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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Secondary batteries (except lithium) for the propulsion of electric road vehicles – Performance and endurance tests

Accumulateurs (excepté lithium) pour la propulsion des véhicules routiers électriques – Essais de performance et d'endurance

IEC 61982:2012

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 61982 has been prepared by IEC technical committee 21: Secondary cells and batteries.

This first edition cancels and replaces the IEC 61982-1:2006, the IEC 61982-2:2002 and the IEC 61982-3: 2001. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to IEC 61982-1, IEC 61982-2 and IEC 61982-3:

– clarification of the scope;
– update of some tests, and
– addition of the Annex A dealing with NiMh batteries for the propulsion of hybrid electric vehicules.

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

FDIS	Report on voting
21/775/FDIS	21/782/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 stability 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.

INTRODUCTION

The first edition of IEC 61982 series was composed of the following three parts:

IEC 61982-1:2006, *Secondary batteries for the propulsion of electric road vehicles – Part 1:Test parameters*

IEC 61982-2:2002, *Secondary batteries for the propulsion of electric road vehicles – Part 2:Dynamic discharge performance test and dynamic endurance test*

IEC 61982-3:2001, *Secondary batteries for the propulsion of electric road vehicles – Part 3: Performance and life testing (traffic compatible, urban use vehicles)*

The current standard IEC 61982:2012 replaces the former IEC 61982 series above.

In terms of lithium ion batteries for automobile application, the following standards are applicable:

IEC 62660-1:2010, *Secondary lithium-ion cells for the propulsion of electric road vehicles – Part 1: Performance testing*

IEC 62660-2:2010, *Secondary lithium-ion cells for the propulsion of electric road vehicles – Part 2: Reliability and abuse testing*

ISO 12405-1:2011, *Electrically propelled road vehicles – Test specification for lithium-ion traction battery packs and systems – Part 1: High-power applications*

ISO 12405-2:2011, *Electrically propelled road vehicles – Test specification for lithium-Ion traction battery systems – Part 2:High energy applications* (to be published)

SECONDARY BATTERIES (EXCEPT LITHIUM) FOR THE PROPULSION OF ELECTRIC ROAD VEHICLES –

Performance and endurance tests

1 Scope

This International Standard is applicable to performance and endurance tests for secondary batteries used for vehicle propulsion applications. Its objective is to specify certain essential characteristics of cells, batteries, monoblocks, modules and battery systems used for propulsion of electric road vehicles, including hybrid electric vehicles, together with the relevant test methods for their specification.

The tests may be used specifically to test batteries developed for use in vehicles such as passenger vehicles, motor cycles, commercial vehicles, etc. This standard is not applicable to battery systems for specialist vehicles such as public transport vehicles, refuse collection vehicles or heavy duty vehicles, where the battery is used in the similar way to the industrial vehicles.

The test procedures are defined as a function of the vehicle requirements of performance.

This standard is applicable to lead-acid batteries, Ni/Cd batteries, Ni/MH batteries and sodium based batteries used in electric road vehicles.

Annex A specifies performance and cycle life test procedures of Ni/MH batteries used for the propulsion of hybrid electric vehicle (HEV).

NOTE This standard is not applicable to lithium-ion batteries for automobile application that are specified in IEC 62660-1, IEC 62660-2, ISO 12405-1 and ISO 12405-2 (to be published).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 61434, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Guide to designation of current in alkaline secondary cell and battery standards*

3 Terms and definitions

For the purposes of this document, the terms and definitions and those given in IEC 60050-482, as well as the following apply.

3.1
battery system
energy storage device that includes cells or cell assemblies or battery pack(s) as well as electrical circuits and electronics

EXAMPLES Battery control unit, contactors.

Note 1 to entry Battery system components can also be distributed in different devices within the vehicle.

3.2
benchmark energy content
the battery energy content measured during the reference test cycle and used as the reference value to assess the battery deterioration during its life

3.3
nominal voltage
numerical value of the voltage of a cell, dependent on the electrochemical system. The cell voltage is the voltage of the test unit divided by the number of cells

Note 1 to entry The symbol used for the nominal voltage of a cell is "U_n (V)".

Note 2 to entry Nominal voltages are given in Table 1.

3.4
type testing
test that measures the performance of the product under closely controlled conditions, largely free from environmental and self-generated influences

3.5
rated capacity
quantity of electricity which a fully charged cell or battery can deliver, when discharged at a constant current I_n to a final voltage U_f over a period of n hours and at a specified temperature

Note 1 to entry The rated capacity C_n of a cell or battery is declared by the manufacturer.

3.6
ambient reference temperature
temperature of 25 °C ± 2 K

4 General test requirements

4.1 Accuracy of measuring instruments

4.1.1 Electrical measuring instruments

4.1.1.1 Range of measuring devices

The instruments used shall enable the values of voltage and current to be correctly measured. The range of these instruments and measuring methods shall be chosen so as to ensure the accuracy specified for each test. For analogue instruments, this implies that the readings shall be taken in the last third of the graduated scale.

Any other measuring instruments may be used provided they give an equivalent accuracy.

4.1.1.2 Voltage measurement

The instruments used for voltage measurement shall be voltmeters of an accuracy class equal to 0,5 or better. The resistance of the voltmeters used shall be at least 1 000 Ω/V (see IEC 60051 series).

4.1.1.3 Current measurement

The instruments used for current measurement shall be ammeters of an accuracy class equal to 0,5 or better. The entire assembly of ammeter, shunt and leads shall be of an accuracy class of 0,5 or better (see IEC 60051 series or refer to IEC 60359).

4.1.2 Temperature measurement

The temperature measuring instruments shall have a suitable range in which the value of each graduated division is not in excess of 1 K. The absolute accuracy of the instrument shall be at least 0,5 K.

The temperature measuring point shall be that specified by the manufacturer, as a location that most closely reflects the electrolyte temperature or if not specified, the point shall be at the centre of the longer side of a cell, be it a single cell or a cell that is an integral part of a monobloc.

In case of battery system that includes a thermal management system, or when cells are not directly accessible for temperature measurement, the temperature can be measured by the battery management system (BMS) supplied by the manufacturer.

4.1.3 Electrolyte density measurement of vented lead-acid batteries

For measuring electrolyte densities, hydrometers shall be used with scales so graduated, that the value of each division is not in excess of 5 kg/m^3. The absolute accuracy of the instrument shall be at least 5 kg/m^3.

4.1.4 Tolerance

The overall accuracy of controlled or measured values, relative to the specified or actual values, shall be within these tolerances:

a) ± 1 % for voltage;
b) ± 1 % for current;
c) ± 2 % for power;
d) ± 2 K for temperature;
e) ± 0,1 % for time;
f) ± 0,1 % for dimensions;
g) ± 0,1 % for mass.

These tolerances comprise the combined accuracy of the measuring instruments, the measurement technique used, and all other sources of error in the test procedure.

4.2 General provisions

4.2.1 Current slew rate

The current slew rate (the time difference expressed in seconds between one steady current and the next) during the dynamic tests shall be ≤ 1 s from one steady state to the next.

Switching between power levels in the micro-cycle shall be timed such that the mid-point of the transition occurs at the point allocated for the transition.

The total duration of each complete micro-cycle shall be 360 s ± 1 s.

4.2.2 Temperature – electrolyte accessible

The cell temperature shall be measured by use of a temperature probe immersed in the electrolyte above the plates.

4.2.3 Temperature – electrolyte not accessible

The cell temperature shall be measured by use of a surface temperature-measuring device. The temperature shall be measured at a location, which most closely reflects the electrolyte temperature.

4.2.4 Electrolyte density readings of vented lead-acid batteries

Because of the varying rates of stabilization of cells, electrolyte density readings shall be taken at times most appropriate to the test sample but within the constraints of the test system.

4.2.5 Mechanical support

If necessary, mechanical support should be provided for the test samples in order to maintain the same dimensions as when installed in batteries, as specified by manufacturer.

4.3 Test samples

Cells constituting the test unit and subjected to a dynamic discharge performance test or a dynamic endurance test shall previously have achieved an actual capacity at least equal to the rated capacity.

The number of test samples required to be subjected to each test condition shall be a minimum of 5 cells and where monoblocs are tested, there shall be a minimum of two test samples.

Where applications tests are conducted on a battery specific to a particular vehicle, a complete battery or a representative section of the battery may be used, agreed between the battery manufacturers and vehicle manufacturers.

4.4 Test temperature

4.4.1 Test temperature for type testing

4.4.1.1 For Lead-acid batteries, the battery temperature at the start of the discharge should be the specified test temperature ± 5K.

Where the cell temperature at the commencement of discharge (initial temperature) is different from the reference temperature and where this has a significant effect on the result, an appropriate correction factor shall be applied to the resulting capacity.

The following formula can be used to correct capacity values to the actual capacity.

$$C_{\mathrm{a}} = \frac{C}{1+\lambda(t_0 - 25)} (\mathrm{Ah})$$

where

C_a is the actual capacity of the test sample at the reference temperature;

C is the measured capacity at the initial temperature;

t_0 is the initial temperature;

λ is the temperature correction factor (see Table 1 for values).

Following discharge, the cells/battery shall be fully charged in accordance with the manufacturer's recommendations and then stabilized to the specified test temperature during a 1 h – 4 h period prior to the next discharge.

4.4.1.2 For Ni/MH and Ni/Cd batteries, the battery temperature at the start of the discharge should be the specified test temperature ± 2 K. For sodium based batteries, the internal temperature measured by BMS should be in the range recommended by the battery manufacturer.

4.4.2 Operation of BMS

A battery system provided with a BMS shall have this function operational during the test. All systems shall be powered as specified by the battery manufacturer.

4.5 Charging and rest after charge

The cells shall be charged in accordance with a charging procedure specified by the manufacturer and within the limits in this standard prior to the discharge test. After charging, the test sample shall be stored for 1 h to 4 h at the test ambient temperature declared for the test to be performed.

4.6 Conditioning

Before starting the test, the battery shall be conditioned according to the manufacturer's specifications. The battery conditioning shall be terminated as soon as the rated capacity is achieved. The number of cycles for conditioning shall be less than 20.

4.7 Test sequence

The following tests shall be carried out in the order stated in this standard:

– conditioning (see 4.6),
– dynamic discharge performance test (see Clause 6),
– dynamic endurance test (see Clause 7).

4.8 Data recording

4.8.1 General

Data recording shall include time, temperature, voltage and current and visual observations. Data shall include a record of any maintenance performed on battery samples during the test sequence.

4.8.2 Sampling frequency

All parameters should be measured and stored at a sample rate adequate to ensure that all relevant deviations are recorded for later data analysis. Additionally, for tests involving short-term transient conditions (e.g. peak power measurement) both the sampling frequency (typically once per second) and the time difference between corresponding current and voltage measurements (typically 0,1 s or less) are important during the critical test period.

5 Rated capacity

5.1 General

This test is intended to measure the capacity expressed in Ah of battery, cells/modules when discharged at a constant current. The rated capacity shall be the 3 h capacity at a temperature of 25 °C declared by the manufacturer, unless otherwise specified.

The battery shall be discharged at a constant current of:

$$I_n(\mathrm{A}) = \frac{C_n(\mathrm{Ah})}{3\mathrm{h}}$$

to a final voltage of U_{f3}.

where

I_n is the constant current in amperes (A);

C_n is the rated capacity as declared by the manufacturer, in ampere-hours (Ah);

U_{f3} is the final voltage specified for the battery type in volts (V) (see Table 1).

New batteries subjected to capacity testing are allowed a maximum of 20 cycles to achieve the rated capacity. The capacity test shall be discontinued at the first cycle at which the rated capacity is achieved. Batteries that do not achieve the rated capacity by the 20th cycle shall not be used for testing. Additional capacities considered appropriate for use in connection with road vehicle applications are the 5 h, 1 h and 0,5 h capacities. The appropriate final voltages for C_5, C_1 and $C_{0,5}$ capacities, i.e. U_5, U_1 and $U_{0,5}$ are contained in Table 1.

NOTE The capacity test for Ni/MH batteries used for the propulsion of HEV is specified in Annex A.

5.2 Additional test temperatures

Where appropriate to the battery type, the following cell/battery test temperatures could provide a useful profile of performance: 45 °C, 0 °C and –20 °C.

6 Dynamic discharge performance test

6.1 Basic considerations

The objective of this test is to specify the conditions to derive a value for the battery capacity which is closely related to the available capacity in an electric road vehicle application.

In electric vehicle applications, propulsion batteries shall be capable of supplying widely varying current rates. The driving profiles can be simplified to high-rate current for acceleration, low-rate current for constant speed driving and zero current for rest periods. When considering battery recharging during vehicle braking (regenerative charging), a high-rate recharge pulse is incorporated in the test profile.

Test temperatures are specified in Table 1.

6.2 Test cycle definition without regenerative charging

The dynamic discharge performance cycle shall be represented by a 60 s repeated micro-cycle having three current levels:

1) I_{dh} (A) discharge/10 s;
2) I_{dl} (A) discharge/20 s;
3) I_0 (A) zero current/30 s.

(see Figure 1 and Table 2)

6.3 Test cycle definition with regenerative charging

The dynamic discharge performance cycle shall be represented by a 60 s repeated micro-cycle having four current levels:

1) I_{dh} (A) discharge/10 s;
2) I_{dl} (A) discharge/20 s;
3) I_{rc} (A) recharge/5 s;
4) I_0 (A) zero current/25 s.

(see Figure 2 and Table 2)

The manufacturer can prescribe a maximum voltage that shall not be exceeded during the I_{rc} pulse.