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**BATTERIES FOR USE IN PHOTOVOLTAIC SYSTEMS -
Specification**

ZAMBIA BUREAU OF STANDARDS

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TECHNICAL COMMITTEE RESPONSIBLE

This Zambian Standard was prepared by the Photovoltaic Systems Technical Committee (TC 5/6) upon which the following organisations were represented:

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Energy Regulation Board
Muhanya Solar Ltd
Rural Electrification Authority
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TABLE OF CONTENTS

	Page
FOREWORD.....	iv
1 SCOPE.....	1
2 NORMATIVE REFERENCES	1
3 DEFINITIONS	1
4 TYPES OF BATTERIES.....	2
5 RATED CAPACITY	3
6 CYCLE LIFE	3
7 DISPOSAL	4
8 CONSTRUCTION.....	4
9 TESTING.....	4
10 MARKING.....	5
11 DOCUMENTATION.....	5
ANNEX A	6

FOREWORD

This National Standard has been prepared by the Photovoltaic Systems Technical Committee (TC 5/6), in accordance with the procedures of ZABS. All users should ensure that they have the latest edition of this publication as standards are revised from time to time.

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The preparation of this Standard has been undertaken by the Photovoltaic Systems Technical Committee (TC 5/6). The revision of this standard was necessary to ensure that technological advancements are taken into consideration.

In the preparation of this standard, the following publications were consulted:

- SAZS 522, Standard specification for batteries for use in photovoltaic systems.
- NRS 052: 6, Standard specification for photovoltaic systems for use in individual homes.
- “Universal technical standard for solar home systems” Thermie B SUP 995-96, EC-DGXVII

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ZAMBIA BUREAU OF STANDARDS

Zambian Standards

BATTERIES FOR USE IN PHOTOVOLTAIC SYSTEMS - Specification

1 SCOPE

This Zambian Standard specifies minimum requirements for different types of batteries for use in Photovoltaic Systems.

2 NORMATIVE REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. All standards are subject to revision and, since any reference to a standard is deemed to be the latest reference to the latest edition of that standard, parties to agreements based on this standard are encouraged to take steps to ensure the use of the most recent editions of the standards indicated below. Information on currently valid national and international standards may be obtained from the Zambia Bureau of Standards:

ZS IEC TS 61836 Solar photovoltaic energy systems – Terms and Symbols

ZS IEC 61427 -1 Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 1 Photovoltaic off- grid applications

ZS IEC 62133 Secondary cells and batteries containing alkaline or other non-acid electrolytes

3 DEFINITIONS

For the purpose of this standard, terms and definitions in ZS IEC 61836 shall apply as well as the following:

3.1 Ampere-hours (Ah).

A unit of measurement quantifying the amount of current flow in a conductor in an hour.

3.2 Battery

A bank of cells connected together so as to store and supply energy.

3.3 Cycle

A sequence of a discharge followed by a charge or a charge followed by a discharge under specified conditions.

3.4 Type of cycle

3.4.1 Deep Cycle:

A cycle in which the discharge is continued until the battery reaches its cut-off voltage, usually 80% of discharge.

3.4.2 Shallow Cycle:

Charge and discharge cycles which do not allow the battery to approach its cutoff voltage.

3.5 Discharge of a battery

An operation, during which a battery delivers current to an external circuit by the conversion of chemical energy into electric energy.

3.6 Float charge

A constant voltage charging stage in which the battery is maintained at a voltage below the gassing point to complete the charging cycle and compensate for battery self-discharge.

3.7 Float voltage

The minimum constant voltage necessary to offset the internal losses of the battery.

3.8 Load reconnect voltage

The voltage set point of the regulator based on the chemistry type of the battery at which the loads are reconnected to the battery after low voltage disconnect has occurred.

3.9 Maximum-permitted Depth of Discharge (DoD)

The maximum permitted charge depletion point chosen to avoid premature damage to the battery.

Note: The maximum permitted DoD is indicated approximately by the battery voltage.

3.10 Percentage Depth of Discharge

The energy removed from a fully charged battery expressed as a percentage of the battery's rated capacity.

Note 1: The removal of 25 Ah from a fully charged 100 Ah rated battery results in a 25% depth of discharge

Note 2: 100% DoD means fully discharged. 0% DoD means fully charged.

3.11 Rated capacity

The quantity of energy, declared by the manufacturer, which a cell or battery can deliver under specified conditions.

Note 1: Typically at a constant discharge current and battery temperature after a full charge. For a current I_n that will fully discharge the battery in n hours, the rated capacity is abbreviated as C_n .

Note 2: The rated capacity of battery is usually expressed in ampere-hours (Ah)

Self-Discharge

This is when batteries discharge when they are in storage under no load conditions.

4 TYPES OF BATTERIES

There are different types of batteries that can be used in a photovoltaic systems based on their chemistry type.

4.1 Lead Acid Batteries

Lead acid batteries used in photovoltaic systems shall meet the following criteria:

4.1.1 Shall be of a design offering deep cycle capability.

4.1.2 Terminals shall be of the lug (bolt-on) type, not the standard automotive tapered pillar type and shall be corrosion resistant, and of such a design that cleaning at intervals is easily accomplished.

4.1.3 Lead-calcium types shall not be used due to their inherent environmental unfriendliness, but lead-

calcium antimony batteries shall be acceptable.

4.1.4 Use of automotive type batteries is not recommended because they are shallow cycle.

4.1.5 The plates in a deep cycle battery, whether flat plate or tubular design, shall contain no less than a ratio of 1.1 grams to 1 gram of negative active material to positive active material and each cell shall contain a minimum of 10.5 grams of positive active material per rated ampere-hour.

4.1.6 The flooded type battery shall be designed in such a way that when fully topped up there shall be 16.6 cubic centimeters (cc) of electrolyte at a minimum of 1.225 specific gravity (at 25 degrees Celsius) in each cell, per rated ampere-hour. Each cell shall have a reserve electrolyte capacity of 0.66 cc per rated ampere-hour above the plates.

Note: The above applies to sealed and valve regulated lead acid batteries.

Lead acid batteries are secondary batteries in which the electrodes are made mainly from lead and the electrolyte is a sulphuric acid solution. There are different types of lead acid batteries such as:

a. Sealed lead acid batteries –

- i. Gel lead acid battery– this is a battery in which the electrolyte is thickened into a gel by the addition of additives (such as silica)
- ii. Absorbed Glass Mat lead acid battery – this is a battery in which the electrolyte is stabilized or held in a glass mat as opposed to freely flooding the plates. The glass mat is made of very thin glass fibres woven into a mat to increase surface area to hold the electrolyte.

b. valve regulated lead acid batteries – Secondary cell which is closed under normal conditions but which has an arrangement which allows the escape of gas if the internal pressure exceeds a predetermined value. The cell cannot normally receive the addition of electrolyte.

Note: Such cells have an immobilized electrolyte to prevent spillage and allow for oxygen recombination on the negative electrode.

4.2 Batteries Other than Lead-Acid

Batteries other than those in 4.1 used in photovoltaic systems shall meet the following criteria:

4.2.1 This refers to secondary battery types in both stationary and portable applications

4.2.2 Safety requirements as stated in ZS IEC 62133 shall apply.

4.2.3 Non lead-acid batteries may be acceptable provided that the specifications do not fall below the approved lead-acid equivalent in any respect.

Note 1: The other types of batteries used in photovoltaic systems may be based on the following chemical compositions such as Nickel Cadmium, Nickel metal hydride, Lithium-ion, Lithium- iron phosphate, Sodium Nickel chloride.

Note 2: Super capacitors may also fall in this criteria.

Note 3: Refer to ZS IEC 62133 in relation to portable solar applications.

5 RATED CAPACITY

Rated capacity values shall correspond to a discharge indicated by the manufacturer in amp-hours (Ah).

6 CYCLE LIFE

Batteries shall have a life of at least 1000 cycles at daily depth of discharge of 25% or 450 cycles at 80% daily depth of discharge.

6.1 Self-Discharge - Lead acid batteries

The minimum self-discharge of batteries shall as follows

- i. Flooded batteries 5%
- ii. Valve regulated batteries 3%

6.2 Self Discharge – Other than lead acid batteries

- i. Lithium-ion %
- ii. Nickel cadmium %

7 DISPOSAL

Shall comply with the Environmental Management Act No. 12 of 2011 of the laws of Zambia.

8 CONSTRUCTION

Deep cycle batteries shall have appropriate separators over either the positive or negative plates in order to prevent self-discharge through direct exposure of the positive and negative plates to each other.

9 TESTING

Testing of batteries shall be done in accordance with Clauses 7 & 8 of ZS IEC 61427-1 as well as the following:

9.1 Rated capacity

The battery to be tested shall be submerged in a bath of water up to 25 mm from the top of the battery. The water temperature shall be controlled at 25 degrees Celsius $\pm 1\%$ in order to maintain the battery temperature at 25 degrees Celsius. The battery shall be allowed to stand in the bath for 24 hours before the tests are commenced.

9.2 Cycle life

9.2.1 Cells shall be subjected to repeated charge/discharge cycles to verify that the cells meet or exceed the manufacturers claimed cycle life over a period of time. The battery shall be discharged at a constant current such that 80% of the rated ampere-hour capacity will be removed and compared against the period indicated by the manufacturer. Should the battery terminal voltage fall below the manufacturer's recommended end-point voltage and rated capacity during this test, the battery will be deemed to have failed.

9.2.2 Each discharge cycle shall be counted.

9.2.3 The battery (lead acid) then to be charged over at the C_{20} rating at 25 °C to restore 100% rated capacity.

9.2.4 The battery is again discharged as per Clauses 5 and 6 above.

9.2.5 At the completion of such cycles as stated in 9.2 the battery shall be deemed to have passed the test.

9.2.6 A minimum of 5 batteries must be supplied for test. Failure of more than one (or 20% of the sample) will prevent certification as "Deep Cycle; suitable for solar photovoltaic application".

10 MARKING

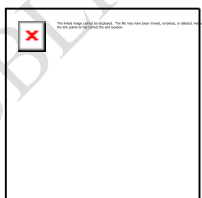
Each battery shall be clearly and permanently marked in English or any other language alongside English with the following information:

- a. The name of the manufacturer or supplier;
- b. Type of battery (indicate whether it's a flooded battery, AGM, Gel, etc)
- c. Serial Number
- d. Date of manufacture;
- e. Rated capacity;
- f. Rated nominal voltage;
- g. An indication that it is designed or may be applicable for use in a PV system.
- h. Polarity marked by symbol (+/-) and/or colour (/e.g Red) for positive and (/e.g Blue/Black) for negative

Note: the colours marked for positive and negative may vary depending on the manufacturer. However the symbols remain as stated above and therefore shall take precedence.

- i. The Zambia Bureau of Standards certification mark, when used.

Note: The Zambia Bureau of Standards is the owner of the registered certification mark shown below, the independent assurance that the product conforms to the requirements of this Zambian Standard. This certification mark may be used by manufacturers only under licence from the Bureau. Particulars of the conditions under which licences are granted may be obtained from the Director, Zambia Bureau of Standards, P. O. Box 50259, Lusaka 10101.



11 DOCUMENTATION

Batteries shall be provided with documentation for transport, installation, commissioning, operation, maintenance, decommissioning and disposal of such cells and batteries for photovoltaic applications.

The manufacturer shall advise if there are special considerations to be observed for the initial charging of batteries when the photovoltaic array is available as the power source.

ANNEX A

(Normative)

Information to Be Supplied By the Manufacturer or Supplier

The manufacturer or supplier shall supply the following information: -

- a.** Recommended depth of discharge;
- b.** Graphical information on charge and discharge characteristics, and cycle life versus cycle depth;
- c.** Maximum charge voltage, float voltage and load disconnect voltage;
- d.** Temperature compensation curves;
- e.** Type of battery cell (electrode and electrolyte type); and
- f.** General Safety and Environmental Protection
 - i.** Restricted access to battery banks
 - ii.** Warning Signs
 - iii.** Touch barriers to prevent inadvertent contact
 - iv.** Disposal
- g.** Percentage of self-discharge of the battery in storage