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Brussels, 7.12.2021
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COMMISSION IMPLEMENTING DECISION

of 7.12.2021

on a standardisation request to the European standardisation organisations as regards performance, safety and sustainability requirements for batteries

(Only the English, French and German texts are authentic)

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(Only the English, French and German texts are authentic)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Regulation (EU) No 1025/2012 of the European Parliament and of the Council of 25 October 2012 on European standardisation, amending Council Directives 89/686/EEC and 93/15/EEC and Directives 94/9/EC, 94/25/EC, 95/16/EC, 97/23/EC, 98/34/EC, 2004/22/EC, 2007/23/EC, 2009/23/EC and 2009/105/EC of the European Parliament and of the Council and repealing Council Decision 87/95/EEC and Decision No 1673/2006/EC of the European Parliament and of the Council[1], and in particular Article 10(1) thereof,

Whereas:

(1) Directive 2006/66/EC of the European Parliament and of the Council[2] lays down rules regarding the placing on the market of batteries and accumulators and, in particular, a prohibition on the placing on the market of batteries and accumulators containing hazardous substances. The Commission is required to review the implementation of the Batteries Directive and the impact of the Directive on the environment.

(2) In accordance with the Strategic Action Plan on Batteries[3] adopted by the Commission it is necessary to review Directive 2006/66/EC to include requirements related to the sustainability and safety of batteries. Such requirements are also necessary to help the internal market to operate more seamlessly and improve the environmental performance of batteries.

(3) The implementation of the Strategic Action Plan on Batteries is also mentioned in the Annex to the Commission's Communication 'A European Green Deal'[4].

(4) The Commission's proposal for a Regulation of the Parliament and of the Council on batteries and waste batteries, amending Regulation (EU) No 2019/1020 and repealing

[1] OJ L 316, 14.11.2012, p. 12.

[2] Directive 2006/66/EC of the European Parliament and of the Council of 6 September 2006 on batteries and accumulators and waste batteries and accumulators and repealing Directive 91/157/EEC (OJ L 266, 26.9.2006, p. 1).

[3] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - On the Move, Sustainable Mobility for Europe: safe, connected and clean of 17 May 2018

[4] Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions 'The European Green Deal' COM/2019/640 final of 11 December 2019.

Directive 2006/66/EC adopted on 10 December 2020 (proposal for a regulation on batteries and waste batteries) includes product requirements for which the availability of reliable, accurate and reproducible state-of-the-art measurement and assessment methods would facilitate conformity assessment.

(5) European standards should help ensure a high level of environmental performance of batteries throughout the Union and thus contribute to their free movement in the Union. Given that such European standards are technology-neutral and performance-based, they also contribute to ensuring equal conditions of competition among relevant economic operators dealing with these products, in particular small and medium-sized enterprises. Indirectly, those European standards also contribute to lower operating costs benefitting consumers in particular.

(6) The intention to request drafting of European standards and European standardisation deliverables in support of the Strategic Action Plan on Batteries was referred to in point 2.3 of the Union work programme for European standardisation for 2019 .

(7) The proposal for a regulation on batteries and waste batteries requires that general-purpose non-rechargeable batteries placed in the Union market are durable and high performing. The introduction of performance and durability requirements that are verifiable requires setting European standards on capacity, minimum average duration, delayed discharged performance and leakage testing.

(8) The proposal for a regulation on batteries and waste batteries also requires that rechargeable industrial and electric vehicle batteries are also durable and high performing. The introduction of performance and durability requirements that are verifiable requires setting European standards on capacity fade, internal resistance increase, energy round-trip efficiency and expected lifetime. The characterisation of the capacity fade and the increase in internal resistance are of particular importance, due to their relevance as indicators for cost efficiency over time. The calculation of values for these parameters could be used in the future for the introduction of legal lifetime guaranties for batteries.

(9) The proposal for a regulation on batteries and waste batteries includes provisions to facilitate the reuse and repurposing of rechargeable industrial and electric vehicle batteries, which should be complemented by European standards on the design, diagnostics and evaluation of batteries for these purposes. In order to take informed decisions, economic operators with a legitimate interest in pursuing second life applications of retired batteries from electric vehicles need accurate estimates of their remaining capacity and overall State of Health (SoH). Given the myriad of existing ways to estimate the battery’s SoH, it seems appropriate to undertake standardisation work in this area. This diagnostic is likely to require access to certain data on battery usage and history, which is normally stored in the Battery Management System (BMS).

(10) The use of retired batteries from electric vehicles (EVs) in second life applications is likely to increase significantly in the near future. Furthermore, the substitution of failing components of a battery or battery pack may be required in some cases, to ensure that it performs its functions as it was initially designed. These operations require a detailed assessment of individual battery modules and cells to determine their ability to be re-used and repurposed, which entail a number of safety hazards.

(11) While the UN-ECE Global Technical Regulation (GTR) No. 20 on the Electric Vehicle Safety[5] covers the safety of batteries in Electric Vehicles, for stationary battery energy storage systems, there are currently no comprehensive legal safety requirements at Union level. As the proposal for a regulation on batteries and waste batteries requires stationary battery energy storage systems to be safe during their operation, the availability of European standards to test these batteries for the safety parameters included in the proposal would create certainty for economic operators.

(12) The European Committee for Standardisation (CEN) and the European Committee for Electrotechnical Standardisation (Cenelec) have indicated that the work covered by the request falls entirely within their area of competence.

(13) It is therefore appropriate to request the European standardisation organisations to draft new European standards in support of the proposal for a regulation for batteries and waste batteries and of the Union's policy objective to improve the environmental performance of batteries. In case the proposal is subject to substantial modifications during the ordinary legislative procedure, this standardisation request may have to be amended accordingly.

(14) The European standardisation organisations have agreed to follow the Guidelines for the execution of standardisation requests[6].

(15) In order to ensure transparency and to facilitate the execution of the requested standardisation activities, CEN and Cenelec should prepare a work programme and submit it to the Commission.

(16) In order to enable the Commission to better monitor the requested standardisation work, CEN and Cenelec should provide the Commission with access to an overall project plan containing detailed information on the execution of the standardisation request.

(17) Experience shows that during execution of the standardisation request, it may be necessary to adjust the scope of the request or the deadlines set therein. CEN and Cenelec should therefore promptly report to the Commission if they consider that more time is required to draft the standards than initially foreseen or that it is appropriate to adapt the scope of the request, in order to allow the Commission to take appropriate action.

(18) In accordance with Article 9(5) of Regulation (EU) No 1025/2012, CEN and Cenelec should report periodically to the Commission on state of the execution of this standardisation request.

(19) In accordance with Article 10(3) of Regulation (EU) No 1025/2012 each standardisation request is subject to acceptance by the relevant European standardisation organisation. It is therefore necessary to provide for the rules on validity of this request if it is not accepted by CEN or Cenelec.

(20) In order to ensure legal certainty as to the validity of the request after its execution, it is appropriate to provide for a date of expiry of this Decision. The European standardisation organisations, the European stakeholders' organisations receiving Union financing and the Committee established by Article 39 of Directive 2008/98/EC

[5] https://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29wgs/wp29gen/wp29registry/ECE-TRANS-180a20e.pdf

[6] SWD(2015) 205 final of 27 October 2015.

of the European Parliament and of the Council[7] have been consulted. The measures provided for in this Decision are in accordance with the opinion of the Committee established by Article 22 of Regulation (EU) No 1025/2012,

HAS ADOPTED THIS DECISION:

Article 1
Requested standardisation activities

The European Committee for Standardisation (CEN) and the European Committee for Electrotechnical Standardisation (Cenelec) are requested to draft new European standards listed in Annex I by the deadlines set in that Annex.

The standards referred to in the first paragraph shall meet the requirements set out in Annex II.

CEN and Cenelec shall provide the Commission with the titles of the requested standards in all the official languages of the Union.

Article 2
Work programme

CEN and Cenelec shall prepare a joint work programme indicating all the standards listed in Annex I, the responsible technical bodies and a timetable for the execution of the requested standardisation activities in line with the deadlines set out that Annex.

CEN and Cenelec shall submit the draft joint work programme to the Commission by 07 June 2022. CEN and Cenelec shall inform the Commission of any amendments to the joint work programme.

CEN and Cenelec shall provide the Commission with access to an overall project plan.

Article 3
Reporting

1. CEN and Cenelec shall report annually to the Commission on the execution of the request referred to in Article 1 indicating the progress made in the implementation of the work programme referred to in Article 2.
2. CEN and Cenelec shall submit the first joint annual report to the Commission by 07 December 2022. Subsequent joint annual reports shall be submitted to the Commission by 15 December each year.
3. CEN and Cenelec shall provide the Commission with the joint final report by 31 December 2025.
4. CEN and Cenelec shall promptly report to the Commission any major concerns relating to the scope of the request referred to in Article 1 or the deadlines set in Annex I.

The European standards developed on the basis of the request referred to in Article 1 of this Decision shall refer to this Decision.

[7] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (OJ L 312, 22.11.2008, p. 3).

If CEN or Cenelec do not accept the request referred to in Article 1 within a month of receiving it, the request may not constitute a basis for the standardisation activities referred to in that Article.

This Decision shall expire on 31 December 2025.

Article 4
Addressees

This Decision is addressed to the European Committee for Standardisation and the European Committee for Electrotechnical Standardisation.

Done at Brussels, 7.12.2021

For the Commission
Thierry BRETON
Member of the Commission

CERTIFIED COPY
For the Secretary-General

Martine DEPREZ
Director
Decision-making & Collegiality
EUROPEAN COMMISSION

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ANNEXES 1 to 2

ANNEXES

to the

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ANNEX I

List of new European standards and European standardisation deliverables to be drafted as referred to in Article 1 and deadlines for their adoption

Reference information		Deadline for the adoption
1.	European standard(s) on performance and durability aspects of portable rechargeable and non-rechargeable batteries	07 December 2025
2.	European standard(s) on performance and durability aspects of rechargeable batteries with internal energy storage	07 December 2025
3.	European standard(s) on the re-use and repurposing of rechargeable batteries with internal energy storage	07 December 2025
4.	European standard(s) on safety aspects of stationary battery energy storage systems with internal energy storage	07 December 2025

ANNEX II

Requirements for new European standards and European standardisation deliverables referred to in Article 1

1. General requirements for all standards

Standards shall reflect the generally acknowledged state of the art. They shall take into account existing international standards, in particular at IEC and ISO level.

For the purpose of this Annex:

‘battery’ shall mean any source of electrical energy generated by direct conversion of chemical energy and consisting of one or more non-rechargeable or rechargeable battery cells or of groups of them;

‘battery cell’ shall mean the basic functional unit in a battery constituted by electrodes, electrolyte, container, terminals and, if applicable, separators and containing the active materials the reaction of which generates electrical energy;

‘active materials’ shall mean material which reacts chemically to produce electric energy when the battery cell discharges;

‘non-rechargeable battery’ shall mean a battery that is not designed to be electrically recharged;

‘rechargeable battery’ shall mean a battery that is designed to be electrically recharged;

‘portable battery’ shall mean any battery that:

- is sealed;
- weighs below 5 kg;
- is not designed for industrial purposes; and
- is neither an electric vehicle battery nor an automotive battery;

‘portable batteries of general use’ shall mean portable batteries with the following common formats: 4,5 Volts (3R12), D, C, AA, AAA, AAAA, A23, 9 Volts (PP3);

‘automotive battery’ shall mean any battery used only for automotive starter, lighting or ignition power;

‘industrial battery’ shall mean any battery designed for industrial uses and any other battery excluding portable batteries, electric vehicle batteries and automotive batteries;

‘electric vehicle battery’ shall mean any battery specifically designed to provide traction to hybrid and electric vehicles for road transport;

‘stationary battery energy storage system’ shall mean a rechargeable industrial battery with internal storage specifically designed to store and deliver electric energy into the grid, regardless of where and by whom this battery is being used;

‘state of charge’ shall mean the available capacity in a battery expressed as a percentage of rated capacity;

‘state of health’ shall mean a measure of the general condition of a rechargeable battery and its ability to deliver the specified performance compared with its initial condition;

‘lifetime’ of a battery shall mean the period of time that starts when the battery is placed on the market, and ends when the battery becomes waste;‘battery pack’ shall mean any source of electrical energy constituted by batteries or groups of cells that are connected together or encapsulated within an outer casing so as to form a complete unit ready for use that the end-user is not intended to split up or open;

‘re-use’ shall mean any operation by which batteries, battery packs or their components that are not waste are used again for the same purpose or application for which they were conceived;

‘repurposing’ shall mean any operation that results in parts or the complete battery being used for a different purpose or application than the one that the battery was originally designed for.

2. Specific Requirements for drafting new European standards listed in Table 1 of Annex I

2.1. Standard(s) on performance and durability aspects of portable rechargeable and non-rechargeable batteries listed in point 1 of Table 1 of Annex I

The standard(s) shall describe the measurement methods necessary for the determination of the performance and durability of portable rechargeable and non-rechargeable batteries of general use.

In particular, it will describe the procedure and conditions for the measurement of the following parameters:

- Battery capacity, electric charge which a battery can deliver under a specific set of conditions.
- Minimum average duration, minimum average time on discharge when used in specific applications, depending on the type of battery.
- Shelf life (delayed discharge performance), the relative decrease of the minimum average duration after a defined period of time and specific conditions.
- Endurance in cycles (for rechargeable batteries), the capacity of the battery after a pre-established number of charge and discharge cycles.
- Resistance to leakages, i.e. resistance to unplanned escape of electrolyte, gas or other material (poor, good or excellent).

The proposed measurement methods for these parameters shall comply with the conditions set out in the international standard IEC 60086-1:2015 Primary batteries - Part 1: General conditions.

Some of the parameters mentioned may need testing of the operating time in various applications depending on the type of battery. Designations in IEC 60086-2:2015 Primary batteries - Part 2: Physical and electrical specifications, shall be used to specify the battery model concerned.

To carry out the proposed standardisation work, CEN and Cenelec shall consider both standards IEC 60086-1:2015 Part 1 and Part 2, as well as any other international standard that

they consider relevant. In addition, the approaches adopted within the 'Nordic Swan Ecolabel' system shall also be taken into consideration.

2.2. Standard(s) on performance and durability aspects of rechargeable batteries with internal energy storage listed in point 2 of Table 1 of Annex I

The standard(s) shall describe the necessary steps and conditions for the measurement of the parameters, which are relevant for the initial application and (if intended for the battery) the reuse and repurposing application. The parameters shall reflect current industry practice for the applications based on existing international standards. The standard(s) shall consider the most appropriate metric based on application and the objective of the metric to enable comparison of electric performance between different models/products on the market. They shall in particular take into account the following:

- rated capacity (in Ah) and rated capacity fade (in %);
- rated power (in W) and rated power fade (in %);
- internal resistance (in Ω) and internal resistance increase (in %);
- energy round trip efficiency and its fade (in %);
- expected lifetime (including both calendar and electrochemical ageing).

The measurement tests of the standard(s) shall be relevant for batteries, battery packs, battery modules and battery cells intended for the following applications:

- motor vehicles, including M and N categories referred to in Article 2 of Regulation (EU) 2018/858 of the European Parliament and of the Council[1] with traction battery;
- L-category vehicles referred to in Article 2 of Regulation EU 168/2013 of the European Parliament and of the Council[2] with traction battery;
- all other wheeled personal mobility devices falling outside of the scope of the L-category vehicles, such as electric bicycles and electric scooters;
- stationary battery energy storage systems.

Tests for battery systems for stationary energy storage systems shall be considered separately from the mobility applications due to inherently different operating conditions.

For batteries intended to be used in other applications -including agriculture, railway, aviation, marine, mining, construction equipment and material handling - standardisation bodies shall determine whether specific measurement tests are required, or whether generic measurements tests can be applied.

The standard(s) shall develop accelerated ageing test methods for performance degradation, e.g. by using a number of defined charging and discharging cycles and cycling protocols, in a way that is unambiguous, representative of each relevant application, and which reflects widely accepted practice.

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1 Regulation (EU) 2018/858 of the European Parliament and of the Council of 30 May 2018 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, amending Regulations (EC) No 715/2007 and (EC) No 595/2009 and repealing Directive 2007/46/EC (OJ L 151, 14.6.2018, p. 1).

2 Regulation (EU) No 168/2013 of the European Parliament and of the Council of 15 January 2013 on the approval and market surveillance of two- or three-wheel vehicles and quadricycles (OJ L 60, 2.3.2013, p. 52).

The accelerated ageing testing protocols for the determination of the estimated capacity fade shall consider the combination of calendar and cycling modes. In the case of on-road electro-mobility applications, testing cycles shall reflect the usage of vehicles in real life applications and different vehicle types and models. The standard(s) shall also specify the methodology for continuous capacity fade estimations during the battery life. If relevant, the standard(s) shall propose verification tolerances to allow for measurement uncertainties.

In case more than one procedure for the same application is described in accelerated ageing test for the determination of capacity fade and internal resistance increase, equivalence methods shall also be included in the standard(s).

The standard(s) shall also define the conditions for assessing the initial parameters of the battery, the conditions for the evaluation of the battery, if applicable, as well as the conditions for defining the termination of the testing, including temperature and state of charge.

Standardisation bodies shall examine the feasibility of developing more sophisticated performance degradation tests, such as accelerated stress testing, for both mobility and stationary applications, on which future regulatory requirements may be based. Such standardisation work shall take full account of ongoing work regarding in-vehicle durability requirements being developed by the Electric Vehicles and the Environment Informal Working Group of UNECE (United Nations Economic Commission for Europe).

Relevant existing international and European standards include:

- ISO 18243:2017 (EN ISO 18243:2019) - Electrically propelled mopeds and motorcycles - Test specifications and safety requirements for lithium-ion battery systems;
- ISO 13064-1:2012 - Battery-electric mopeds and motorcycles - Performance - Part 1: Reference energy consumption and range;
- ISO 13064-2:2012 - Battery-electric mopeds and motorcycles - Performance - Part 2: Road operating characteristics;
- ISO 12405-4:2018 - Electrically propelled road vehicles —Test specification for lithium-ion traction battery packs and systems — Part 4: Performance testing;
- SAE J1798:2008 - Recommended Practice for Performance Rating of Electric Vehicle Battery Modules;
- SAE J2288:2008 - Life Cycle Testing of Electric Vehicle Battery Modules;
- IEC 61982:2012 (EN 61982:2012) - Secondary batteries (except lithium) for the propulsion of electric road vehicles - Performance and endurance tests;
- IEC 62660-1:2018 (EN IEC 62660-1:2019) - Secondary Li-ion cells for the propulsion of electric road vehicles. Part 1: Performance testing;
- IEC 62576:2018 (EN 62576:2010) - Electric double-layer capacitors for use in hybrid electric vehicles - Test methods for electrical characteristics;
- ISO 18300:2016 - Electrically propelled vehicles -- Test specifications for lithium-ion battery systems combined with lead acid battery or capacitor;
- IEC 61427-2:2013 (EN 61427-2:2015), IEC 61427-1:2013 (EN 61427-1:2013) - Secondary cells and batteries for renewable energy storage - General requirements and methods of test - Part 2: On-grid applications; Secondary cells and batteries for

renewable energy storage - General requirements and methods of test - Part 1: Photovoltaic off-grid application;

- IEC 62620:2014 (EN 62620:2015) - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for use in industrial applications;
- IEC 63115-1:2020 (EN IEC 63115-1:2020) - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Sealed nickel-metal hydride cells and batteries for use in industrial applications - Part 1: Performance;
- IEC 62984-3:2020 (EN IEC 62984-3:2020)- High-temperature secondary batteries - Part 3: Sodium-based batteries - Performance requirements and tests;
- IEC 61960-3:2017 (EN 61960-3:2017) - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Secondary lithium cells and batteries for portable applications - Part 3: Prismatic and cylindrical lithium secondary cells and batteries made from them.

2.3. Standard(s) on the re-use and repurposing of rechargeable batteries with internal energy storage listed in point 3 of Table 1 of Annex I

The standard shall include the necessary technical provisions to facilitate the re-use and repurposing of batteries, battery packs and battery modules.

2.3.1. Design

The standard shall include informative guidance on design and assembly techniques that facilitate the maintenance, repair, reuse and repurpose of batteries and battery packs.

It shall also describe how certain assembly techniques can be used that do not prevent the re-use, repair, repurpose and recycling of battery cells and modules. It shall explain how disassembly operations should be performed, including targeting certain components, and how the use of standardised tools may facilitate such disassembly.

Relevant existing international standards include:

- DOE-INL/EXT-15-34184 (2015): U.S. DOE Battery Test Manual for Electric Vehicles;
- DOE-INL/EXT-07-12536 (2008): Battery test manual for plug-in hybrid electric vehicles;
- IEC 62984-3-2:2017 (EN IEC 62984-2:2020): High Temperature Secondary Batteries – Part 3: Sodium-based batteries – Section 2: Performance requirements and tests;
- ANSI/CAN/UL 1974:2018 - Standard for Evaluation for Repurposing Batteries.

2.3.2. Diagnostics and determination of the State of Health (SoH)

The standard(s) shall describe the procedure(s) for the determination of the SoH of batteries, The procedure shall be robust and precise, as it may be used for the certification of batteries at the end of their first life with a view to providing a reliable estimate of their remaining capacity and expected behaviour.

The test procedure shall evaluate the parameters that are specifically related to performance in the intended second life application.

Standardisation work shall take full of account ongoing work regarding the on-board display of Electric Vehicle (EV) batteries' SoH being developed by the Electric Vehicles and the Environment Informal Working Group of UNECE (United Nations Economic Commission for Europe)

If necessary, the standard(s) shall include separate applicable procedures for lithium-ion and for chemistries other than lithium-ion.

Relevant existing international standards include:

- ANSI/CAN/UL 1974, Evaluation for repurposing batteries;
- SAE J2950, SAE J2997 Standards for Battery Secondary Use;
- DOE-INL/EXT-15-34184 (2015): U.S. DOE Battery Test Manual for Electric Vehicles;
- DOE-INL/EXT-07-12536 (2008): Battery test manual for plug-in hybrid electric vehicles.

2.3.3. Battery evaluation for repairing or repurposing

The standard shall describe the necessary steps, conditions and protocols for the safe repair, re-use and repurpose of batteries and battery packs, modules and cells originally designed for electro-mobility applications.

Relevant existing international standards and recommended practices include:

- ANSI/CAN/UL 1974, Evaluation for repurposing batteries;
- IEC 62619:2017 - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications;
- SAE J2950, SAE J2997 Standards for Battery Secondary Use;
- IEC TR 61438:1996 - Possible safety and health hazards in the use of alkaline secondary cells and batteries - Guide to equipment manufacturers and users.

2.4. Standard(s) on the safety of Stationary Battery Energy Storage Systems with internal energy storage listed in point 4 of Table 1 of Annex I

The standard(s) shall describe the necessary steps and conditions to test, at least, the following aspects related to the safe operation of stationary battery energy storage systems, with proper consideration to be given to the risk of gases emitted from non-aqueous electrolytes:

2.4.1. Thermal shock and cycling

This test is designed to evaluate changes in the integrity of the battery arising from expansion and contraction of cell components upon exposure to extreme and sudden changes in temperature and potential consequences of such changes. During a thermal shock the battery is exposed to two temperature limits and held at each temperature limit for a specified period of time.

2.4.2. External short circuit protection

The purpose of this test is to evaluate the safety performance of a battery when applying an external short circuit. The test can evaluate the activation of the overcurrent protection device or the ability of cells to withstand the current without reaching a hazardous situation (e.g. thermal runaway, explosion, fire). The main risk factors are heat generation at cell level and arching which may damage circuitry or may lead to reduced isolation resistance.

2.4.3. Overcharge protection

The main safety risks during overcharge are the decomposition of the electrolyte, cathode and anode breakdown, exothermic decomposition of the solid electrolyte interphase (SEI) layer, separator degradation, and the Li plating, which can lead to self-heating of the battery and thermal runaway. Also fluorinated binders, such as polyvinilidene fluoride (PVDF), have been found to react exothermically with lithiated carbon if sufficient temperature is reached (e.g. 200 °C). Factors affecting the outcome of the test are amongst others, the charging rate and the finally reached state-of-charge (SOC). The protection can be ensured by either voltage control (interruption after reaching the limit charging voltage) or current control (interruption after exceeding maximum charging current).

2.4.4. Over-discharge protection

Safety risks during over-discharge are polarity reversal leading to oxidation of the anode current collector (Copper) and to plating on the cathode side. Even minor over-discharge may cause dendrite formation and finally short circuit.

2.4.5. Over-temperature protection

This test aims at evaluating the effect of temperature control failure or failure of other protection features against internal overheating during operation.

2.4.6. Thermal propagation

A thermal runaway in one cell can cause a cascading reaction through the entire battery which can be composed of numerous cells. It can lead to severe consequences including a significant gas release. A standardised test is also under development for transport application by ISO and UN-EVS-GTR.

2.4.7. Mechanical damage by external forces (drop and impact)

These tests simulate a situation when a battery accidentally drops or is impacted by a heavy load.

2.4.8. Internal short circuit

The occurrence of internal short circuits, one of the main concerns for battery manufacturers, potentially leads to venting, thermal runaway, along with sparking which can ignite the electrolyte vapours escaping from the cell. The generation of these internal shorts can be triggered by manufacturing imperfections, presence of impurities in the cells or dendritic growth of lithium, and leads to most of in-field safety incidents. Multiple internal short circuits scenarios are possible (e.g. electrical contact of cathode/anode, aluminium current collector/copper current collector, aluminium current collector /anode) each with a different contact resistance.

2.4.9. Thermal abuse

During this test, the battery is exposed to elevated temperatures (in IEC 62619 this is 85 °C) which can trigger exothermal decomposition reactions and lead to a thermal runaway of the cell.

Standardisation work shall result in a set of operational instructions and conditions to ensure the safety of battery packs, modules and cells specifically designed for stationary use, as well as for the operation of repurposed battery packs, modules and cells in stationary applications that were originally designed for electro-mobility applications.

Relevant existing international and European standards and recommended practices include:

- ANSI/CAN/UL 1974, Evaluation for repurposing batteries;

- ISO 18243:2017 (EN ISO 18243:2019) - Electrically propelled mopeds and motorcycles - Test specifications and safety requirements for lithium-ion battery systems;
- EN 50604-1:2016 - Secondary lithium batteries for light EV (electric vehicle) applications - Part 1: General safety requirements and test methods;
- IEC TS 62840-2:2016 (EN IEC 62840-2:2019) - Electric vehicle battery swap system - Part 1: safety requirements;
- ISO 13063:2012 - Electrically propelled mopeds and motorcycles - Safety specifications;
- IEC 62619:2017 (prEN IEC 62619:2020) - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications;
- EN 50272-3:2002 - Safety requirements for secondary batteries installations. Part 3: traction batteries;
- ISO 6469-1:2019 -Electrically propelled road vehicles - Safety specifications - Part 1: On-board rechargeable energy storage system (RESS);
- IEC 61982-4:2015 (EN 61982-4:2016) - Secondary batteries (except lithium) for the propulsion of electric road vehicles - Safety requirements of nickel-metal hydride batteries;
- IEC 62660-2:2018 (EN IEC 62660-2:2019) - Secondary lithium-ion cells for the propulsion of electric road vehicles - Part 2: Reliability and abuse testing;
- IEC 62660-3:2016 (prEN IEC 62660-3) - Secondary lithium-ion cells for the propulsion of electric road vehicles - Part 3: Safety requirements;
- SAE J2929: 2013 - Safety Standard for Electric and Hybrid Vehicle Propulsion Battery Systems Utilizing Lithium-based Rechargeable Cells;
- SAE J2464:2009 - Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse Testing;
- IEC 62485-1:2015 (EN IEC 62485-1:2018) - Safety requirements for secondary batteries and battery installations Part 1: General safety information;
- IEC 62485-2:2010 (EN IEC 62485-2:2018) - Safety requirements for secondary batteries and battery installations - Part 2: Stationary batteries;
- IEC 62485-3:2014 (EN 62485-3:2014) - Safety requirements for secondary batteries and battery installations - Part 3: Traction batteries;
- IEC 62485-4:2015 (EN IEC 62485-4:2018) - Safety requirements for secondary batteries and battery installations - Part 4: Valve-regulated lead-acid batteries for use in portable appliances;
- IEC 62485-5:2020 ED1 (EN IEC 62485-5:2021) - Safety requirements for secondary batteries and battery installations – Part - 5: Safe operation of stationary lithium-ion batteries;
- IEC 62485-6:2021 ED1 (EN IEC 62485-6:2021) - Safety requirements for secondary batteries and battery installations - Part 6: Safe operation of lithium-ion batteries in traction applications;

- IEC 63115-2:2020 (prEN IEC 63115-2:2019) - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Sealed nickel-metal hydride rechargeable cells and modules for use in industrial applications - Part 2: Safety;
- IEC 63056:2020 (EN IEC 63056:2020) - 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;
- IEC 62933-5-2:2020 (EN IEC 62933-5-2:2020) - Electrical energy storage (EES) systems – Part 5-2: Safety requirements for grid integrated EES systems - electrochemical based systems;
- IEC/TS 62933-5-1:2017 - Electrical energy storage (EES) systems - Part 5-1: Safety considerations for grid-integrated EES systems - General specification;
- IEC 63057:2020 (EN IEC 63057:2020) - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium batteries for use in road vehicles not for the propulsion;
- IEC 62984-2:2020 (EN IEC 62984-2:2020) - High-temperature secondary batteries - Part 2: Safety requirements and tests;