IEC 62660-3

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Secondary lithium-ion cells for the propulsion of electric road vehicles – Part 3: Safety requirements

Éléments d'accumulateurs lithium-ion pour la propulsion des véhicules routiers électriques – Partie 3: Exigences de sécurité

IEC 62660-3:2016-08(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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Part 3: Safety requirements

FOREWORD

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

FDIS	Report on voting
21/890/FDIS	21/897/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.

A list of all 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 publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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INTRODUCTION

The electric road vehicles (EV) including hybrid and plug-in hybrid electric vehicles are beginning to diffuse in the global market with backing from global concerns on CO_2 reduction and energy, recent advances in technology and cost reduction. This has led to a rapidly increasing demand for high-power and high-energy density traction batteries represented by lithium-ion batteries.

For securing a basic level of quality of lithium-ion batteries for automotive applications, relevant international standards, i.e. IEC 62660-1, IEC 62660-2, ISO 12405-1 and ISO 12405-2, have been published. These standards specify the performance, reliability and abuse testing of lithium-ion battery cells, packs and systems for EV applications. Further, in the light of increasing concerns on the safety of lithium-ion batteries and demand for a referenceable international standard, safety requirements for lithium-ion battery packs and systems are defined in ISO 12405-3. Regulations, such as UN ECE R100, are also being revised that include acceptance criteria for rechargeable energy storage systems of EVs.

It is essential to specify the safety criteria at cell level in this standard, in order to secure the basic safety level of cells which differ in performance and design, and are applied to a variety of types of packs and systems. For automobile applications, it is important to note 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 standard is to provide a basic level of safety test methodology and criteria with general versatility, which serves a function in common primary testing of lithium-ion cells to be used in a variety of battery systems. Specific requirements for the safety of cells differ depending on the system designs of battery packs or vehicles, and should be evaluated by the users. Final pass-fail criteria of cells are to be based on the agreement between the cell manufacturers and the customers.

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

Part 3: Safety requirements

1 Scope

This part of IEC 62660 specifies test procedures and the acceptance criteria for safety performance of secondary lithium-ion cells and cell blocks used for the propulsion of electric vehicles (EV) including battery electric vehicles (BEV) and hybrid electric vehicles (HEV).

NOTE 1 Cell blocks can be used as an alternative to cells according to the agreement between the manufacturer and the customer.

NOTE 2 Concerning the cell for plug-in hybrid electric vehicle (PHEV), the manufacturer can select either the test condition of the BEV application or the HEV application.

This International Standard intends to determine the basic safety performance of cells used in a battery pack and system under intended use, and reasonably foreseeable misuse or incident, during the normal operation of the EV. The safety requirements of the cell in this standard are based on the premise that the cells are properly used in a battery pack and system within the limits for voltage, current and temperature as specified by the cell manufacturer (cell operating region).

The evaluation of the safety of cells during transport and storage is not covered by this standard.

NOTE 3 The safety performance requirements for lithium-ion battery packs and systems are defined in ISO 12405-3. The specifications and safety requirements for lithium-ion battery packs and systems of electrically propelled mopeds and motorcycles are defined in ISO 18243 (under development). IEC 62619 (under development) covers the safety requirements for the lithium ion cells and batteries for industrial applications including forklift trucks, golf carts, and automated guided vehicles.

NOTE 4 Information on the cell operating region is provided in Annex A.

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, *International Electrotechnical Vocabulary – Part 482: Primary and secondary cells and batteries*

IEC 61434, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Guide to the designation of current in alkaline secondary cell and battery standards*

IEC 62619:— [1], *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications*

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

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1 Under preparation. Stage at the time of publication: IEC/CDV 62619:2015

3 Terms and definitions

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

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

3.2
cell block
a 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
explosion
failure that occurs when a cell container, if any, opens violently and major components are forcibly expelled

3.4
fire
emission of flames from a cell or cell block

3.5
hybrid electric vehicle
HEV
vehicle with both a rechargeable energy storage system and a fuelled power source for propulsion

3.6
internal short circuit
unintentional electrical connection between the negative and positive electrodes inside a cell

3.7
leakage
visible escape of liquid electrolyte from a part except vent, such as casing, sealing part and/or terminals

3.8
nominal voltage
suitable approximate value of the voltage used to designate or identify a cell

[SOURCE: IEC 60050-482:2004, 482-03-31, modified – Deletion of "a battery or an electrochemical system" at the end of the definition.]

3.9
rated capacity
quantity of electricity C_3Ah (ampere-hours) for BEV and C_1Ah for HEV declared by the manufacturer

3.10
reference test current
I_t
current in amperes which is expressed as

I_t (A) = C_n (Ah)/n (h)

where

C_n is the rated capacity of the cell;

n in C_n is the time base (h).

3.11
room temperature
temperature of 25 °C ± 2 K

3.12
rupture
mechanical failure of a container case of cell induced by an internal or external cause, resulting in exposure or spillage but not ejection of materials

3.13
secondary lithium-ion cell
cell
secondary single cell whose electrical energy is derived from the insertion/extraction reactions of lithium-ions between the anode and the cathode

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

Note 2 to entry: In this standard, "cell" means the "secondary lithium-ion cell" to be used for the propulsion of electric road vehicles.

3.14
state of charge
SOC
available capacity in a battery expressed as a percentage of rated capacity

3.15
venting
release of excessive internal pressure from a cell in a manner intended by design to preclude rupture or explosion

4 Test conditions

4.1 General

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

The cell can be tested under restraint to avoid swelling if acceptable according to the purpose of test. The restraint should refer to the battery design.

4.2 Measuring instruments

4.2.1 Range of measuring devices

The instruments used shall enable the voltage and current values 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 M Ω/V.

4.2.3 Current measurement

The entire assembly of the ammeter, the shunt and the 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 manufacturer shall be followed.

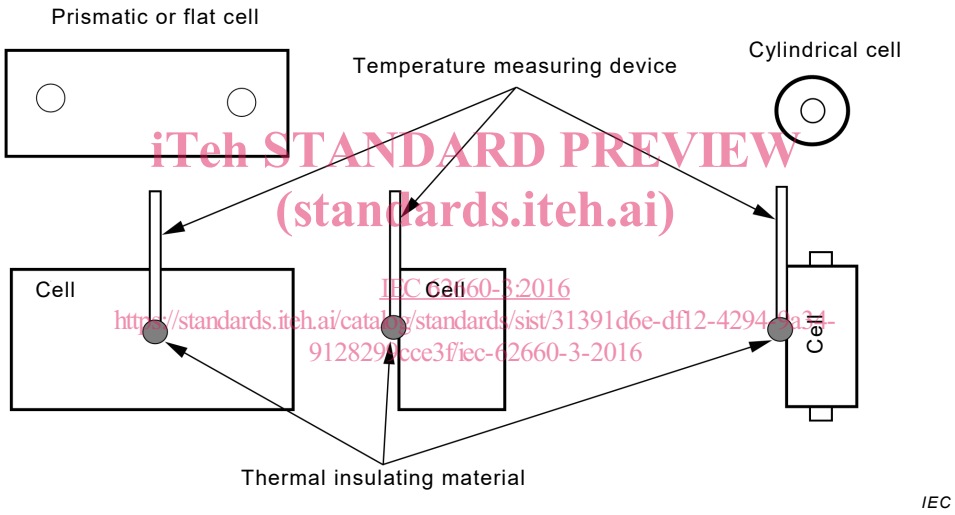


Figure 1 – Example of temperature measurement of cell

4.2.5 Other measurements

Other values including capacity and power 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 these 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 Test temperature

If not otherwise defined, before each test the cell has to be stabilized at the test temperature for a minimum of 12 h. This period can be reduced if thermal equilibrium is reached. Thermal equilibrium is considered to be reached if after one interval of 1 h, the change of cell temperature is lower than 1 K.

Unless otherwise stated in this standard, cells shall be tested at room temperature.

5 Electrical measurement

5.1 General charge conditions

Unless otherwise stated in this standard, prior to the 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 of 1/3 I_t (A) for BEV application and 1 I_t (A) for HEV application down to an end-of-discharge voltage specified by the manufacturer. Then, the cell shall be charged according to the charging method declared by the manufacturer at room temperature.

5.2 Capacity

Before the SOC adjustment in 5.3, the capacity of the test cell shall be confirmed to be the rated value in accordance with the following steps.

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

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

Step 2 – The cell shall be discharged at the room temperature at a constant current of 1/3 I_t (A) for BEV application and 1 I_t (A) for HEV application to the end-of-discharge voltage that is provided by the manufacturer.

The method of designation of test current I_t is defined in IEC 61434. See also 3.9.

Step 3 – Measure the discharge endurance duration until the specified end-of-discharge voltage is reached, and calculate the capacity of cell expressed in Ah up to three significant figures.

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 standard.

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

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

Step 3 – The cell shall be discharged at a constant current of 1/3 I_t (A) for BEV application and 1 I_t (A) for HEV application for (100 – n)/100 × 3 h for BEV application and (100 – n)/100 × 1 h for HEV application, where n is the SOC (%) to be adjusted for each test.

6 Safety tests

6.1 General

For all the tests specified in this clause, the test installation shall be reported including the method used for fixing and wiring the cell.

The tests shall be performed on cells that are not more than six months old. The number of cells under each test can be determined according to the agreement between the manufacturer and the customer. A cell block may be used for testing in place of a single cell according to the agreement between the manufacturer and the customer.

The number and type of test sample (cell or cell block) shall be provided in a test report.

Each test shall end with the one-hour observation period, unless otherwise specified in this standard.

Warning: THE TESTS USE PROCEDURES WHICH MAY RESULT IN HARM IF ADEQUATE PRECAUTIONS ARE NOT TAKEN. TESTS SHOULD ONLY BE PERFORMED BY QUALIFIED AND EXPERIENCED TECHNICIANS USING ADEQUATE PROTECTION. TO PREVENT BURNS, CAUTION SHOULD BE TAKEN FOR THOSE CELLS WHOSE CASINGS MAY EXCEED 75 °C AS A RESULT OF TESTING.

6.2 Mechanical tests

6.2.1 Vibration

6.2.1.1 Purpose

This test is performed to simulate vibration to a cell that may occur during the normal operation of the vehicle, and to verify the safety performance of the cell under such conditions.

6.2.1.2 Test

The test shall be performed in accordance with 6.1.1.1 of IEC 62660-2:2010.

6.2.1.3 Acceptance criteria

During the test, the cell shall exhibit no evidence of leakage, venting, rupture, fire or explosion.

6.2.2 Mechanical shock

6.2.2.1 Purpose

This test is performed to simulate mechanical shocks to a cell that may occur during the normal operation of the vehicle, and to verify the safety performance of the cell under such conditions.

6.2.2.2 Test

The test shall be performed in accordance with 6.1.2.1 of IEC 62660-2:2010.

6.2.2.3 Acceptance criteria

During the test, the cell shall exhibit no evidence of leakage, venting, rupture, fire or explosion.

6.2.3 Crush

6.2.3.1 Purpose

This test is performed to simulate external load forces that may cause deformation of a cell, and to verify the safety performance of the cell under such conditions.

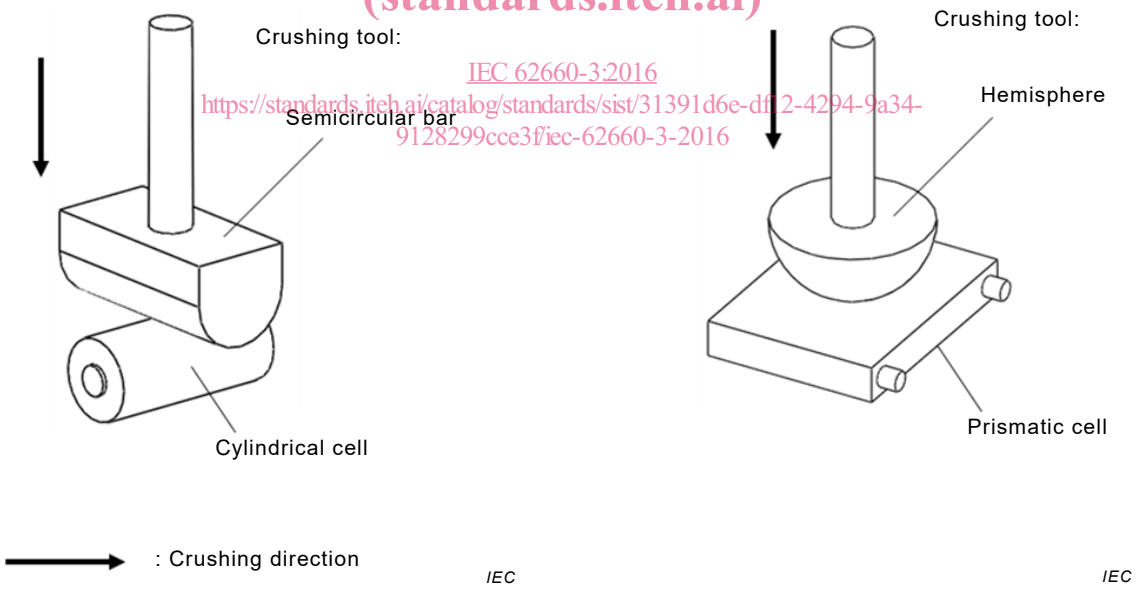
6.2.3.2 Test

The test shall be performed as follows.

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

b) The cell shall be placed on an insulated rigid flat supporting surface, and shall be applied a force with a crushing tool made of a solid material in the shape of a round or semicircular bar, or in the shape of a sphere or hemisphere with a 150 mm diameter. It is recommended to use the round bar to crush a cylindrical cell, and the sphere for a prismatic cell, including a flat or pouch cell. The force for the crushing shall be applied in a direction nearly perpendicular to the layered face of the positive and negative electrodes inside cell. The force shall be applied to the approximate centre of the cell as shown in Figure 2. The crush speed shall be less than or equal to 6 mm/min.

c) The force shall be released when an abrupt voltage drop of one-third of the original cell voltage occurs, or a deformation of 15 % or more of the initial cell dimension occurs, or a force of 1 000 times the weight of the cell is applied, whichever comes first. The cells shall be under observation for 24 h or until the cell temperature declines by 80 % of the maximum temperature rise, whichever is sooner.



a) Example for cylindrical cell **b) Example for prismatic cell**

Figure 2 – Example of crush test

6.2.3.3 Acceptance criteria

During the test, the cell shall exhibit no evidence of fire or explosion.