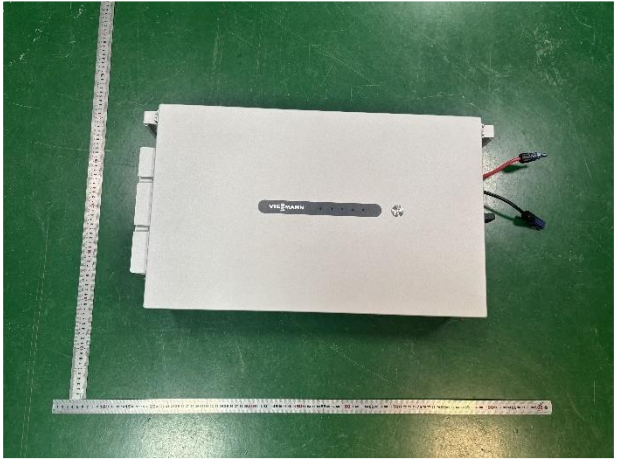




| | | | | |
|---|--|---|---|--------------------------------|
| Prüfbericht-Nr.: Test report no.: | CN24D291 002 | Auftrags-Nr.: Order no.: | 326099352 P01845930 | Seite 1 von 20 Page 1 of 20 |
| Kunden-Referenz-Nr.: Client reference no.: | 2322559 | Auftragsdatum: Order date: | 2025-03-04 | |
| Auftraggeber: Client: | Viessmann Climate Solutions SE Viessmannstr. 1 /35108 Allendorf (Eder) Deutschland | | | |
| Prüfgegenstand: Test item: | Rechargeable Li-ion Battery System | | | |
| Bezeichnung / Typ-Nr.: Identification / Type no.: | Viessmann Battery HV5-A | | | |
| Auftrags-Inhalt: Order content: | Test Report | | | |
| Prüfgrundlage: Test specification: | Regulation (EU) 2023/1542 Article 12 - Safety of stationary battery energy storage systems | | | |
| Wareneingangsdatum: Date of sample receipt: | 2025-03-04 |  | | |
| Prüfmuster-Nr.: Test sample no.: | HV5-20250304-001~003, Cell-20250304-001~010 | | | |
| Prüfzeitraum: Testing period: | 2025-03-04 - 2025-03-25 | | | |
| Ort der Prüfung: Place of testing: | See page 4 for details | | | |
| Prüflaboratorium: Testing laboratory: | TÜV Rheinland (Shanghai) Co., Ltd. | | | |
| Prüfergebnis*: Test result*: | Pass | | | |
| geprüft von: tested by: Depeng Cao |  | genehmigt von: authorized by: Feng Xu |  | |
| Datum: Date: 2025-03-30 | | Ausstellungsdatum: Issue date: 2025-03-30 | | |
| Stellung / Position: | Sachverständige(r)/Expert | Stellung / Position: | Sachverständige(r)/Expert | |
| Sonstiges / Other: | <p>The product has been evaluated with Regulation (EU) 2023/1542 Article 12 refer to TUV Rhineland test report No. CN24D291 001. The mentioned models listed on above are identical to the original models in the previous report CN24D291 001, except for license holder and model name.</p> <p>This report does not evidence compliance of the provided sample with the relevant standards but only with the referred tests. This test report documents the findings of examination conducted on the delivered product mentioned above only. This report does not entitle the applicant to carry any safety mark on this or similar product.</p> | | | |
| Zustand des Prüfgegenstandes bei Anlieferung: Condition of the test item at delivery: | Prüfmuster vollständig und unbeschädigt Test item complete and undamaged | | | |
| * Legende: P(ass) = entspricht o.g. Prüfgrundlage(n) F(ail) = entspricht nicht o.g. Prüfgrundlage(n) N/A = nicht anwendbar N/T = nicht getestet | | | | |
| * Legend: P(ass) = passed a.m. test specification(s) F(ail) = failed a.m. test specification(s) N/A = not applicable N/T = not tested | | | | |
| <p>Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.</p> <p><i>This test report only relates to the above mentioned test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.</i></p> | | | | |


Prüfbericht-Nr.: CN24D291 002
Test report no.:

Seite 2 von 20
Page 2 of 20

Anmerkungen Remarks

| | |
|---|--|
| 1 | <p>Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibrierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben.</p> <p>Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden.</p> <p><i>The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system. Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.</i></p> |
| 2 | <p>Wie vertraglich vereinbart, wurde dieses Dokument nur digital unterzeichnet. Der TÜV Rheinland hat nicht überprüft, welche rechtlichen oder sonstigen diesbezüglichen Anforderungen für dieses Dokument gelten. Diese Überprüfung liegt in der Verantwortung des Benutzers dieses Dokuments. Auf Verlangen des Kunden kann der TÜV Rheinland die Gültigkeit der digitalen Signatur durch ein gesondertes Dokument bestätigen. Diese Anfrage ist an unseren Vertrieb zu richten. Eine Umweltgebühr für einen solchen zusätzlichen Service wird erhoben. Informationen zur Verifizierung der Authentizität unserer Dokumente erhalten Sie auf folgender Webseite: go.tuv.com/digital-signature</p> <p><i>As contractually agreed, this document has been signed digitally only. TUV Rheinland has not verified and unable to verify which legal or other pertaining requirements are applicable for this document. Such verification is within the responsibility of the user of this document. Upon request by its client, TUV Rheinland can confirm the validity of the digital signature by a separate document. Such request shall be addressed to our Sales department. An environmental fee for such additional service will be charged. For information on verifying the authenticity of our documents, please visit the following website: go.tuv.com/digital-signature</i></p> |
| 3 | <p>Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben.</p> <p>Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt.</p> <p><i>Test clauses with remark of * are subcontracted to qualified subcontractors and described under the respective test clause in the report.</i></p> <p><i>Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.</i></p> |
| 4 | <p>Die Entscheidungsregel für Konformitätserklärungen basierend auf numerischen Messergebnissen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC G8:2019 und IEC Guide 115:2021, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird. Zu weiteren Informationen bezüglich des Risikos durch diese Entscheidungsregel siehe ILAC G8:2019.</p> <p><i>The decision rule for statements of conformity, based on numerical measurement results, in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance with ILAC G8:2019 and IEC Guide 115:2021, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report. For additional information to the resulting risk based of this decision rule please refer to ILAC G8:2019.</i></p> |

| | |
|--|---|
| <p align="center">TEST REPORT Regulation (EU) 2023/1542 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 July 2023</p> | |
| Report Number..... | CN24D291 002 |
| Date of issue..... | See cover page |
| Total number of pages | See cover page |
| Name of Testing Laboratory preparing the Report | TÜV Rheinland (Shanghai) Co., Ltd. No.177, 178, Lane 777 West Guangzhong Road, Jing'an District, Shanghai, China |
| Applicant's name | Viessmann Climate Solutions SE |
| Address..... | Viessmannstr. 1 /35108 Allendorf (Eder) Deutschland |
| Test specification: | |
| Standard | Regulation (EU) 2023/1542 |
| Test procedure | Test report |
| Non-standard test method | N/A |
| TRF template used..... | Regulation (EU) 2023/1542 - Article 12, Ed 1.0 |
| Test Report Form No. | (EU) 2023/1542_A |
| Test Report Form(s) Originator | TÜV Rheinland (Shanghai) Co., Ltd. |
| Master TRF | Dated 2024-05-28 |
| General disclaimer: | |
| <p>The test results presented in this report relate only to the object tested. This report shall not be reproduced, except in full, without the written approval of TÜV Rheinland. The authenticity of this Test Report and its contents can be verified by contacting TÜV Rheinland.</p> | |

| Test item description..... : Trade Mark..... : Manufacturer : Model/Type reference : Ratings..... : | Rechargeable Li-ion Battery System  Same as applicant See cover page See copy of marking label and model list. | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--|---------|-----------|---------------------------|-----------|-----------------------------------|-----------|-----------------------|-----------|---------------------------|-----------|-----------------------------|-----------|--------------------------------|-----------|--------------------------------------|-----------|------------------------|-----------|---------------|------------|-----------|------------|-------------------|--|
| List of Attachments (including a total number of pages in each attachment): N/A | | | | | | | | | | | | | | | | | | | | | | | | | |
| Summary of testing: | | | | | | | | | | | | | | | | | | | | | | | | | |
| Tests performed: <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr style="background-color: #d3d3d3;"> <th style="width: 20%;">Clause(s)</th> <th style="width: 80%;">Test(s)</th> </tr> </thead> <tbody> <tr><td>ANNEX V-1</td><td>Thermal shock and cycling</td></tr> <tr><td>ANNEX V-2</td><td>External short circuit protection</td></tr> <tr><td>ANNEX V-3</td><td>Overcharge protection</td></tr> <tr><td>ANNEX V-4</td><td>Over-discharge protection</td></tr> <tr><td>ANNEX V-5</td><td>Over-temperature protection</td></tr> <tr><td>ANNEX V-6</td><td>Thermal propagation protection</td></tr> <tr><td>ANNEX V-7</td><td>Mechanical damage by external forces</td></tr> <tr><td>ANNEX V-8</td><td>Internal short circuit</td></tr> <tr><td>ANNEX V-9</td><td>Thermal abuse</td></tr> <tr><td>ANNEX V-10</td><td>Fire test</td></tr> <tr><td>ANNEX V-11</td><td>Emission of gases</td></tr> </tbody> </table> | Clause(s) | Test(s) | ANNEX V-1 | Thermal shock and cycling | ANNEX V-2 | External short circuit protection | ANNEX V-3 | Overcharge protection | ANNEX V-4 | Over-discharge protection | ANNEX V-5 | Over-temperature protection | ANNEX V-6 | Thermal propagation protection | ANNEX V-7 | Mechanical damage by external forces | ANNEX V-8 | Internal short circuit | ANNEX V-9 | Thermal abuse | ANNEX V-10 | Fire test | ANNEX V-11 | Emission of gases | Testing location: For tests ANNEX V -1~5 and 7~10: SRF (Changzhou) Testing Technology Co., Ltd. No.27, Chuangzhi Road, Kunlun Street, Liyang, Jiangsu 213000, P. R. China For test ANNEX V -6 and 11: Shanghai Testing & Inspection Institute for Electrical Equipment Co., Ltd. Area A, 1F, Building 1, No.988, Shangxue Road, Malu Town, Jiading District, Shanghai, P.R. China |
| Clause(s) | Test(s) | | | | | | | | | | | | | | | | | | | | | | | | |
| ANNEX V-1 | Thermal shock and cycling | | | | | | | | | | | | | | | | | | | | | | | | |
| ANNEX V-2 | External short circuit protection | | | | | | | | | | | | | | | | | | | | | | | | |
| ANNEX V-3 | Overcharge protection | | | | | | | | | | | | | | | | | | | | | | | | |
| ANNEX V-4 | Over-discharge protection | | | | | | | | | | | | | | | | | | | | | | | | |
| ANNEX V-5 | Over-temperature protection | | | | | | | | | | | | | | | | | | | | | | | | |
| ANNEX V-6 | Thermal propagation protection | | | | | | | | | | | | | | | | | | | | | | | | |
| ANNEX V-7 | Mechanical damage by external forces | | | | | | | | | | | | | | | | | | | | | | | | |
| ANNEX V-8 | Internal short circuit | | | | | | | | | | | | | | | | | | | | | | | | |
| ANNEX V-9 | Thermal abuse | | | | | | | | | | | | | | | | | | | | | | | | |
| ANNEX V-10 | Fire test | | | | | | | | | | | | | | | | | | | | | | | | |
| ANNEX V-11 | Emission of gases | | | | | | | | | | | | | | | | | | | | | | | | |

Use of uncertainty of measurement for decisions on conformity (decision rule) :

☒ No decision rule is specified by the IEC standard, when comparing the measurement result with the applicable limit according to the specification in that standard. The decisions on conformity are made without applying the measurement uncertainty ("simple acceptance" decision rule, previously known as "accuracy method").

☐ Other: (to be specified, for example when required by the standard or client, or if national accreditation requirements apply)

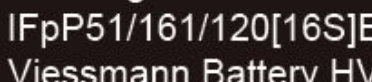









Information on uncertainty of measurement:

The uncertainties of measurement are calculated by the laboratory based on application of criteria given by OD-5014 for test equipment and application of test methods, decision sheets and operational procedures of IECEE.

IEC Guide 115 provides guidance on the application of measurement uncertainty principles and applying the decision rule when reporting test results within IECEE scheme, noting that the reporting of the measurement uncertainty for measurements is not necessary unless required by the test standard or customer.

Calculations leading to the reported values are on file with the NCB and testing laboratory that conducted the testing.

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.

| | |
|--|--------------|
| <div>  </div> | |
| <div> Product Name: Rechargeable Li-ion Battery System IFpP51/161/120[16S]E/-20+50/90 Product Model: Viessmann Battery HV5-A </div> | |
| C_{Rat} (Rated Capacity) | 100Ah |
| E_{Usa} (Usable Energy) | 5kWh |
| V_{Nom} (Nominal Voltage) | 51.2Vd.c. |
| V_{Batt} (Battery Voltage) | 45~57.6Vd.c. |
| I_{Batt} (Battery Current) | 60Ad.c. |
| V_{Output} (Output Voltage) | 320~480Vd.c. |
| P_{Output} (Output Power) | 3kW |
| T_{Charging} (Charging Temperature Range) | 0~53°C |
| T_{Discharging} (Discharging Temperature Range) | -20~53°C |
| <div> IP66, Protective Class I , LFP(LiFePO4) </div> | |
| <div>   <div> Type Approved Safety Regular Production Surveillance www.tuv.com ID 11113590 </div>        </div> | |
| <div> SN: </div> | |
| <div> Viessmann Climate Solutions SE Viessmannstr. 1 35108 Allendorf Deutschland Note: only available in Europe </div> | |

| | |
|---|--|
| Test item particulars.....: | |
| Classification of application.....: | <input type="checkbox"/> Portable battery <input type="checkbox"/> Starting, Lighting and Ignition Battery <input type="checkbox"/> Light Means of Transport Battery <input checked="" type="checkbox"/> Industrial Battery <input type="checkbox"/> Electric Vehicle Battery |
| Classification of installation and use.....: | <input type="checkbox"/> Ordinary Person <input checked="" type="checkbox"/> Instructed Person <input checked="" type="checkbox"/> Skilled Person |
| Supply Connection | <input type="checkbox"/> pluggable equipment <input type="checkbox"/> type A <input type="checkbox"/> type B <input checked="" type="checkbox"/> permanent connection <input type="checkbox"/> detachable power supply cord <input type="checkbox"/> non-detachable power supply cord |
| Environmental category | <input type="checkbox"/> indoor <input checked="" type="checkbox"/> unconditional <input type="checkbox"/> conditional <input checked="" type="checkbox"/> outdoor |
| Over voltage category | <input type="checkbox"/> OVC I <input checked="" type="checkbox"/> OVC II <input type="checkbox"/> OVC III <input type="checkbox"/> OVC IV |
| Class of equipment..... | <input checked="" type="checkbox"/> Class I <input type="checkbox"/> Class II <input type="checkbox"/> Class III |
| Pollution degree (PD) | <input type="checkbox"/> PD1 <input checked="" type="checkbox"/> PD2 (Inside) <input checked="" type="checkbox"/> PD3 (Outside) |
| Possible test case verdicts: | |
| - test case does not apply to the test object..... : N/A | |
| - test object does meet the requirement..... : P (Pass) | |
| - test object does not meet the requirement..... : F (Fail) | |
| Testing.....: | |
| Date of receipt of test item : See cover page | |
| Date (s) of performance of tests : See cover page | |
| General remarks: | |
| "(See Enclosure #)" refers to additional information appended to the report. "(See appended table)" refers to a table appended to the report. Throughout this report a <input type="checkbox"/> comma / <input checked="" type="checkbox"/> point is used as the decimal separator. | |
| When differences exist; they shall be identified in the General product information section. | |
| Name and address of factory (ies) : GoodWe (GuangDe) Power Supply Technology Co., Ltd. No.8, Dongting Rd., Guangde Economic Development Zone, Anhui, China | |

Operating parameters:

| | Product | Li-ion battery Cell | Rechargeable Li-ion Battery System |
|---|--|-------------------------------|------------------------------------|
| Battery system | Type/model | LF100LA | Viessmann Battery HV5-A |
| Battery module parameters inside of product | Nominal voltage [Vdc] | 3.2 | 51.2 |
| | Rated Capacity [Ah] | 102 | 100 |
| | Battery structure | - | 16S1P |
| | Battery Voltage Range [Vdc] | - | 45 to 57.6 |
| | Upper limit charging voltage [Vdc] | 3.90 | 57.6 |
| | Discharge cut-off voltage [Vdc] | 2.0 | 45.0 |
| | Maximum charging current [A] | 100 | 60 |
| | Maximum discharge current [A] | 250 | 60 |
| Battery system parameters | Output Voltage range [Vdc] * | - | 320 to 480 |
| | Output Power [kW] * | - | 3 |
| | Usable Energy [kWh] | - | 5 |
| | Temperature range for charging [°C] | 0 to 65 | 0 to 53 |
| | Temperature range for discharging [°C] | -30 to 65 | -20 to 53 |
| | Dimension (height* thickness*width) [mm] | (118.5±1)*(49.9±1)* (160.0±1) | 380*170*700 |
| | Weight [kg] | 1.98±0.1 | 52 |
| | Ingress Protection (IP) | - | IP66 |
| | Protective Class | - | I |
| | Pollution Degree | - | PD3 (PD 2 inside) |
| | Cooling type | - | Fan cooling |
| | Altitude (m) | - | 4000 |

Note: The product used a DC-DC power board as output terminal, and for this product the input and output voltage range is 320Vdc to 480Vdc, output power is 3kW.

| Regulation (EU) 2023/1542 | | | |
|---------------------------|--------------------|-----------------|---------|
| Clause | Requirement + Test | Result - Remark | Verdict |

| | | | |
|---------------------|---|--|-----|
| Chapter I | General provisions | | N/A |
| Chapter II | Sustainability and safety requirements | | -- |
| Article 12 | Safety of stationary battery energy storage systems | | P |
| 1. | Stationary battery energy storage systems placed on the market or put into service shall be safe during their normal operation and use. | | P |
| 2. | By 18 August 2024, the technical documentation referred to in Annex VIII shall: | | P |
| | (a) demonstrate that the stationary battery energy storage systems are compliant with paragraph 1 and include evidence that they have been successfully tested for the safety parameters set out in Annex V, for which state-of-the-art testing methodologies shall be used. The safety parameters shall only apply in so far as a corresponding hazard exists for the stationary battery energy storage system in question when it is used under the conditions envisaged by the manufacturer; | | P |
| | (b) include an assessment of possible safety hazards of the stationary battery energy storage system that are not addressed in Annex V; | | P |
| | (c) include evidence that the hazards referred to in point (b) have been successfully mitigated and tested; state-of-the-art testing methodologies shall be used for such testing; | | P |
| | (d) include mitigation instructions in case the identified hazards could occur, for example a fire or explosion. | | P |
| | The technical documentation shall be reviewed if a battery is prepared for re-use, prepared for repurposing, remanufactured or repurposed. | | N/A |
| 3. | The Commission is empowered to adopt delegated acts in accordance with Article 89 to amend the safety parameters set out in Annex V in view of technical and scientific progress. | | — |
| CHAPTER III | Labelling, marking and information requirements | | N/A |
| CHAPTER IV | Conformity of batteries | | N/A |
| CHAPTER V | Notification of conformity assessment bodies | | N/A |
| CHAPTER VI | Obligations of economic operators other than the obligations in Chapters VII and VIII | | N/A |
| CHAPTER VII | Obligations of economic operators as regards battery due diligence policies | | N/A |
| CHAPTER VIII | Management of waste batteries | | N/A |
| CHAPTER IX | Digital battery passport | | N/A |
| CHAPTER X | Union market surveillance and Union safeguard procedures | | N/A |

| Regulation (EU) 2023/1542 | | | |
|---------------------------|---|---|------------|
| Clause | Requirement + Test | Result - Remark | Verdict |
| CHAPTER XI | Green public procurement and procedure for amending restrictions on substances | | N/A |
| CHAPTER XII | Delegated powers and committee procedure | | N/A |
| CHAPTER XIII | Amendments | | N/A |
| CHAPTER XIV | Final provisions | | N/A |
| ANNEX I | RESTRICTION ON SUBSTANCES | | N/A |
| ANNEX II | CARBON FOOTPRINT | | N/A |
| ANNEX III | ELECTROCHEMICAL PERFORMANCE AND DURABILITY PARAMETERS FOR PORTABLE BATTERIES OF GENERAL USE | | N/A |
| ANNEX IV | ELECTROCHEMICAL PERFORMANCE AND DURABILITY REQUIREMENTS FOR LMT BATTERIES, INDUSTRIAL BATTERIES WITH A CAPACITY GREATER THAN 2 KWH AND ELECTRIC VEHICLE BATTERIES | | N/A |
| ANNEX V | SAFETY PARAMETERS | | P |
| 1. | Thermal shock and cycling | Test results refer to table ANNEX V - 1 | P |
| | This test shall be 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 shall be exposed to two temperature limits and held at each temperature limit for a specified period. | | P |
| 2. | External short circuit protection | Test results refer to table ANNEX V - 2 | P |
| | This test shall 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 electrical arcing, which can damage circuitry or lead to reduced isolation resistance. | | P |
| 3. | Overcharge protection | Test results refer to ANNEX V - 3 | P |

| Regulation (EU) 2023/1542 | | | |
|---------------------------|--|-----------------------------------|---------|
| Clause | Requirement + Test | Result - Remark | Verdict |
| | This test shall evaluate the safety performance of a battery in overcharge situations. 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 lithium plating, which can lead to self-heating of the battery and thermal runaway. The factors affecting the outcome of the test shall, as a minimum, include, the charging rate and the finally reached state of charge. The protection can be ensured either by voltage control (interruption after reaching the limit charging voltage) or current control (interruption after exceeding maximum charging current). | | P |
| 4. | Over-discharge protection | Test results refer to ANNEX V - 4 | P |
| | This test shall evaluate the safety performance of a battery in over-discharge situations. Safety risks during over-discharge include polarity reversal leading to oxidation of the anode current collector (Copper) and to plating on the cathode side. Even minor over-discharge can cause dendrite formation and ultimately short-circuiting. | | P |
| 5. | Over-temperature protection | Test results refer to ANNEX V - 5 | P |
| | This test shall evaluate the effect of temperature control failure or failure of other features for protection against internal overheating during operation. | | |
| 6. | Thermal propagation protection | Test results refer to ANNEX V - 6 | P |
| | This test shall evaluate the safety performance of a battery in thermal propagation situations. A thermal runaway in one cell can cause a cascading reaction throughout the entire battery which can be composed of numerous cells. It can lead to severe consequences including a significant gas release. The test shall take into account the tests that are under development for transport applications by ISO and the UN Global Technical Regulation. | | P |
| 7. | Mechanical damage by external forces | Test results refer to ANNEX V - 7 | P |
| | These tests shall simulate one or more situations in which a battery is accidentally exposed to mechanical stresses and remains operational for the purpose for which it was designed. The criteria to simulate these situations should reflect real life uses. | | P |
| 8. | Internal short circuit | Test results refer to ANNEX V - 8 | P |

| Regulation (EU) 2023/1542 | | | |
|---------------------------|---|------------------------------------|------------|
| Clause | Requirement + Test | Result - Remark | Verdict |
| | This test shall evaluate the safety performance of a battery in internal short-circuit situations. The occurrence of internal short circuits, one of the main concerns for battery manufacturers, potentially leads to venting, thermal runaway, and sparking which can ignite the electrolyte vapours escaping from the cell. The generation of such internal short circuits can be triggered by manufacturing imperfections, the presence of impurities in the cells or dendritic growth of lithium, and is the cause of most in-field safety incidents. Multiple internal short circuit 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. | | P |
| 9. | Thermal abuse | Test results refer to ANNEX V - 9 | P |
| | During this test, the battery shall be exposed to elevated temperatures (in IEC 62619 the temperature is 85 °C) which can trigger exothermal decomposition reactions and lead to a thermal runaway in the cell. | | P |
| 10. | Fire test | Test results refer to ANNEX V - 10 | P |
| | The risk of explosion shall be assessed by exposing the battery to fire. | | P |
| 11. | Emission of gases | Test results refer to ANNEX V - 11 | P |
| | Batteries can contain significant amounts of potentially hazardous materials, for example highly flammable electrolytes, corrosive and toxic components. If exposed to certain conditions, the integrity of the battery could be compromised, resulting in the release of hazardous gases. Therefore, it is important to identify emissions of gases from substances released from the battery during tests: the risk of toxic gases emitted from non-aqueous electrolytes shall be properly taken into account for all safety parameters listed in points 1 to 10. | | P |
| ANNEX VI | LABELLING, MARKING AND INFORMATION REQUIREMENTS | | N/A |
| ANNEX VII | PARAMETERS FOR DETERMINING THE STATE OF HEALTH AND EXPECTED LIFETIME OF BATTERIES | | N/A |
| ANNEX VIII | CONFORMITY ASSESSMENT PROCEDURES | | N/A |
| ANNEX IX | EU DECLARATION OF CONFORMITY No* ... * (identification number of the declaration) | | N/A |
| ANNEX X | LIST OF RAW MATERIALS AND RISK CATEGORIES | | N/A |
| ANNEX XI | CALCULATION OF COLLECTION RATES FOR WASTE PORTABLE BATTERIES AND WASTE LMT BATTERIES | | N/A |
| ANNEX XII | STORAGE AND TREATMENT, INCLUDING RECYCLING, REQUIREMENTS | | N/A |
| ANNEX XIII | INFORMATION TO BE INCLUDED IN THE BATTERY PASSPORT | | N/A |

| Regulation (EU) 2023/1542 | | | |
|---------------------------|---|-----------------|------------|
| Clause | Requirement + Test | Result - Remark | Verdict |
| ANNEX XIV | MINIMUM REQUIREMENTS FOR SHIPMENTS OF USED BATTERIES | | N/A |
| ANNEX XV | CORRELATION TABLE | | N/A |

| Regulation (EU) 2023/1542 | | | |
|---------------------------|--------------------|-----------------|---------|
| Clause | Requirement + Test | Result - Remark | Verdict |

| Table ANNEX V - 1 | Thermal shock and cycling | | | | -- |
|--|-----------------------------------|-----------------------------------|--|-------------------------|--------|
| Sample No. | OCV at start of test, (V dc) | Max temperature, (°C) | Min temperature, (°C) | OCV at End test, (V dc) | Remark |
| HV5-20250304-002 | 51.5 | 72 | -40 | 51.4 | A, B |
| | Max temperature Storage time, (h) | Min temperature Storage time, (h) | Interval time between max and min Temperature, (h) | Cycles | |
| | 6 | 6 | 0.5 | 10 | |
| Remark: A – No Fire, explosion, venting, leakage or rupture, OCV change ≤ 10%, mass loss ≤ 0.1%. B – Other (Please explain): Test method and requirement based on Recommendations on the Transport of Dangerous Goods, Manual of Tests and Criteria, ST/SG/AC.10/11/Rev.7/Amend.1/Section 38.3.4.2 | | | | | |

| Table ANNEX V - 2 | External short circuit protection | | | | | -- |
|---|-----------------------------------|------------------------------|----------------------------|---|------------------|--------|
| Sample No. | Ambient, (°C) | OCV at start of test, (V dc) | Max discharge current, (A) | Maximum Case Temperature Rise ΔT , (°C) | Test termination | Remark |
| HV5-20250304-003 | 23 | 51.4 | 1010A | 0* | A | C, F |
| Remark: A - The test was completed after 6 h; B - The test was completed after the cell casing cooled to 20% of the maximum temperature rise Results: C - No fire or Explosion; D - Fire; E - Explosion; F - Other (Please explain): Test method and requirement based on IEC 63056:2020 Clause 7.6. Note*: No obviously temperature rise due to protection device operating immediately. | | | | | | |

| Regulation (EU) 2023/1542 | | | |
|---------------------------|--------------------|-----------------|---------|
| Clause | Requirement + Test | Result - Remark | Verdict |

| | | | | | | |
|---|--|-------------------------------------|---|---------------------------------|---------------|----|
| Table ANNEX V - 3 | Overcharge protection | | | | | -- |
| Sample No. | OCV at start of test for Cell, (V dc) | Maximum Charging Current, (A) | Max. Charging Voltage of Battery system, (V dc) | Max. Voltage of Cell, (V dc) | Remark | |
| HV5- 20250304-002 | 2.819 to 2.896 | 60 | 57.6 | 3.613 | A, D, F, H | |
| -- | | | Charge Voltage Applied Battery System | | | |
| | | | Whole | | Part | |
| | | | 57.6*1.1=63.36 | | - | |
| Remark: A – No Fire or Explosion B – Fire C – Explosion D – The voltage of the measured cells or cell blocks did not exceed the upper limit charging voltage E – The voltage of the measured cells or cell blocks did exceed the upper limit charging voltage F – All function of battery system did operate as intended during the test. G – All function of battery system did not operate as intended during the test. H – Other (Please explain): Test method and requirement based on IEC 62619:2022 Clause 8.2.3. | | | | | | |

| Table ANNEX V - 4 | Over-discharge protection | | | | | -- |
|---|---------------------------|------------------------------|-------------------|--------------------------------|---------------------------------------|--------|
| Sample No. | Ambient, (°C) | OCV at start of test, (V dc) | Discharge current | | Measured minimum cell voltage, (V dc) | Remark |
| | | | 0.2 It (A) | Maximum discharge current, (A) | | |
| HV5-20250304-002 | 24.0 | 53.8 | 20 | 60 | 2.648 | A, C |
| Remark: A - The BMS interrupt the over discharging current by an automatic disconnect of the main contactors before the cell voltage dropped below lower limit discharging voltage of the cell. B - Measured minimum cell voltage less than lower limit discharging voltage of the cell. C - Other (Please explain): Test method and requirement based on IEC 63056:2020 Clause 7.8. | | | | | | |

| Regulation (EU) 2023/1542 | | | |
|---------------------------|--------------------|-----------------|---------|
| Clause | Requirement + Test | Result - Remark | Verdict |

| Table ANNEX V - 5 Over temperature protection | | | -- |
|--|--|--|----------------------------------|
| Sample No. | OCV at start (SOC 50%) of test, (V dc) | Maximum Charging Current, (A) | Maximum Charging Voltage, (V dc) |
| HV5-20250304-002 | 52.9 | 60 | 57.6 |
| Maximum Specified Temperature of Battery System, °C | | Maximum Measured Cell Case Temperature, °C | Remark |
| 53.0 | | 55.1 | A, D, F, H |
| Remark: A – No fire or Explosion B – Fire C – Explosion D – Temperature sensing function of BMU did operate and then charging stopped E – Temperature sensing function of BMU did not operate and then charging stopped F – All function of battery system did operate as intended during the test. G – All function of battery system did not operate as intended during the test. H – Other (Please explain): Test method and requirement based on IEC 62619:2022 Clause 8.2.4 | | | |

| | | | | | |
|--|---|--|-------------------------------------|--|--------|
| Table ANNEX V – 6, ANNEX V – 11 | Thermal propagation protection | | | | -- |
| Sample No. | OCV of Battery System Before Test, (V dc) | OCV of Target Cell Before Test, (V dc) | Maximum Cell Case Temperature, (°C) | Maximum DUT Enclosure Temperature, (°C) | Remark |
| HV5-20250304-001 | 53.3 | 3.34 | 673.5 | 163.1 | A, E |
| Method of cell failure ¹⁾ | | Location of target cell | | Area for fire protection (m ²) | |
| Overcharge | | Middle cell of the battery pack | | -- | |
| Flammable gas generation and composition data: | | | | | |
| Measurement Method | Gas Compound | Gas Type | Pre-Flaming (L) | Post-Flaming (L) | |
| Flame ionization detection | Total Hydrocarbons (Propane Equivalent) | Hydrocarbons | 319.59 | No flaming | |
| Fourier-Transform infrared Spectrometer | Carbon Monoxide | Carbon Containing | 33.63 | No flaming | |
| | Carbon Dioxide | Carbon Containing | 213.96 | No flaming | |
| Solid-state Hydrogen Sensor | Hydrogen | Hydrogen | 409.01 | No flaming | |

| Regulation (EU) 2023/1542 | | | |
|---------------------------|--------------------|-----------------|---------|
| Clause | Requirement + Test | Result - Remark | Verdict |

| Measurement Method | Gas type | Gas components | | Total volume of gas (L) | |
|---|---------------------|----------------|-------------------------------|-------------------------|---------------------|
| | | | | Before cell venting | Throughout the test |
| Fourier-Transform infrared Spectrometer | Hydrocarbon species | Methane | CH ₄ | 0.00 | 44.17 |
| | | Acetylene | C ₂ H ₂ | 0.00 | 10.26 |
| | | Ethylene | C ₂ H ₄ | 0.00 | 22.38 |
| | | Ethane | C ₂ H ₆ | 0.00 | 4.87 |
| | | Propylene | C ₃ H ₆ | 0.00 | 8.18 |
| | | Propane | C ₃ H ₈ | 0.00 | 5.03 |

Supplementary information:

- 1) Cell can be failed through laser exposure, applied heat, overcharge, nail penetration or combinations of these failures or other acceptable methods. See supporting documentation for details on cell failure method
- 2) If the battery system has no outer covering, the manufacturer is required to specify the area for fire protection.

Remark:

A – No fire external to DUT enclosure or area for fire protection or no battery case rupture

B – Fire external to DUT enclosure or area for fire protection

C – Explosion

D – Battery case rupture

E – Other (Please explain): Test method and requirement based on IEC 62619:2022 Clause 7.3.3.

| Table ANNEX V - 7 | Mechanical damage by external forces | | | -- |
|--|--------------------------------------|------------------------------|------------------------|--------|
| Sample No. | Test item | OCV at start of test, (V dc) | OCV after test, (V dc) | Remark |
| HV5-20250304-002 | Steady force test (250N) | 52.8 | 52.8 | A, B |
| | Vibration test | 52.8 | 52.8 | A, B |
| Remark: A – Tested with no non-compliant results. B - Other (Please explain): Test method and requirement based on EN 62477-1+A11+A1+A12 Clause 5.2.2.4.2.3 and 5.2.6.4. | | | | |

| Table ANNEX V - 8 | Internal short circuit | | | -- |
|-------------------|------------------------------|---------------------------------|-------------------------------|--------|
| Sample No.* | OCV at start of test, (V dc) | Particle location ¹⁾ | Maximum applied pressure, (N) | Remark |

| Regulation (EU) 2023/1542 | | | |
|---------------------------|--------------------|-----------------|---------|
| Clause | Requirement + Test | Result - Remark | Verdict |

| | | | | |
|-------------------|-------|---|-----|---------|
| Cell-20250304-001 | 3.395 | 1 | 400 | A, E, G |
| Cell-20250304-002 | 3.380 | 1 | 400 | A, E, G |
| Cell-20250304-003 | 3.393 | 1 | 400 | A, E, G |
| Cell-20250304-004 | 3.375 | 1 | 400 | A, E, G |
| Cell-20250304-005 | 3.376 | 1 | 400 | A, E, G |

Supplementary information:

1) Identify one of the following:

1: Nickel particle inserted between positive and negative (active material) coated area.

2: Nickel particle inserted between positive aluminium foil and negative active material coated area.

Remark:

A – No fire or explosion

B – Fire

C – Explosion

D – Test concluded when 50 mV voltage drop occurred prior to reaching force limit

E – Test concluded when 800/400 N pressure was reached and 50 mV voltage drop was not achieved

F – Test was concluded when fire or explosion occurred

G – Other (Please explain): Test method and requirement based on IEC 62619:2022 Clause 7.3.2

Note*: Tested on cells.

| Table ANNEX V - 9 | | Thermal abuse | | | -- |
|---|------------------------------|------------------------|--------------------------------------|------------------------------------|--------|
| Sample No.* | OCV at start of test, (V dc) | Test temperature, (°C) | Max. DUT Enclosure Temperature, (°C) | Max. Temperature storage time, (h) | Remark |
| Cell-20250304-008 | 3.382 | 85.0 | 85.2 | 3 | A, B |
| Cell-20250304-009 | 3.392 | 85.0 | 85.3 | 3 | A, B |
| Cell-20250304-010 | 3.389 | 85.0 | 85.2 | 3 | A, B |
| Remark: A – No fire or no explosion B – Other (Please explain): Test method and requirement based on IEC 62619:2022 Clause 7.2.4 Note*: Tested on cells. | | | | | |

| Regulation (EU) 2023/1542 | | | |
|---------------------------|--------------------|-----------------|---------|
| Clause | Requirement + Test | Result - Remark | Verdict |

| | | | |
|---|--------------------------------|-------------------------------|---------------|
| Table ANNEX V - 10 | Fire test | | -- |
| Sample No.* | OCV before test, (V dc) | OCV after test, (V dc) | Remark |
| Cell-20250304-006 | 3.382 | 0 | D, E, F |
| Cell-20250304-007 | 3.388 | 0 | D, E, F |
| Remark: A – Cell did not explode. B – Cell exploded but no part of the cell casing penetrated the wire screen. C – Cell exploded such that particles from the casing penetrated the wire screen. D – Cell vented without exploding. E – Cell caught on fire without explosion F – Other. (Please explain): Test method and requirement based on UL 1973:2022 Annex E9. Note*: Tested on cells. | | | |

- End of report -