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Secondary cells and batteries for photovoltaic energy systems (PVES) – General requirements and methods of test

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International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SECONDARY CELLS AND BATTERIES FOR PHOTOVOLTAIC ENERGY SYSTEMS (PVES)– GENERAL REQUIREMENTS AND METHODS OF TEST

FOREWORD

International Standard IEC 61427 has been prepared by IEC technical committee 21: Secondary cells and batteries.

This second edition cancels and replaces the first edition published in 1999. This edition constitutes a technical revision.

This second edition is a restructuring of the previous edition of the document, clarifying the different clauses with regard to conditions of use, general requirements, functional characteristics, general tests conditions, test method and recommended use of tests, the aim being to ensure a better understanding by the end user. The test method is clearly explained in detail for both technologies: lead-acid and nickel-cadmium.

The text of this standard is based on the following documents:

FDIS	Report on voting
21/621/FDIS	21/624/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

SECONDARY CELLS AND BATTERIES FOR PHOTOVOLTAIC ENERGY SYSTEMS (PVES) – GENERAL REQUIREMENTS AND METHODS OF TEST

1 Scope

This International Standard gives general information relating to the requirements of the secondary batteries used in photovoltaic energy systems (PVES) and to the typical methods of test used for the verification of battery performances.

This International Standard does not include specific information relating to battery sizing, method of charge or PVES design.

NOTE This standard is applicable to lead-acid and nickel-cadmium cells and batteries. It is intended to amend this standard to include other electrochemical systems when they become available.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-482:2004, *International Electrotechnical Vocabulary (IEV) – Part 482: Primary and secondary cells and batteries*

IEC 60622, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Sealed nickel-cadmium prismatic rechargeable single cells*

IEC 60623, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Vented nickel-cadmium prismatic rechargeable single cells*

IEC 60721-1, *Classification of environmental conditions – Part 1: Environmental parameters and their severities*

IEC 60896-11, *Stationary lead-acid batteries – Part 11: Vented types – General requirements and methods of test*

IEC 60896-21, *Stationary lead-acid batteries – Part 21: Valve-regulated types – Methods of test*

IEC 61056-1, *General purpose lead-acid batteries (valve-regulated types) – Part 1: General requirements, functional characteristics – Methods of test*

IEC 61836, *Solar photovoltaic energy systems – Terms and symbols*

IEC 62259, *Secondary cells and batteries containing alkaline or other non-acid electrolytes - Nickel cadmium prismatic secondary single cells with partial gas recombination*

3 Terms and definitions

For the purpose of this document, the definitions and terms for secondary cells and batteries given in IEC 60050-482, and those for photovoltaic generator systems given in IEC 61836 apply.

4 Conditions of use

This clause specifies the particular operating conditions experienced by secondary batteries in photovoltaic applications during their use.

4.1 Photovoltaic energy system

The photovoltaic energy system with secondary batteries referred to in this standard can supply a constant, variable, or intermittent energy to the connected equipment. This system may include hybrid or grid-connected systems. The connected equipments may be pumps, refrigerators, lighting systems, communication systems, etc.

4.2 Secondary cells and batteries

Secondary cells and batteries mainly used in photovoltaic energy systems are of the following types:

- vented (flooded);
- valve-regulated, including those with partial gas recombination;
- gastight sealed (nickel-cadmium only).

The cells and batteries can normally be delivered in the following conditions:

- discharged and drained (nickel-cadmium batteries only);
- charged and filled;
- dry charged and unfilled (lead-acid batteries only);
- discharged and filled (nickel-cadmium batteries only).

For optimum service life, the battery manufacturer's instructions for initial charge of the battery shall be followed.

4.3 General operating conditions

Batteries in a typical PV system operating under average site weather conditions may be subjected to the following conditions:

4.3.1 Autonomy time

The battery is designed to supply energy under specified conditions for a period of time, typically from 3 days to 15 days, with or without solar irradiation.

NOTE When calculating the required battery capacity, the following items should be considered, e.g.:

- required daily/seasonal cycle (there may be restrictions on the maximum depth of discharge);
- time required to access the site;
- ageing;
- operating temperature;
- future expansion of the load.

4.3.2 Typical charge and discharge currents

The charge current generated by the photovoltaic generator and the discharge current determined by the load are shown in Table 1.

Table 1 – Charge and discharge currents

	Lead acid	Nickel cadmium
Charge current generated by the PV generator		
Maximum charge current	$I_{20} = C_{20}/20\text{h}$	$I_{20} = I_t/20$
Average charge current	$I_{50} = C_{50}/50\text{h}$	$I_{50} = I_t/50$
Discharge current determined by the load		
Average discharge current	$I_{120} = C_{120}/120\text{h}$	$I_{120} = I_t/120$

NOTE 1 Depending on the system design, e.g. for hybrid systems, the charge and the discharge current may vary in a wider range.

NOTE 2 In some systems the load current must be supplied at the same time as the battery charging current.

NOTE 3

For Lead Acid

C_n is the rated capacity (Ah)

n is the time base in hours for which the capacity is declared

t is the time in hours

$I_n = C_n / t$

For Nickel Cadmium

C_n is the rated capacity (Ah)

n is the time base in hours for which the capacity is declared

t is the time in hours

See IEC 61434 for the reference test current I_t

$I_t = C_n$ (Ah)/1 h and $I_n = I_t / t$

4.3.3 Daily cycle

The battery is normally exposed to a daily cycle as follows:

a) charging during daylight hours;

b) discharging during night-time hours.

A typical daily usage results in a discharge between 2 % to 20 % of the battery capacity.

4.3.4 Seasonal cycle

The battery may be exposed to a seasonal cycle of state of charge. This arises from varying average-charging conditions as follows:

- periods with low solar irradiation, for instance during winter causing low energy production. The state of charge of the battery (available capacity) can go down to 20 % of the rated capacity or less;
- periods with high solar irradiation, e.g. in summer, which will bring the battery up to the fully charged condition, with the possibility that the battery could be overcharged.

4.3.5 Period of high state of charge

During summer for example, the battery will be operated at a high state of charge (SOC), typically between 80 % and 100 % of rated capacity.

A voltage regulator system normally limits the maximum battery voltage during the recharge period.

NOTE In a "self-regulated" PV system, the battery voltage is not limited by a charge controller but by the characteristics of the PV generator.

The system designer normally chooses the maximum charge voltage of the battery as a compromise allowing to recover to a maximum state of charge (SOC) as early as possible in the summer season but without substantially overcharging the battery.

The overcharge increases the gas production resulting in water consumption in vented cells. In valve-regulated lead-acid cells, the overcharge will cause a lesser increase of water consumption and gas emission but more heat generation.

Typically the maximum charge voltage is 2,4 V per cell for lead-acid batteries and 1,55 V per cell for nickel-cadmium batteries at the reference temperature specified by the manufacturer. Some regulators allow the battery voltage to exceed these values for a short period as an equalizing or boost charge. Charge voltage compensation shall be used according to the battery manufacturer instructions if the battery operating temperature deviates significantly from the reference temperature.

The expected life-time of a battery in a PV system even kept regularly at a high state of charge may be considerably less than the published life of the battery used under continuous float charge.

4.3.6 Period of sustained low state of charge

During periods of low solar irradiation, the energy produced by the photovoltaic array may not be sufficient to fully recharge the battery. The state of charge will then decrease and cycling will take place at a low state of charge. The low solar irradiation on the photovoltaic array may be a result of the geographical location combined with the winter periods, heavy clouds, rains or accumulation of dust on photovoltaic array.

4.3.7 Electrolyte stratification

Electrolyte stratification may occur in lead-acid batteries. In vented lead-acid batteries, electrolyte stratification can be avoided by electrolyte agitation or periodic overcharge whilst in service. In valve regulated lead-acid (VRLA) batteries, electrolyte stratification can be avoided by design or by operating them according to the manufacturer's instructions.

4.3.8 Storage

Manufacturers' recommendations for storage shall be observed. In the absence of such information, the storage period may be estimated according to the climatic conditions as shown in Table 2 as below.