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0.1 Circulation List

COPY NO.	COPY HOLDER
1	Head of Department , Standards
2	Supply Chain Manager (Procurement)
Electronic copy (pdf) on Kenya Power Server (currently :Network-\\stima-fprnt-001\techstd&specs	

0.2 Amendment Record

Rev No.	Date (YYYY-MM-DD)	Description of Change	Prepared by (Name & Signature)	Approved by (Name & Signature)
0	2014-08-25	New Issue	Michael Apudo	Eng. Simon Kimitei

FOREWORD

This specification has been prepared by the Standards Department in collaboration with Network Management Division – Transport Department of The Kenya Power and Lighting Company Limited (abbreviated as KPLC) and it lays down requirements for **Lead Acid Starting, Ignition and Lighting (SLI) batteries for motor vehicles**, rated voltage of **12 volts**. It is intended for use by Kenya Power in purchasing of the batteries.

1. SCOPE

1.1. This specification lays down the general mechanical, electrical and functional requirements of the batteries. In line with current usage and practical reference, the batteries covered in this specification shall be rated at 20-h rate only.

1.2. The specification also covers characteristics, dimensions, inspection and test of the batteries as well as schedule of Guaranteed Technical Particulars to be filled, signed by the manufacturer and submitted for tender evaluation.

1.3. The specification stipulates the minimum requirements for the batteries; 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 batteries for The Kenya Power & Lighting Company.

1.4. 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 60095-1& 2: Standard specification for lead-acid starter batteries. Part 1: General requirements and methods of test; Part 2: Dimensions of batteries; dimensions and marking of terminals

IEC 61373: Railway applications – Rolling stock equipment – Shock and vibration tests

ISO/IEC 17025: General requirements for the competence of calibration and testing laboratories

ISO 2212: Standard specification for trichloroethylene for industrial use - Methods of test

ISO 9001:	Quality management systems – Requirements
JIS D5 301:	Lead acid batteries for automobiles.
DIN 43 539- 2:	Starter batteries for starting, lighting and ignition; test methods.
BS EN 12659:	Standard specification for lead and lead alloys,
BS 2000:	Standards specification for testing of bitumen and bituminous products: Part 49: Penetration of bitumen and bituminous materials; Part 58: Softening point of bitumen.
ASTM E 49:	Tentative method of spectro-chemical analysis of lead alloys for minor constituents and impurities
KS 1783:	Rubber and plastic containers for lead-acid storage batteries - Specification.
KS 04-1067-2:	Specification for lead-acid batteries - Part 2: Requirements for pasted plate type batteries.
KS 04-185:	Specification for lead-acid starter batteries -- Part 1: General requirements and methods of test – Specification -- Part 2: Dimensions of batteries, Dimensions and marking of terminals.
KS 03-242:	Specification for sulphuric acid for use in lead-acid batteries.
KS 2258:	Standard specification for water for lead acid batteries

3. TERMS AND DEFINITIONS

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

4. REQUIREMENTS

4.1. Service Conditions

The SLI lead acid storage batteries shall be suitable for continuous use outdoors in tropical areas at;

a) Altitudes of up to 2200m above sea level,
b) Humidity of up to 90%,
c) Heavy saline conditions along the coast.

d) The batteries shall give good performance in the temperature range from –20°C to +60°C.
e) Storage in the temperature range from–30°C to +75°C shall not affect the battery.

4.2. General Requirements

4.2.1. The battery shall provide a 12 volts d.c capable for smooth, quick starting, ignition and lighting systems of motor vehicles ranging from passenger to heavy commercial. The battery expected life shall be at least 10 years.

4.2.2. It shall have a minimum internal resistance, welded construction, and be at least 80% efficient on recharge.

4.2.3. It shall have a robust housing that can withstand vibrations, shock and high temperatures with easily visible electrolyte level indicators. The vibrations and shock shall be tested in accordance with IEC 61373, Section 9, Category 1, Class B at values of:
a) Vibration tests - 5-150 Hz, 0.8grms vertical, 0.56grms longitudinal, 0.36grms transverse; 5 hours in each axis for long-life random vibration and
b) Shock tests - 30msec. pulses in each axis (3 positive, 3 negative); 3.06g peak vertical, 5.1g peak longitudinal, 3.06g peak transverse for shock.

4.2.4. The product manufacturer shall produce the consent/clearances as per the provisions of Environmental Management and Coordination Act, 1999 and Water Quality Regulation , 2006 (Legal notice No. 121)

4.3. Design and Construction

4.3.1. General requirements

4.3.1.1. The lead acid SLI batteries shall be designed manufactured and tested to IEC 60095, JIS D5 301, DIN 43 539- 2 and KS 04-185 standard specifications and the requirements of this specification.

4.3.1.2. The batteries shall be sealed type (maintenance free) batteries designed in a manner that the oxygen generated during charging is captured and recombined in the battery. The design shall include one of the following options:

a) A valve-regulated type (VRLA) having a spring-controlled valve that vents gases at a predetermined pressure of between 2 to 5 psi,
b) A replaceable vent plugs,

c) Other mechanisms to relieve excess pressure.

4.3.1.3. The batteries shall not be designed for deep discharge as the grid plates could easily be damaged. They shall have a large number of thin grid plates designed for maximum surface area, and therefore maximum current output.

4.3.1.4. They shall be constructed with the positive electrode (the anode) made from a lead-antimony alloy with lead (IV) oxide mixed with expanders and binding agents pressed into it. The negative electrode (the cathode) shall be made from pure lead. Both electrodes shall be fully immersed in sulphuric acid conforming to KS 03-242.

4.3.1.5. The battery configuration shall be flat pasted plate design with the active material (lead IV oxide) contained in a supporting grid that provides the current path. The pastes shall be forced into the plates by rolling process as per KS 04-1067-2.

4.3.1.6. The design of the plate grid thickness shall allow for improved ageing characteristics and resistance to damage by elevated temperatures.

4.3.1.7. The battery shall consist of six elements connected in series and housed in a plastic monobolic container. Each element shall consist of positive plates, negative plates and separators.

4.3.2. **Specific Requirements**

4.3.2.1. **Container and lid**

The container and lid shall be made of polypropylene rubber in accordance with KS 1783. The material shall be able to resist action by sulphuric acid and shall not liberate any substance which will contaminate the electrolyte and impair the life and efficiency of the battery.

4.3.2.2. **Separators**

4.3.2.2.1. Separators shall be of envelope type with a glass fiber mat (boron-silicate mat), soaked in electrolyte or polyethylene plastic.

4.3.2.2.2. They shall possess excellent properties; such as permeability, porosity, pore size distribution, specific surface area, mechanical design and strength, electrical resistance, ionic conductivity, and chemical compatibility with the electrolyte.

4.3.2.2.3. In service, the separator shall be able to maintain good resistance to acid and oxidation. The area of the separator shall be a little larger than the area of the plates to prevent material shorting between the plates.

4.3.2.2.4. The separators shall remain stable over the battery's operating temperature range.

4.3.2.3. **Electrolyte**

4.3.2.3.1. The sulphuric acid and water shall be used for the preparation of the electrolyte to bring the level of electrolyte to approximately the correct level during the course of preparation or testing and they shall conform to KS 03-242 and KS 2258 requirements respectively.

4.3.2.3.2. For the purpose of tests, a fully charged SLI battery with electrolyte level corresponding to the upper level marked on the battery, shall have a specific gravity of 1.280±0.01 and 1.17±0.01 for a discharged cell (corrected to 27^0C) as per IEC 60095-1 requirements.

4.3.2.3.3. The temperature correction shall be made by the following formula as per IEC 60095-1:

$SG_{27} = SG_t + 0.0007(t-27)$

Where, SG_{27} = specific gravity at 27^0C

SG_t = specific gravity at t^0C, and

t = temperature of electrolyte at the time of measurement, ^{0}C

4.3.2.4. **Sealing Material**

4.3.2.4.1. The lid shall be of one piece construction, sealed to the container by addition of sealing material (Trichloroethylene) with one positive and one negative terminal.

4.3.2.4.2. The sealing material employed shall be an acid resistant adhesive and shall not be affected by heat sealing or ultrasonic welding. The properties shall be as specified as per Table 2.

Table 2: Requirements for Sealing Compound.

	Characteristic	Requirement	Method of Test
1	Penetration at 25^0C, 100g 5s in o.1mm	17 to 45	BS 2000:Part 49
2	Softening point, ^{0}C	90 to 110	BS 2000: Part 58
3	Matter insoluble in trichloroethylene, % mass, ***Max***	1	ISO 2212

	Characteristic	Requirement	Method of Test
4	Resistance to sulphuric acid	To pass test	ISO 2212
5	Resistance to adhesion- the adhesion of the material in Kg pull to break, ***Min***	To pass test	ISO 2212
6	Resistance to contraction, % , ***Min***	8	ISO 2212
7	Ductility test – expressed in centimeters elongation at : 1. 25^0C 2. 4^0C	 3 2	ISO 2212

4.4. Terminal, Capacities, Dimensions, Rating and Charging

4.4.1. Terminals

4.4.1.1. Design

4.4.1.1.1. Terminals shall be made of lead-antimony alloy and shall not contain impurities in excess of those shown on Table 3. Active material shall be prepared from the best grade lead oxide suitable for the performance of the battery.

4.4.1.1.2. The inspectors may test for absence of impurities beyond the limit given. Specification of impurities and free lead in lead oxide and the typical limiting percentage (%) of impurities in lead oxide are shown in Table 3.

4.4.1.1.3. Sum of all these impurities shall not exceed 0.030 percent, when analyzed by spectro-photometric method as per ASTM E49 requirements.

Table 3: Pure Lead and Lead-Antimony Alloys as per BS EN 12659: 1999

No	Element	Maximum Percentage	
		Lead-Antimony Alloy	Pure Lead
1	Lead	91-92	99.970
2	Antimony	5.2-5.8	0.0010
3	Iron	0.005	-
4	Arsenic	0.8-1.0	0.0010
5	Bismuth	0.02	0.0030
6	Copper	0.05	0.0030
7	Silver	0.008	0.0050
8	Tin	1.7-1.9	0.0010
9	Zinc	0.001	0.0005
10	Nickel	-	0.0010

4.4.1.1.4. The terminals both positive and negative shall be strong enough to withstand a torque force of 15Nm applied to the adaptors tightly fitted to them.

4.4.1.1.5. The terminals shall be tapered standard type and conform in shape and dimensions given in Fig. 1 as per the requirements of IEC 60095-2 and this specification.

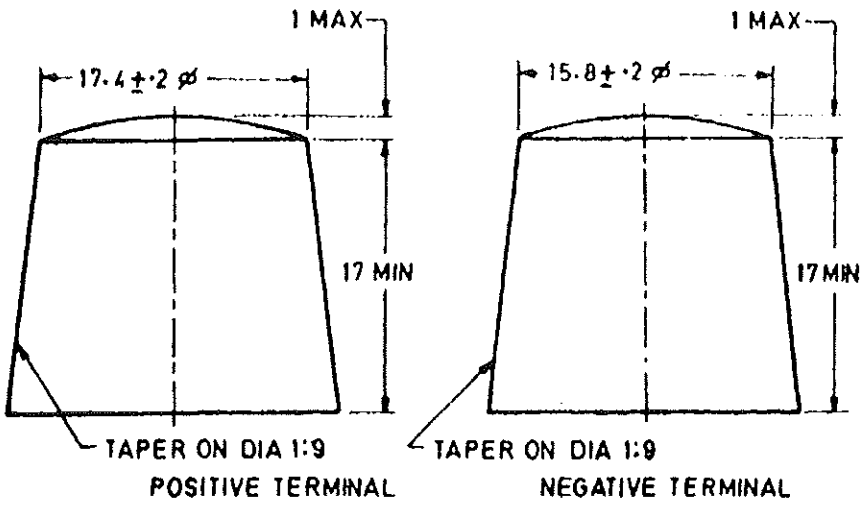

Fig. 1: Tapered Terminal

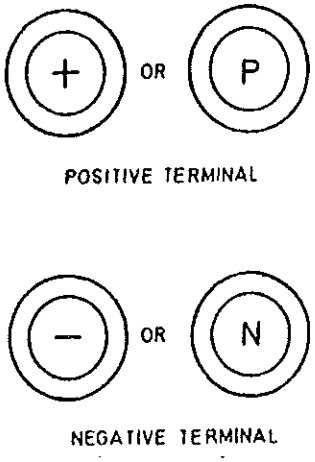

Fig. 2: Terminal markings

4.4.1.2. **Pole orientation**

A suffix shall be added to the dimensional reference to denote the battery layout in accordance with Fig. 3 during tender.

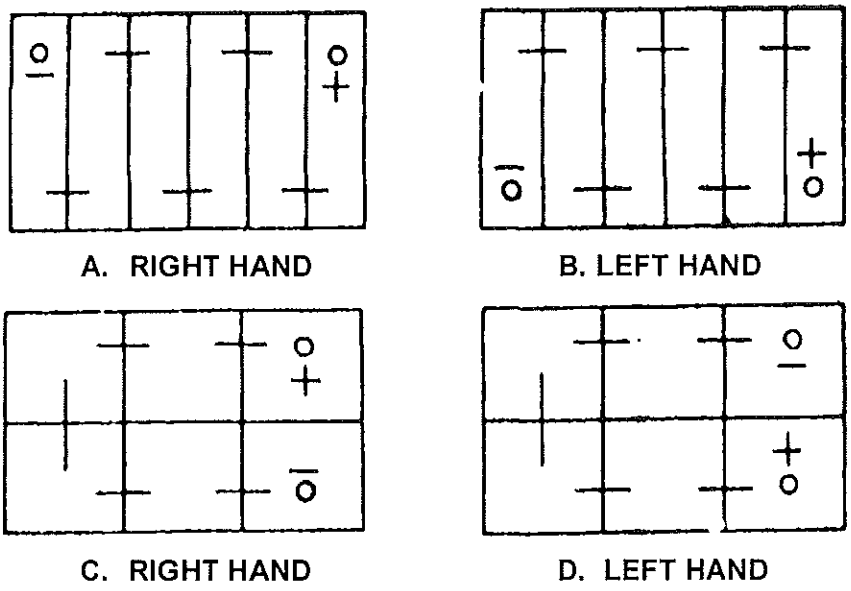

Fig. 3: Terminal layout for 12V battery

4.4.2. **Capacity and dimensions**

Capacities and overall dimensions shall conform to Table 4.The layout of the battery and polarity of the terminals shall conform to Fig 3 as per IEC 60095-2 and requirement of this specification.

Table 4: Capacities, and Overall Dimensions

Designation	Capacity Rating C_{20}	CCA Min.	RC Min.	Maximum overall dimensions (mm)			Overall Height
				Length	Width	Container Height	
	Ah	A	minutes	mm	mm	mm	mm
12-volt range	45	400	75	260	177	200	225
	65	580	90	320	177	203	225
	70	600	100	368	177	215	240
	90	830	115	430	185	215	240
	120	870	140	525	225	240	240
	150	1000	160	525	255	240	240

4.4.3. Ratings

High performance storage SLI batteries shall be rated at the 20-h rate that is at a constant current, $I = 0.05C_{20}$ A, until the terminal voltage has fallen to 10.50V for a 12-volt battery, the capacity being corrected to an electrolyte temperature of 27^0C. The ratings shall be chosen as per JIS D5 301 standard given as below:

a) Cold Cranking Amperes (CCA)

The CCA rating shall specify, in amperes, the discharge load, a fully charged battery at 0^0F (-17.8^0C) can deliver in 30 seconds while maintaining a voltage of at least 1.2 volts per cell (7.2 volts) for a 12-volt battery. The CCA ratings shall range from 400A – 1000A and are shown in Table 4.

b) Reserve Capacity (RC)

The RC rating shall specify, in minutes, the length of time a fully charged battery at 80^0F (27^0C) can be discharged at 25A while maintaining a voltage of at least 1.75 volts per cell (10.5 volts total) for a 12-volt battery. The RC ratings range from 75 to 160 minutes. Refer to Table 4.

c) Power (Watts)

The Power rating, in watts, shall be determined by multiplying the current available in the battery at 0^0F (-17.8^0C) and rated voltage. The power ratings shall range from 4,000 to 12,000 watts.

d) Amp-Hour (Ah)

The Ah rating shall specify, in amp-hours, the current the battery can provide for 20 hours at 80^0F (27^0C) while maintaining a voltage of at least 1.75 volts per cell (10.5 volts total) for a 12-volt battery. The Ah ratings shall be as per Table 4.

4.4.4. Charging

4.4.4.1. The initial and normal charging of batteries shall be done in accordance with the manufacturer's instructions. The following shall be provided with the manufacturer's instructions:

a) The last date of filling in and charging
b) For dry charged batteries, the date of expiry of dry charged condition together with instructions.

4.4.4.2. A battery shall be deemed fully charged when the terminal voltage and specific gravity of the electrolyte (corrected for temperature) measured every 30 minutes towards the

end of charging at the recommended current shows a constant value 3 times consecutively.

4.5. Sampling Scheme and Criteria for Acceptance

4.5.1. All batteries of the same type, design and rating, manufactured by the same factory during the same period using the process and materials offered for inspection at a time shall constitute a lot.

4.5.2. The number of batteries to be selected at random from the lot shall be in accordance with column 1 and 2 of Table 5.

Table 5: Sampling and acceptance criteria as per DIN 43 539- 2

Lot Size	First Stage	Second Stage	2n	C1	C2	C3
N	n	n				
Up to 50	2	2	4	0	1	1
51-300	3	3	6	0	1	1
301-500	5	5	10	0	2	2
501-1,000	8	8	16	0	2	2
> 1,001	13	13	26	0	3	4

Note:

a) Each battery selected in the first stage in accordance with column 2 shall be tested for acceptance.
b) A battery shall be declared defective if it fails in one or more of the acceptance tests.
c) If the number of defects is less than or equal to C1, the lot shall be considered as conforming but if the number of defective is equal to or less than C2 and greater than C1, a further sample of same size as taken in the first stage shall be taken and tested.
d) If the number of defectives in the two samples combined is less than C3, the lot shall be considered conforming otherwise the lot shall be considered as not conforming to the requirements of this specification.

4.6. QUALITY MANAGEMENT SYSTEMS

4.6.1. The supplier shall submit a quality assurance plan (QAP) that will be used to ensure that the batteries 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.

4.6.2. 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.

4.6.3. The bidder shall indicate the delivery time of the batteries, manufacturer's monthly & annual production capacity and experience in the production of the type and size of the batteries being offered.

5.0. TESTS AND INSPECTION

5.1. The SLI batteries shall be inspected and tested in accordance with the requirements of IEC 60095-1&2, KS 04-185, KS 03-242, KS 04-1067-2, DIN 43 539-2, JIS D5 301, IEC 61373, ASTM E49, BS EN 12659, KS 2258, ISO 2212 and BS 2000 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 in accordance with the standards mentioned in clause 5.1 (by bidder) for evaluation shall be as stated below:

a) Short circuit current and internal resistance test
b) Ampere- hour and watt-hour efficiency tests
c) Test for voltages during discharge
d) 20-hour capacity check C_e
e) Reserve capacity check $Cr,_e$
f) Cranking performance test
g) Endurance test for batteries
h) Life Cycle Test
i) Vibration resistance test
j) Type tests for separator materials

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

before shipment/delivery. The acceptance test certificates shall be submitted for approval, before dispatch of the batteries. Also one set shall be submitted and sent with batteries.

5.5. Tests to be witnessed by KPLC Engineers at the factory before shipment shall be in accordance with IEC 60095-1&2, KS 04-185, KS 03-242, KS 04-1067-2, DIN 43 539-2, JIS D5 301, IEC 61373, ASTM E49, BS EN 12659, KS 2258, ISO 2212 and BS 2000 standards and provisions of specification shall include:

a) Verification of constructional requirements.
b) Verification of marking and packaging.
c) Verifications of dimensions.
d) Verification of strength of terminals
e) Charge retention test
f) Water consumption test
g) Electrolyte retention test
h) Charge acceptance test
i) 20-hour capacity check C_e
j) Test for voltage during discharge
k) Battery impedance measurement test.
l) Cranking performance for dry-charged (or conserved-charge) batteries after activation.

5.6. On receipt of the goods KPLC may perform any of the tests specified in order to verify compliance with this specification. The supplier shall replace without charge to KPLC the batteries, which upon examination test or use, fail to meet any of the requirements in the specification.

6.0. MARKING AND PACKING

6.1. MARKING

6.1.1. The following information shall be legibly and indelibly marked in English Language on each battery by molding screen printing process:

a) Serial Number of battery.(To be engraved)
b) Battery type
c) Month and year of manufacture.(To be engraved)
d) Supplier's name.
e) Country of Manufacture
f) Nomenclature, Rated Voltage & Rated Ampere Hour Capacity.
g) Words "**PROPERTY OF KPLC**".

6.1.2. In addition to the foregoing, detailed instructions regarding climate classification, vent plugs, cleaning, specific gravity of the electrolyte for initial filling, initial charging and maintenance of the battery shall be printed on a label and fixed on the body of the battery.

6.1.3. A label that will indicate "best before dates" i.e. 42 months from date of manufacture and /or embossed marking indicating free replacement of battery shall be provided if the battery does not perform as best before dates.

6.1.4. The labels shall be durable, acid resistant and the instructions shall be legible during use of the battery till completion of all the specified tests.

6.2. PACKAGING

6.2.1. The battery shall be supplied in dry and uncharged condition suitably packed, securely in wooden crates tightly strapped with metallic straps.

6.2.2. Packing shall be suitable for handling during transit by rail/road and secured to avoid any loss or damage during transit.

6.2.3. The cases shall be furnished with an illustrated safety, operating and maintenance instructions for the batteries.

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, and technical data sheets for battery and battery layout drawings;
c) Product Data: Electrical characteristics of selected battery.
d) Sales records for the last five years and at least four customer reference letters;
e) Details of manufacturing capacity and the manufacturer's experience;
f) Copies of required type test reports by a third party testing laboratory accredited to ISO/IEC 17025;
g) Copy of accreditation certificate to ISO/IEC 17025 for the third party testing laboratory;
h) 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) 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.
c) Marking details and method to be used in marking the batteries.
d) Detailed test program to be used during factory testing;
e) Packaging details (including packaging materials).
f) Material Safety Data Sheet (MSDS) of the battery that shall include but not limited to:
   (i) Product and company identification,
   (ii) Hazard identification,
   (iii) Composition and information on ingredients,
   (iv) Accidental release and first aid measures
   (v) Handling and storage
   (vi) Exposure control/personal protection
   (vii) Physical and chemical properties
   (viii) Stability and reactivity
   (ix) Toxicological, ecological, disposal, transport and regulatory information.

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 batteries to KPLC stores.

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 reports for tender evaluation, all in English Language)*

Tender No. .....

Clause number	KPLC Requirements	Bidder's offer (indicate full details)
A. Manufacturer's Name and address		
B. Country of Manufacture		
C. Bidder's Name and address		
1. Scope		
1.1-1.4		
2. Applicable Standards		

Clause number	KPLC Requirements	Bidder's offer (indicate full details)
3. Terms & Definitions		
4. Requirements		
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4.2 General Requirements		
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4.3. Product specification requirements		
4.4 Design and construction		
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4.4.2.2 - Separators		
4.4.2.2.1 - 4.4.2.2.4		
4.4.2.3 Electrolyte		
4.4.2.3.1 - 4.4.2.3.3		
4.4.2.4 Sealing material		
4.4.2.4.1 - 4.4.2.4.2		
4.5 Terminal, Capacities, Dimensions, Rating and Charging		
4.5.1 Terminals		
4.5.1.1 Design		
4.5.1.2 Pole orientation		
4.5.2 Capacity and overall dimensions		
4.5.3 Ratings		
a) Cold Cranking Amperes (CCA) in amperes		
b) Reserve Capacity (RC) in minutes		
c) Power in watts		
d) Ampere hours (Ah) in amp-hours		
4.5.4 Charging		
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4.6. Sampling Scheme and Criteria for Acceptance		
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4.7. Quality Management System		
4.7.1 – 4.7.3		
5. Tests & Inspection		
5.1. -5.6		
6. Marking & Packaging		
6.1. Marking		

Clause number	KPLC Requirements	Bidder's offer (indicate full details)
6.1.1 – 6.1.4		
Packaging		
6.2.1 – 6.2.3		
7. Documentation		
7.1 – 7.3		
8.0 Manufacturer's Guarantee and Warranty		
9.0 List catalogues, brochures, technical data and drawings submitted to support the offer.		
10.0 List customer sales records and customer reference letters submitted to support the offer.		
11.0 List Test Certificates submitted with tender		
12.0 List test & calibration reports to be submitted to KPLC for approval before shipment		
13.0 List test reports of the batteries to be submitted to KPLC for approval before shipment		
14.0 Statement of compliance to specification (indicate deviations if any & supporting documents)		
15.0 List Acceptance Tests to be witnessed by KPLC Engineers at the factory		

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Manufacturer's Name, Signature, Stamp and Date