IEC 63056

Edition 1.0 2020-03

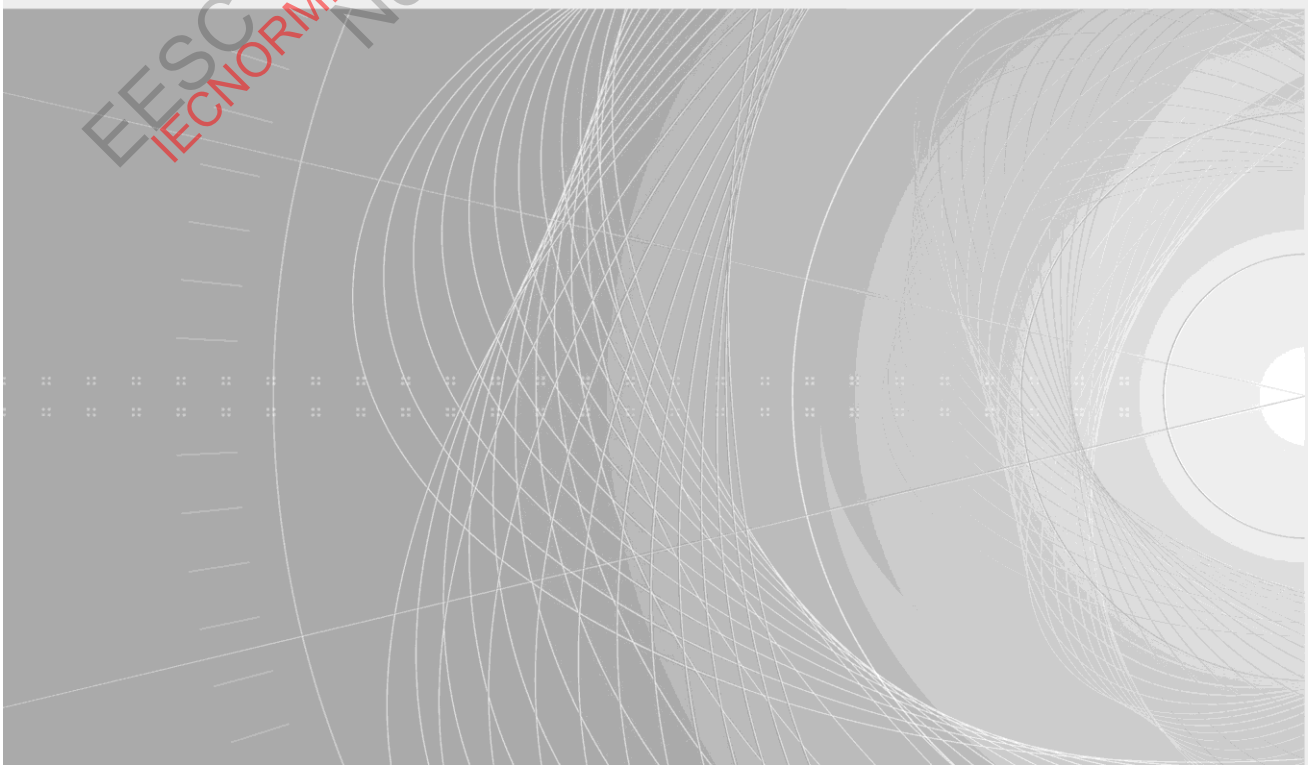
INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries for use in electrical energy storage systems

Accumulateurs alcalins et autres accumulateurs à électrolyte non acide – Exigences de sécurité pour les accumulateurs au lithium pour utilisation dans des systèmes de stockage d'énergie électrique



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SECONDARY CELLS AND BATTERIES CONTAINING ALKALINE OR OTHER NON-ACID ELECTROLYTES – SAFETY REQUIREMENTS FOR SECONDARY LITHIUM CELLS AND BATTERIES FOR USE IN ELECTRICAL ENERGY STORAGE SYSTEMS

FOREWORD

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

FDIS	Report on voting
21A/718/FDIS	21A/723/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.

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- withdrawn,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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The contents of the corrigendum of June 2021 have been included in this copy.

INTRODUCTION

This document covers safety requirements for secondary lithium cells and batteries for use in Electrical Energy Storage Systems and is under the umbrella standard IEC 62619 as shown in Figure 1. As an umbrella standard, IEC 62619 had been developed which covered various industrial applications in 2017.

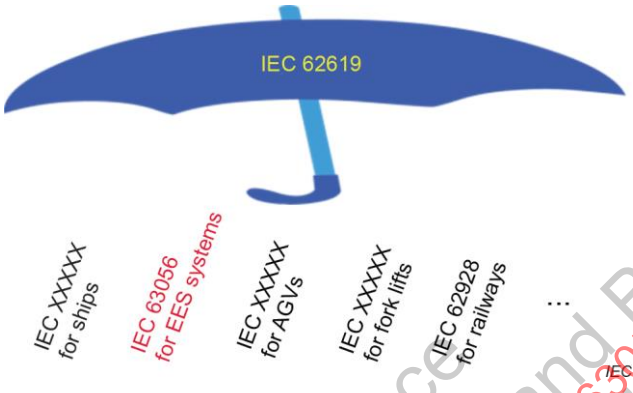

Figure 1 – IEC 62619 as umbrella standard to various industrial applications

SECONDARY CELLS AND BATTERIES CONTAINING ALKALINE OR OTHER NON-ACID ELECTROLYTES – SAFETY REQUIREMENTS FOR SECONDARY LITHIUM CELLS AND BATTERIES FOR USE IN ELECTRICAL ENERGY STORAGE SYSTEMS

1 Scope

This document specifies requirements and tests for the product safety of secondary lithium cells and batteries used in electrical energy storage systems (Figure 2) with a maximum DC voltage of 1 500 V (nominal).

Basic safety requirements for the secondary lithium cells and batteries used in industrial applications are included in IEC 62619. This document provides additional or specific requirements for electrical energy storage systems.

Since this document covers batteries for various electrical energy storage systems, it includes those requirements which are common and minimum to the electrical energy storage systems.

Examples of appliances that are within the scope of this document are:

- telecommunications,
- central emergency lighting and alarm systems,
- stationary engine starting,
- photovoltaic systems,
- home (residential) energy storage systems (HESS), and
- large energy storage: on-grid/off-grid.

This document applies to cells and batteries for uninterruptible power supplies (UPS).

This document does not apply to portable systems 500 Wh or below, which are covered by IEC 61960-3.

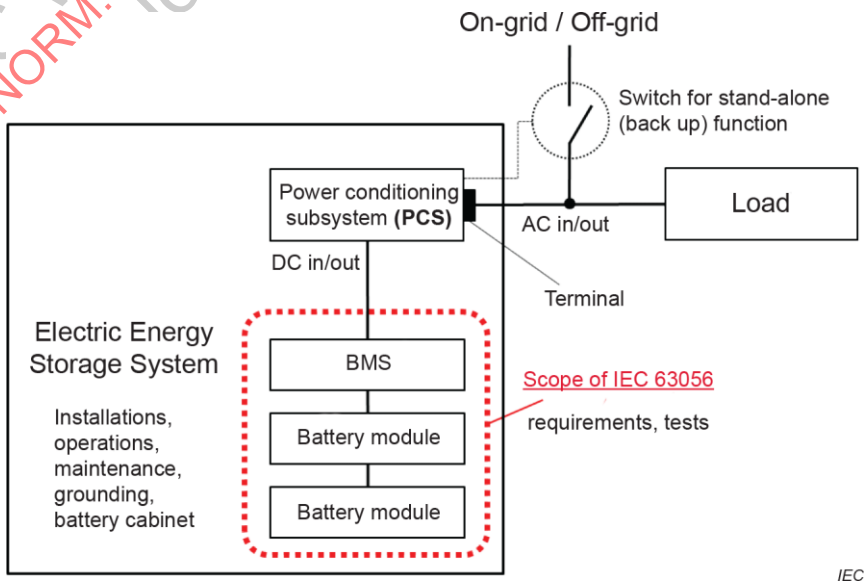

Figure 2 – Scope of IEC 63056

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 (IEV) – Part 482: Primary and secondary cells and batteries* (available at http://www.electropedia.org/)

IEC 60695-10-2, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60950-1:2005, *Information technology equipment – Safety – Part 1: General requirements*

IEC 62619, *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 62620:2014, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Secondary lithium cells and batteries for use in industrial applications*

ISO/IEC Guide 51, *Safety aspects – Guidelines for their inclusion in standards*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-482, ISO/IEC Guide 51, 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
safety
freedom from unacceptable risk

3.2
risk
combination of the probability of occurrence of harm and the severity of that harm

3.3
harm
physical injury or damage to the health of people or damage to property or to the environment

3.4
hazard
potential source of harm

3.5
intended use
use of a product, process or service in accordance with specifications, instructions and information provided by the supplier

3.6
reasonably foreseeable misuse
use of a product, process or service in a way which is not intended by the supplier, but which may result from readily predictable human behaviour

3.7
secondary lithium cell
cell
secondary cell where electrical energy is derived from the insertion/extraction reactions of lithium ions or oxidation/reduction reaction of lithium between the negative electrode and the positive electrode

Note 1 to entry: The cell typically has an electrolyte that consists of a lithium salt and organic solvent compound in liquid, gel or solid form and has a metal or a laminate film casing. It is not ready for use in an application because it is not yet fitted with its final housing, terminal arrangement and electronic control device.

3.8
cell block
group of cells connected together in parallel configuration with or without protective devices (e.g. fuse or positive temperature coefficient device) and monitoring circuitry

Note 1 to entry: It is not ready for use in an application because it is not yet fitted with its final housing, terminal arrangement and electronic control device.

3.9
module
group of cells connected together in a series and/or parallel configuration with or without protective devices (e.g. fuse or positive temperature coefficient device) and monitoring circuitry

3.10
battery pack
energy storage device which comprises one or more cells or modules electrically connected and has monitoring circuitry which provides information (e.g. cell voltage) to a battery system to influence the battery's safety, performance and/or service life

Note 1 to entry: It may incorporate a protective housing and be provided with terminals or other interconnection arrangement.

3.11
battery system
battery
system which comprises one or more cells, modules or battery packs and has a battery management system capable of controlling current in case of overcharge, overcurrent, overdischarge, and overheating

Note 1 to entry: Overdischarge cut off is not mandatory if there is an agreement between the cell manufacturer and the customer

Note 2 to entry: The battery system may have cooling or heating units. More than one battery system may constitute a larger battery system.

3.12
battery management system
BMS
set of protection functions associated with a battery to prevent overcharge, overcurrent, over-temperature, under-temperature and, if applicable, overdischarge and which monitors and/or manages its state, calculates secondary data, reports that data and/or controls its environment to influence the battery's safety, performance and/or service life

Note 1 to entry: Overdischarge cutoff is not mandatory if there is an agreement between the cell manufacturer and the customer.

Note 2 to entry: The function of the BMS can be assigned to the battery pack or to equipment that uses the battery.

Note 3 to entry: The BMS can be divided and it can be found partially in the battery pack and partially on the equipment that uses the battery.

Note 4 to entry: The BMS is sometimes also referred to as a BMU (battery management unit).

Note 5 to entry: This note applies to the French language only.

3.13
leakage
visible escape of liquid electrolyte

3.14
venting
release of excessive internal pressure from a cell, module, battery pack, or battery system in a manner intended by design to preclude rupture or explosion

3.15
rupture
mechanical failure of a cell container or battery case induced by an internal or external cause, resulting in exposure or spillage but not ejection of materials

3.16
explosion
failure that occurs when a cell container or battery case opens violently, and solid components are forcibly expelled

Note 1 to entry: Liquid, gas, and smoke may be erupted.

3.17
fire
emission of flames from a cell, module, battery pack, or battery system

3.18
rated capacity
capacity value of a cell or battery determined under specified conditions and declared by the manufacturer

Note 1 to entry: The rated capacity is the quantity of electricity C_n Ah (ampere-hours) declared by the manufacturer, which a single cell or battery can deliver during an n-hour period when charging, storing and discharging under the conditions specified in IEC 62620:2014, 6.3.1.

[SOURCE: IEC 60050-482:2004, 482-03-15, modified – "battery" has been replaced by "cell or battery" and Note 1 to entry has been added.]

4 Parameter measurement tolerances

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

a) ±0,5 % for voltage;

b) ±1 % for current;

c) ±2 °C for temperature;

d) ±0,1 % for time;

e) ±1 % for mass;

f) ±1 % for dimensions.

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

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

5 General safety considerations

5.1 General

Battery systems and the cells they contain shall comply with the applicable general safety considerations of IEC 62619. Within the standard temperature range, secondary cells can be charged at the maximum charge current, which is specified from a safety point of view. Lithium-ion cells shall always be operated within the operating region values and the storage conditions specified by the manufacturer.

The safety of lithium secondary cells and battery systems requires the consideration of two sets of applied conditions:

1) intended use;
2) reasonably foreseeable misuse.

Cells and battery systems shall be so designed and constructed that they are safe under conditions of both intended use and reasonably foreseeable misuse. It may also be expected that cells and battery systems subjected to intended use shall not only be safe but shall continue to be functional in all respects.

It is expected that cells or battery systems subjected to misuse may fail to function. However, even if such a situation occurs, they shall not present any significant hazards.

Potential hazards which are the subject of this document are:

a) fire,
b) burst/explosion,
c) critical electrical short circuit due to leakage of cell electrolyte, mechanical deformation or incorrect installation,
d) venting that continuously vents out flammable gases,
e) rupture of the casing of cell, module, battery pack, and battery system with exposure of internal components.

Conformity is checked by the tests in accordance with the appropriate standards in Clause 2.

Moving parts that have potential to cause human injuries shall be applied appropriate design and necessary measures in order to reduce the risk of injuries, including those that may be incurred during installation while cells or battery systems are being incorporated into equipment.

5.2 Insulation and wiring

Wiring and its insulation shall be sufficient to withstand the maximum anticipated voltage, current, temperature, altitude and humidity requirements. The design of wiring shall be such that adequate clearances and creepage distances are maintained between conductors in accordance with IEC 60950-1:2005, 3.1 and 3.2 (test temperature relies on the battery system's operating region specified by the manufacturer). Hazardous live parts of the battery system shall be protected to avoid the risk of electric shocks, including during installation.

The mechanical integrity of the whole battery system (cell/module/BMS) and their connections shall follow the requirements from the end-use equipment manufacturer. When there are no requirements provided from the end use equipment in which the battery system is to be installed, Annex A may be used.

The battery system manufacturer shall indicate the maximum allowed number of series connections of a module or a battery system in the specification or instruction manual.

5.3 The peak voltage of charging

When a charging current has an alternating component, a battery system manufacturer shall ensure that the peak voltage of the charging current is under the upper limit charging voltage, specified by the cell manufacturer, by monitoring the voltage of every single cell or cell block.

6 Type test conditions

6.1 General

A battery system that is used outside of its operating region may exhibit hazards resulting from the cells or battery system. Such risks have to be taken into consideration in order to prepare a safe test plan.

The test facility should have a sufficient structural integrity and a fire suppression system to sustain the conditions of overpressure and fire that may occur as a result of testing. The facility should have a ventilation system to remove and capture gas that might be produced during the tests. Consideration should be given to high-voltage hazards when applicable.

Warning: **THESE 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, PRECAUTIONS SHOULD BE TAKEN FOR THOSE CELLS OR BATTERY SYSTEMS WHOSE CASINGS MAY EXCEED 75 °C AS A RESULT OF TESTING.**

6.2 Test items

Tests are made with the DUT (device under test), using cells or battery systems that are stored under conditions specified by the cell manufacturer for not more than six months.

The DUT charged by the method specified in 7.2 shall deliver the rated capacity or more when they are discharged at 25 °C ± 5 °C, at a constant current of 0,2 I_t A, down to a specified final voltage. This capacity confirmation may be done in the cell manufacturer's shipping inspection.
In the case of a battery system, the capacity may be calculated on the basis of the cell capacity measurements during the cell manufacturer's shipping inspection.

Unless otherwise specified, tests are carried out in an ambient temperature of 25 °C ± 5 °C.

NOTE Test conditions are for type tests only and do not imply that intended use includes operation under these conditions. Similarly, the limit of six months is introduced for consistency and does not imply that cell and battery system safety is reduced after six months.

The type test is outlined in Table 1.

Table 1 – Type test

Test items	DUT
7.2 Resistance to abnormal heat	minimum of 1
7.6 Protection for short circuit during transport and installation	minimum of 1
7.4 Electric insulation check during transport and installation	minimum of 1
7.7 Protection for reverse connection	minimum of 1
7.9 Drop test	minimum of 1
7.8 Overdischarge control of voltage (battery system)	minimum of 1

7 Specific requirements and tests

7.1 Basic requirement

Cells and battery systems employed in battery systems evaluated in accordance with this document shall comply with the test in the safety requirements of IEC 62619 for secondary lithium cells and battery systems for use in industrial applications, in addition to the test requirements of this document.

7.2 Resistance to abnormal heat

Non-metallic materials on which parts at HAZARDOUS VOLTAGE are directly mounted shall be resistant to abnormal heat. Compliance shall be checked by subjecting the part to the ball pressure test in IEC 60695-10-2. The test is not carried out if it is clear from examination of the physical characteristics of the material that it will meet the requirements of this test.

The test is made in a heating cabinet at a temperature of (ΔT + T_{max} + 15 °C) ± 2 °C.

ΔT means the maximum temperature rise of thermoplastic parts during the most adverse operation specified by the battery system manufacturer at 25 °C ± 5 °C.

T_{max} means upper limit ambient temperature specified by the battery system manufacturer.

7.3 Casing material of a battery system that can be transported for installation or maintenance

Thermoplastic materials used for casing should be of class V-2, V-1 or V-0. Where it is not practical to protect components against overheating under fault conditions, the components shall be mounted on V-1 CLASS MATERIAL. Additionally, such components shall be separated from case material of V-2 CLASS MATERIAL by at least 13 mm of air, or by a solid barrier of V-1 CLASS MATERIAL. Materials shall be tested at a thickness equal to the smallest thickness used in the application and classified in accordance with IEC 60695-11-10.

7.4 Electric insulation check during transport and installation

The hazardous live parts of the battery pack or battery module or cell block shall be covered or insulated against contact with the personnel during transport and installation. Compliance is checked by an insulation resistance test or other equivalent test method to evaluate electrical insulation.

Unless the end use equipment has specific requirements, the test method shall be in accordance with the insulation resistance test of IEC 62133:2017, 5.2. Tests are carried out in an ambient temperature of 25 °C ± 5 °C.

7.5 Charging procedures for test purposes

Prior to charging, the DUT shall be discharged in an ambient temperature of 25 °C ± 5 °C, at a constant current of 0,2 I_t A, down to a specified final voltage.

Unless otherwise stated in this document, the DUT shall be charged in an ambient temperature of 25 °C ± 5 °C, using the method specified by the manufacturer.

NOTE 1 Charging and discharging currents for the tests are based on the value of the rated capacity (C_n Ah). These currents are expressed as a multiple of I_t A, where: I_t A = C_n Ah/1 h (see IEC 61434).

NOTE 2 A battery system that cannot be discharged at a constant current of 0,2 I_t A can be discharged at the current specified by the manufacturer.

7.6 Protection against short circuit during transport and installation

A safeguard shall be provided by the battery system manufacturer to reduce the risk of short circuit for personnel at the time of electrical installation or transport.

Where the battery pack is divided into parts for the purpose of transportation, protective safeguards shall be provided not only for the battery system, but also for each part.

f) Test

Each fully charged DUT shall be discharged at a constant current of 0,2 I_t A, to SOC (state of charge) for installation or maintenance, which is specified by the manufacturer. Unless otherwise specified by the manufacturer, tests are carried out without discharging after charging in accordance with 7.2.

The DUT is stored in an ambient temperature until its temperature is stabilized at 25 °C ± 5 °C. The DUT is then short-circuited by connecting the positive and negative terminals. An external resistance to short circuits is (30 mΩ ± 10 mΩ) × module configuration (= number of series connections / number of parallel connections) or less than 5 mΩ, whichever is higher.

Total external resistance is less than 100 mΩ.

The cells shall remain on test for 6 h or until the case temperature declines by 80 % of the maximum temperature rise, whichever is sooner.

g) Acceptance criteria

No rupture, no fire, no explosion.

7.7 Protection for reverse connection

When a battery system has multiple battery packs or modules, the battery system shall remain in a safe condition at the time of installation, even if one of the battery packs or modules is connected with opposite polarity to the others.

a) Test

The test shall be carried out at 25 °C ± 5 °C. Each fully charged DUT shall be discharged at a constant current of 0,2 I_t A to the SOC for installation or maintenance which is specified by battery system manufacturer. Turn off, if possible, the main power of the BMS and to the battery system. Connect one of the DUTs of the battery system with opposite polarity. Connect the remaining other DUTs in the battery system with the correct polarity. Turn on the main power of the BMS and of the battery system. Charge the battery system with the conditions specified by the manufacturer, until it is fully charged or charging is stopped by a safety protection. The battery system shall be put on rest for an hour. If the battery system can be discharged, discharge it with the maximum specified discharge current until the battery system stops the discharge. The system shall be rested for an hour. If the system cannot be discharged, it shall be rested for an hour instead of discharging then resting.

Exception: A DUT which has a feature that prevents a reverse connection, or when modules or battery packs are connected in the battery system with the BMS at the factory, this test is not required.

b) Acceptance criteria

No rupture, no fire, no explosion.

7.8 Overdischarge control of voltage (battery system)

The BMS shall control the cell voltage during discharging above the lower limit discharging voltage of the cells.

c) Test

The test shall be carried out at an ambient temperature of 25 °C ± 5 °C under BMS controlled conditions. If the battery system has a cooling system, it may remain functional during the test. The main contactors are closed with the battery system controlled by the BMS. A fully charged battery system shall be discharged at a constant current of 0,2 I_t A to 30 % of the rated capacity. The system shall then be discharged at the specified maximum discharging current.

The test shall be carried out until the BMS terminates the discharging before exceeding the lower limit discharging voltage of the cells.

If it is difficult to overdischarge the whole system, the exceeded voltage can be applied to a part of the system such as the cell(s) in the battery system.

Data acquisition/monitoring shall be continued for 1 h after discharging is stopped. All functions of the battery system shall be fully operational as designed during the test.

d) Acceptance criteria

The BMS shall interrupt the overdischarging current by an automatic disconnect of the main contactors in order to protect the battery system against further related severe effects such as fire, explosion or cell voltages below their specified limits.

7.9 Drop test

7.9.1 General

This test is performed to simulate a drop during installation and maintenance.

The DUT of this test is a cell, a module, or a battery system which can be transported for installation or maintenance. The manufacturer shall clearly declare the type of DUT.

The drop test is conducted on a DUT. The test method and the height of the drop are determined by the mass of the DUT as shown in Table 2.

Table 2 – Drop test method and condition

Mass of the DUT, m	Test method	Orientation	Height of drop
m < 7 kg	Whole	Random	100,0 cm
7 kg ≤ m < 20 kg	Whole	Bottom down direction [a]	100,0 cm
20 kg ≤ m < 50 kg	Whole	Bottom down direction [a]	50,0 cm
50 kg ≤ m < 100 kg	Edge and corner	-	5,0 cm
m ≥ 100 kg	Edge and corner	-	2,5 cm
[a] The bottom surface of the DUT is specified by the manufacturer			