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Edition 2.0 2018-12

INTERNATIONAL STANDARD

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colour inside

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

Éléments d'accumulateurs lithium-ion pour la propulsion des véhicules routiers électriques – Partie 2: Essais de fiabilité et de traitement abusif

IEC 62660-2:2018-12(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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Part 2: Reliability and abuse testing

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International Standard IEC 62660-2 has been prepared by IEC technical committee 21: Secondary cells and batteries.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) The procedure of forced discharge test has been clarified (6.4.3.2).
b) "Cell block" has been added to the scope (Clause 1).
c) Option of temperature cycling test with electrical operation has been deleted (6.3.2).
d) The test conditions for overcharge test have been revised (6.4.2.2).

The text of this International Standard is based on the following documents:

FDIS	Report on voting
21/976/FDIS	21/986/RVD

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

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

A list of all the parts in the IEC 62660 series, published under the general title *Secondary lithium-ion cells for the propulsion of electric road vehicles*, can be found on the IEC website.

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

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- withdrawn,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

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INTRODUCTION

The commercialization of electric road vehicles including battery, hybrid and plug-in hybrid electric vehicles has been accelerated in the global market, responding to the global concerns on CO_2 reduction and energy security. This, in turn, has led to rapidly increasing demand for high-power and high-energy-density traction batteries. Lithium-ion batteries are estimated to be one of the most promising secondary batteries for the propulsion of electric vehicles. In the light of the rapid spread of hybrid electric vehicles and the emergence of battery and plug-in hybrid electric vehicles, a standard method for testing reliability and abuse requirements of lithium-ion batteries is indispensable for securing a basic level of safety and obtaining essential data for the design of vehicle systems and battery packs.

This document specifies reliability and abuse testing for automobile traction lithium-ion cells that basically differ from the other cells including those for portable and stationary applications specified by other IEC standards. For automobile application, it is important to note the usage specificity; i.e. the design diversity of automobile battery packs and systems, and specific requirements for cells and batteries corresponding to each of such designs. Based on these facts, the purpose of this document is to provide a basic test methodology with general versatility, which serves a function in common primary testing of lithium-ion cells to be used in a variety of battery systems. This document does not provide any pass-fail criteria for the tests, but specifies a standard classification of descriptions for test results.

This document is associated with ISO 12405-4 [1][1].

IEC 62660-1 [2] specifies the performance testing of lithium-ion cells for electric vehicle application.

IEC 62660-3 [3] specifies the safety requirements of lithium-ion cells for electric vehicle application.

1 Numbers in square brackets refer to the Bibliography.

SECONDARY LITHIUM-ION CELLS FOR THE PROPULSION OF ELECTRIC ROAD VEHICLES –

Part 2: Reliability and abuse testing

1 Scope

This part of IEC 62660 specifies test procedures to observe the reliability and abuse behaviour of secondary lithium-ion cells and cell blocks used for propulsion of electric vehicles including battery electric vehicles (BEV) and hybrid electric vehicles (HEV).

NOTE 1 Secondary lithium-ion cells used for propulsion of plug-in hybrid electric vehicles (PHEV) can be tested by the procedure either for BEV application or HEV application, according to the battery system design, based on the agreement between the cell manufacturer and the customer.

This document specifies the standard test procedures and conditions for basic characteristics of lithium-ion cells for use in propulsion of battery and hybrid electric vehicles. The tests are indispensable for obtaining essential data on reliability and abuse behaviour of lithium-ion cells for use in various designs of battery systems and battery packs.

This document provides standard classification of description of test results to be used for the design of battery systems or battery packs.

NOTE 2 Cell blocks can be used as an alternative to cells according to the agreement between the cell manufacturer and the customer.

NOTE 3 The safety requirements of lithium-ion cells for electric vehicle application are defined in IEC 62660-3 [3].

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60068-2-64, *Environmental testing – Part 2-64: Tests – Test Fh: Vibration, broadband random and guidance*

ISO 16750-3, *Road vehicles – Environmental conditions and testing for electrical and electronic equipment – Part 3: Mechanical loads*

ISO 16750-4, *Road vehicles – Environmental conditions and testing for electrical and electronic equipment – Part 4: Climatic loads*

ISO/TR 8713, *Electrically propelled road vehicles – Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/TR 8713 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
battery electric vehicle
BEV
electric vehicle with only a traction battery as power source for vehicle propulsion

3.2
cell block
group of cells connected together in parallel configuration with or without protective devices, e.g. fuse or positive temperature coefficient resistor (PTC), not yet fitted with its final housing, terminal arrangement and electronic control device

3.3
hybrid electric vehicle
HEV
vehicle with both a rechargeable energy storage system and a fuelled power source for propulsion

3.4
rated capacity
C_n
capacity value of a cell in ampere hours (Ah) determined under specified conditions and declared by the cell manufacturer

Note 1 to entry: n in C_n is the time base in hours (h). In this document, n = 3 for BEV application and n = 1 for HEV application unless otherwise specified.

3.5
I_t
reference test current in amperes (A) which is expressed as

$I_t = C_n / 1$

Note 1 to entry: 1 has a dimension of time in hours (h).

Note 2 to entry: See IEC 61434:1996 [4], Clause 2.

3.6
room temperature
temperature of 25 °C ± 2 K

3.7
secondary lithium-ion cell
cell
secondary single cell whose electric energy is derived from the insertion and extraction reactions of lithium ions between the anode and the cathode

Note 1 to entry: The secondary lithium-ion cell is a basic manufactured unit providing a source of electric energy by direct conversion of chemical energy. The cell consists of electrodes, separators, electrolyte, container and terminals, and is designed to be charged electrically.

3.8
state of charge
SOC
capacity in a cell expressed as a percentage of rated capacity

4 Test conditions

4.1 General

The details of the instrumentation used shall be provided in any report of results.

NOTE Test and measurement can be conducted under fixing conditions recommended by the cell manufacturer.

4.2 Measuring instruments

4.2.1 Range of measuring devices

The instruments used shall enable the values of voltage and current to be 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.

4.2.2 Voltage measurement

The resistance of the voltmeters used shall be at least 1 MΩ/V.

4.2.3 Current measurement

The entire assembly of ammeter, shunt and leads shall be of an accuracy class of 0,5 or better.

4.2.4 Temperature measurements

The cell temperature shall be measured by use of a surface temperature measuring device capable of an equivalent scale definition and accuracy of calibration as specified in 4.2.1. The temperature should be measured at a location which most closely reflects the cell or cell block temperature. The temperature may be measured at additional appropriate locations, if necessary.

The examples for temperature measurement are shown in Figure 1. The instructions for temperature measurement specified by the cell manufacturer shall be followed.

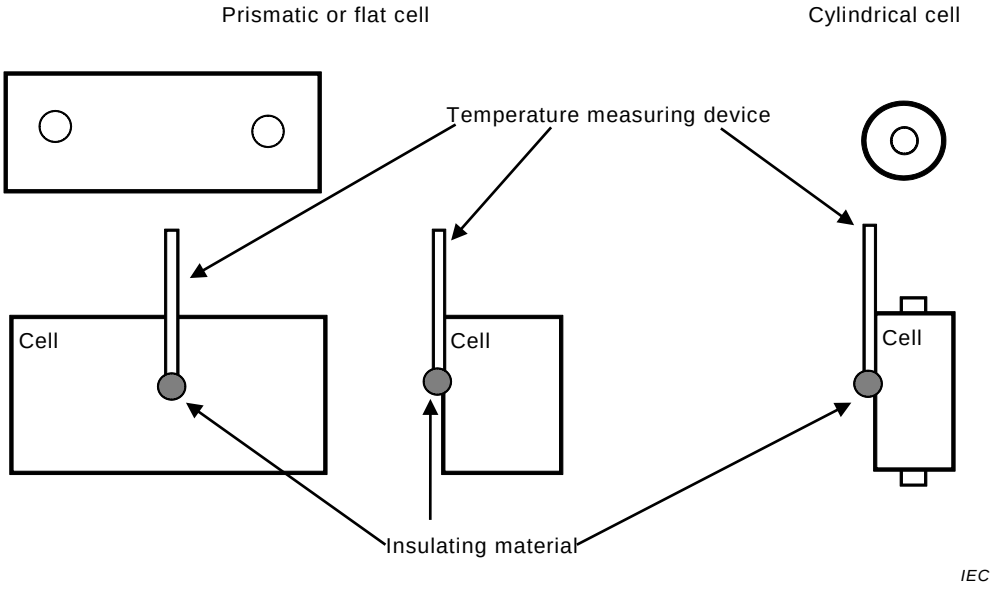

Figure 1 – Example of temperature measurement of cell

4.2.5 Other measurements

Other values may be measured by use of a measuring device, provided that it complies with 4.3.

4.3 Tolerance

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

a) ± 0,1 % for voltage;

b) ± 1 % for current;

c) ± 2 K for temperature;

d) ± 0,1 % for time;

e) ± 0,1 % for mass;

f) ± 0,1 % for dimensions.

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

4.4 Thermal stabilization

For the stablization of cell temperature, the cell shall be soaked to a specified ambient temperature for a minimum of 12 h. This period may be reduced if thermal stabilization is reached. Thermal stabilization is considered to be reached if after one interval of 1 h, the change of cell temperature is lower than 1 K.

5 Electrical measurement

5.1 General charge conditions

Unless otherwise stated in this document, prior to electrical measurement test, the cell shall be charged as follows.

Prior to charging, the cell shall be discharged at room temperature at a constant current described in Table 1 down to an end-of-discharge voltage specified by the cell manufacturer. Then, the cell shall be charged according to the charging method declared by the cell manufacturer at room temperature.

5.2 Capacity

The capacity of a cell shall be measured in accordance with the following phases.

Phase 1 – The cell shall be charged in accordance with 5.1.

After recharge, the cell temperature shall be stabilized in accordance with 4.4.

Phase 2 – The cell shall be discharged at specified temperature at a constant current I_t (A) to the end-of-discharge voltage that is provided by the cell manufacturer. The discharge current and temperatures indicated in Table 1 shall be used.

In addition to Table 1, specific test conditions may be selected based on the agreement between the cell manufacturer and the customer. Selective test conditions are provided in Annex A.

Table 1 – Discharge conditions

Cell temperature °C	Discharge current A	
	BEV application	HEV application
0	1/3 I_t	1 I_t
25		
45		

Phase 3 – Measure the discharge duration until the specified end-of-discharge voltage is reached. Calculate the capacity of cell expressed in Ah up to three significant figures, by multiplying the discharge current (A) with the discharge duration (h).

5.3 SOC adjustment

The test cells shall be charged as specified below. The SOC adjustment is the procedure to be followed for preparing cells to the various SOCs for the tests in this document.

Phase 1 – The cell shall be charged in accordance with 5.1.

Phase 2 – The cell shall be left at rest at room temperature in accordance with 4.4.

Phase 3 – The cell shall be discharged at a constant current according to Table 1 for $(100 - n)/100 \times 3$ h for BEV application and $(100 - n)/100 \times 1$ h for HEV application, where n is SOC (%) to be adjusted for each test.

6 Reliability and abuse tests

6.1 General

For all the tests specified in Clause 6, the test installation shall be reported including fixing and wiring of the cell. If necessary, to prevent deformation, the cell may be maintained during the test in a manner that does not violate the test purpose.

Before each test, the cell shall be stabilized at room temperature according to 4.4, unless otherwise specified.

The value of SOC may be changed according to the agreement between the customer and the cell manufacturer.

6.2 Mechanical test

6.2.1 Vibration

6.2.1.1 Purpose

This test is performed to characterize cell responses to vibration assumed in the use of a vehicle.

6.2.1.2 Test

The test shall be performed as follows.

a) Adjust the SOC of the cell to 100 % for BEV application, and to 80 % for HEV application in accordance with 5.3.

b) Perform the test referring to IEC 60068-2-64 random vibration. Use test duration of 8 h for each plane of the test cell.

c) The RMS acceleration value shall be 27,8 m/s^2. The power spectrum density (PSD) plotted against frequency is shown in Figure 2 and Table 2. The maximum frequency shall be 2 000 Hz.

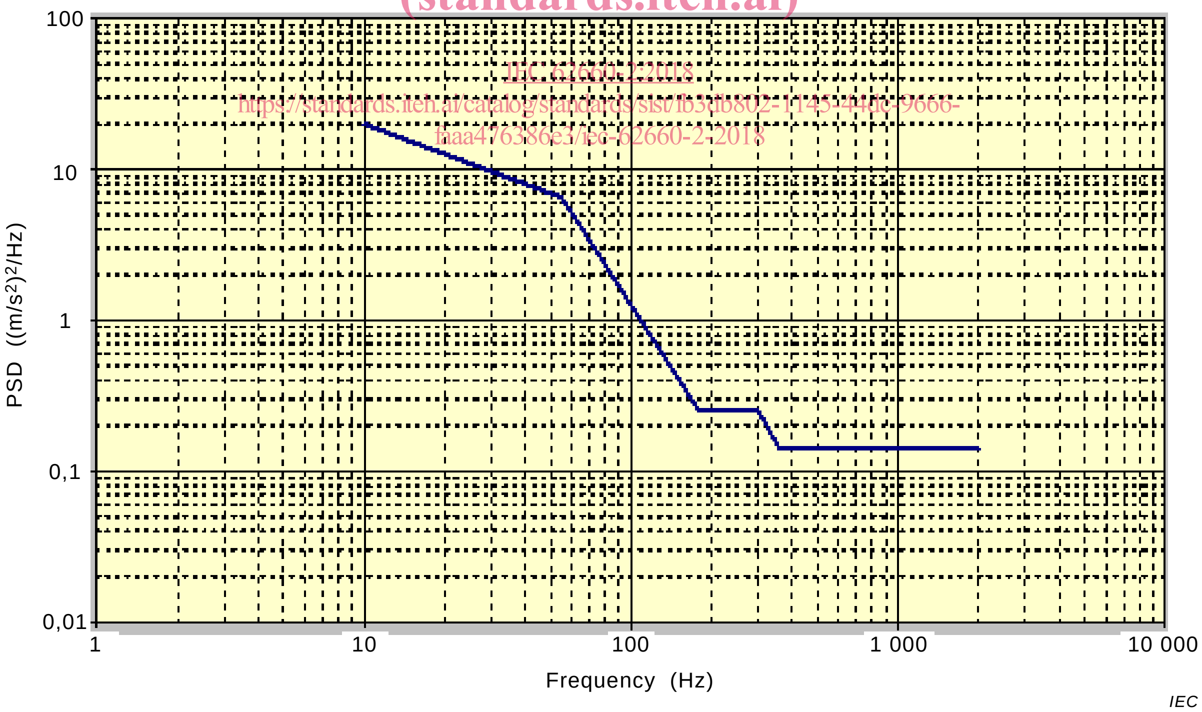

Figure 2 – PSD of acceleration plotted against frequency