maximum

accuracy by preventing errors caused by measurement lead resistance. This feature shall be used to ensure accuracy of a ground bond test.

4.2.8.10 **Arc Detection before Breakdown**

4.2.8.10.1 The tester design shall incorporate an arc detection feature as an anticipatory tool that can be used to detect an impending fault that may occur later in the product's life cycle.

4.2.8.10.2 This feature shall help the tester by detecting the presence of high frequency transients in the current waveform. If such variations exceed a specified level and persist for more than 10μsec, the tester should instantly alarm and interrupt the test.

4.2.8.11 **Sequence Testing**

4.2.8.11.1 Because a hipot test is a stress test of the insulation, it may in some cases cause degradation in the insulation resistance of a Device Under Test (DUT).

4.2.8.11.2 By measuring insulation resistance both before and after a hipot test, you can determine whether or not the hipot test damaged the insulation. Therefore, the ability to program the tester to perform these tests automatically in sequence shall be provided.

4.2.9 Accessory Equipment

Some of the accessories typically needed for a laboratory/production test facility shall be:

a) High Voltage Probes.
b) High Voltage Probe Guns (trigger operated).
c) High Voltage Lead Sets with various lengths of cable.
   - Input power supply cord 3 meters in length.
   - Return lead with clip and boot 6 meters in length.
   - Ground leads with clip and boot 6 meters in length.
   - Ground sticks with lead and clip 6 meters in length.
d) Corded Product Adapter Fixture (to accept 2-prong or 3-prong line cords)
e) Foot Switch to start/stop tests.

f) Ground Continuity Lead Set.
g) Power Entry Adapter Cable for Ground Continuity Tests.
h) Multiple Port Scanners for laboratory/production test applications.
i) Rack Mount Kit.

4.3 QUALITY MANAGEMENT SYSTEM

4.3.1. The supplier shall submit a quality assurance plan (QAP) that will be used to ensure that the DC Hipot Megohmmeter physical properties, tests 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.

4.3.2. 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.

4.3.3. The bidder shall indicate the delivery time of the items, 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 the DC Hipot Megohmmeter 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.

5.0. TESTS AND INSPECTION

5.1. The DC Hipot Megohmmeter shall be inspected and tested in accordance with the requirements of IEC 61010-1, IEC 60664- 1 & 3, IEC 61326, IEC 60112 and IEC 60529 standards. It shall be the responsibility of the supplier to perform or to have performed the tests specified and whatever other tests he normally performs at works.

5.2. Copies of previous Type Tests 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 to ISO/IEC 17025 for the same third party testing laboratory used shall also be submitted with the tender document (all in English Language)

5.3. Copies of type test reports to be submitted with the tender (by bidder) for evaluation shall be as stated below:

5.3.1. Type Tests for Equipment Performance

- Electromagnetic compatibility (EMC)
- Switching tests on the equipment.
- Impulse overvoltage tests on the equipment -Clearances
- Dielectric voltage withstand tests on the equipment - Controlled overvoltage

5.3.2. Type Tests for Printed Circuit Board Coating Performance

- Environmental, humidity and thermal conditioning tests
- Dielectric voltage withstand tests
- Comparative tracking index (CTI)
- Resistance to soldering heat
- Flammability
- Coating adhesion
- Insulation resistance between conductors

5.4. Routine and sample test reports for the instruments and meters to be supplied shall be submitted to KPLC for approval before shipment/delivery of the goods. KPLC Engineers will witness tests at the factory before shipment.

5.5. On receipt of the goods KPLC will perform any of the tests specified in order to verify compliance with this specification. The supplier shall replace without charge to KPLC the DC Hipot Megohmmeter, which upon examination, test or use; fail to meet any of the requirements in the specification.

5.6. Tests to be witnessed by KPLC Engineers at the factory before shipment shall be in accordance with IEC 61010-1, IEC 60664- 1 & 3, IEC 61326, IEC 60112 and IEC 60529 standards and this specification and shall include the following:

5.6.1. Routine Tests Equipment Performance

- Insulation Resistance of the equipment
- Leakage Current of the equipment
- Ground Continuity of the equipment
- Ground Bond of the equipment
- Polarization Test of the equipment

- Recurring Peak Voltage Determination
- Dielectric Voltage Withstand Tests - Measuring clearances

6.0. MARKING AND PACKING

6.1. The DC Hipot Megohmmeter shall be packed in a standard rugged heavy duty robust case with cushion grip handles and rubberized gripping surface for outdoor use (protection category IP X5) in such a manner to avoid damage during transportation.

6.2. The housing shall be complete with a gasket to seals the lid when closed so as to protect the instrument against water and dirt while the instrument is carried through rainstorms or other hazardous conditions. The lid shall be secured by two latches and a handle for portability. A compartment shall also be provided for storage of test cables and line cord.

6.3. The DC Hipot Megohmmeter shall be marked in a permanent manner with the following information (in English Language):

a) Standard to which the DC Hipot Megohmmeter complies
b) Name of manufacturer
c) Type of DC Hipot Megohmmeter (description of type, number and overall size of sections)
d) Year and month of manufacture and serial number
e) Maximum permissible measurement limits
f) The words "**Property of Kenya Power & Lighting Co**" shall be engraved permanently on each DC Hipot Megohmmeter while the other parameters shall be marked on a permanent label.
g) The overvoltage protection category and duty rating e.g. category IV-field
h) The DC Hipot Megohmmeter shall be provided with a separate permanent label displaying advice to the user.
i) In addition, the Hipot Megaohmeter shall be marked with the necessary labels that conform to IEC 61010-1, clause 5.1.2 to 5.

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 signed by the manufacturer;
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;
e) Copies of required 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 third party testing laboratory;
g) Manufacturers letter of authorization, ISO 9001:2008 certificate and other technical documents required in the tender.

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 signed by the manufacturer;
b) Design Drawings with details of DC Hipot Megohmmeter 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 fulfill the requirements stated in the contract documents, standards, specifications and regulations. The QAP shall be based on and include relevant parts to fulfill the requirements of ISO 9001:2008
d) Detailed test program to be used during factory testing;
e) All documentation necessary for safety of the equipment as specified in IEC 61010-1 clause 5.4 shall be provided with the equipment.
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 DC Hipot Megohmmeter for The Kenya Power & Lighting Company;
g) Packaging details (including packaging materials).

7.3 The supplier shall submit recommendations for use, care, storage and routine inspection/testing procedures, all in the English Language, during delivery of the testers to KPLC stores

ANNEX A: *Guaranteed Technical Particulars (to be filled and signed by the supplier and submitted together with copies of the Manufacturer's catalogues, brochures, drawings, technical data, sales records and copies of test certificates for tender evaluation)*

Tender No ..... Bidder's Name & Address .....

	Description		Bidder's Offer
1	Name of the manufacturer and country of origin		Specify
	Type Reference Number or Model Number		Specify
2	**Applicable Standards**		Specify
3	**Terms and Definitions**		Specify
4	Requirements		
4.1	Service conditions		Specify
4.2	**Design and Construction**		
	4.2.1-4.2.6		
	Input 50/60 Hz	220-250V, 5A	Specify
	Output	0-100kV, 10mA	Specify
	Polarity	Negative Output, Positive ground	Specify
	Duty	Continuous, capacitive charging	Specify
	Ripple	Less than 2.5% RMS resistive load	Specify
	Regulation	No Ferro-resonant regulator	Specify
	Kilovolt meter	0-50/100 kV dc	Specify
	Current meter	0-2.0 dc μA, w/x1,x10,x100,x1k,x10k	Specify
	Megohm Scale (Megohm readings at any output voltage)	100-1 MΩ, w/x0.1x1,x10,x100,x1k	Specify
	Control dimensions (Approx.)	359 mm-w x 279 mm-d x 356 mm-h	Specify
	H.V Tank dimensions (Approx.)	241 mm-w x 298 mm-d x 368 mm-h	Specify
	Approx. control weight	14 kg	Specify
	Approx. tank weight	31 kg	Specify
	Output Termination	Shielded output cable with clip and boot, 6 m	Specify
	Other features	Automatic transit protected	Specify

		Glass front meters eliminate static buildup	Specify
	Rated Impulse Voltage for equipment -1.2/50µs	6000 V as per IEC 60664-1, table 1	Specify
	Overvoltage category	Class IV as per IEC 61010-1	Specify
	Pollution category	Class 2 as per IEC 61010-1	Specify
	Insulation material group as per IEC 60112	Group II - 400≤CTI<600 (PLC=1)	Specify
	Minimum clearances for equipment to withstand steady state voltages, temporary over-voltages and to avoid partial discharge	5.5 mm	Specify
	Creepage distance for equipment subject to long term stresses, min	1.8 mm	Specify
	Minimum acceptable creepage distances on printed circuit boards	1.0 mm	Specify
	Maximum recurring peak voltage related to creepage distance on printed wiring boards	913 V	Specify
	Width of grooves by pollution degree on printed circuit boards	1.0 mm	Specify
	Partial discharge requirements	As per IEC 60664-1 Annex C	Specify
	Solid insulation design	Shall withstand short term and long term stresses as per IEC 60664-1 clause 3.3	Specify
	EMC category	Class B emission limits as per IEC 61326-1	Specify
4.2.7	**General tester design features**		
4.2.7.1	Range of test voltages and current		Specify
4.2.7.2	Range of insulation levels		Specify
4.2.7.3	Flexibility		Specify
4.2.7.4	Line and Load Regulation		Specify
4.2.7.5	Accuracy		Specify
4.2.7.7	Ease of use		Specify
4.2.7.8	Operator safety		Specify
4.2.8	**Laboratory tester design features**		
4.2.8.1	Programmability		Specify
4.2.8.2	Minimum current detection		Specify
4.2.8.3	Displays and alarms		Specify
4.2.8.4	Data communication interfaces		Specify

4.2.8.5	Front panel lockout	Specify
4.2.8.6	Ramping	Specify
4.2.8.7	Automatic range sensing	Specify
4.2.8.8	Automatic shutdown alarm	Specify
4.2.8.9	Automatic offset	Specify
4.2.8.10	Arc detection before breakdown	Specify
4.2.8.11	Sequence testing	Specify
4.2.9	Accessories equipment	Specify
4.3	Quality Management Systems	Specify
5.0	**Tests and Inspection**	
	5.1 – 5.6	Specify
6.0	**Marking and packing**	
	6.1 – 6.3	Specify
7.0	**Documentation**	
	7.1 – 7.2	Specify
8	Manufacturer's Guarantee and Warranty	Specify
9	List catalogues, brochures, technical data and drawings submitted to support the offer.	Specify
10	List customer sales records submitted to support the offer.	Specify
11	List Test Certificates submitted with tender	Specify
12	List test & calibration reports to be submitted to KPLC for approval before shipment	Specify
13	Statement of compliance to specification (indicate deviations if any & supporting documents)	Specify

.....

Manufacturer's Name, Signature, Stamp and Date