



**CE MARKING**

*ELECTROMAGNETIC COMPATIBILITY  
ELECTRICAL SAFETY  
LASER SPECTROSCOPY  
ENVIRONMENTAL PHYSICS*

**G.S.D. S.r.l.**  
Certified in accordance with  
**UNI EN ISO 9001:2015**  
by  
**TÜV Rheinland Italia S.r.l.**  
Certificate N. 39 00 1850509

**Test Report n. 20097**

**Manufacturer:**            **NRG S.r.l.**  
Via R. Lombardi, 19/18  
20153 Milano (MI)  
Italy

**Applicant:**                **Ghibli & Wirbel S.p.A.**  
Via Circonvallazione, 5  
27020 Dorno (PV)  
Italy

**Eut:**                            **SDI INR 18650-29E 7S4P**  
**P/N 3071010**  
**Li-Ion Battery**

Pisa, 2020 May, 28

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## 1 MANUFACTURER AND EUT IDENTIFICATION

Manufacturer: **NRG S.r.l.**  
Via R. Lombardi, 19/18  
20153 Milano (MI)  
Italy

Applicant: **Ghibli & Wirbel S.p.A.**  
Via Circonvallazione, 5  
27020 Dorno (PV)  
Italy

Eut: **SDI INR 18650-29E 7S4P**  
**P/N 3071010**  
**Li-Ion Battery**

Complete EUT Id: **SDI INR 18650-29E 7S4P**

Sample receiving date: 2020 April, 23

Test date: 2020 April, 23 - 2020, May 22

Description: Li-Ion Battery

### Battery pack specification:

Model: SDI INR 18650-29E 7S4P  
P/N: 3071010  
Technology: Li-Ion Battery  
Configuration: 7S4P  
Nominal voltage: 25,5 V  
Capacity: 11,0 Ah  
Charge voltage: 29,4 V  
Basic cell: Samsung mod. INR18650-29E

### Label:



EUT identification:

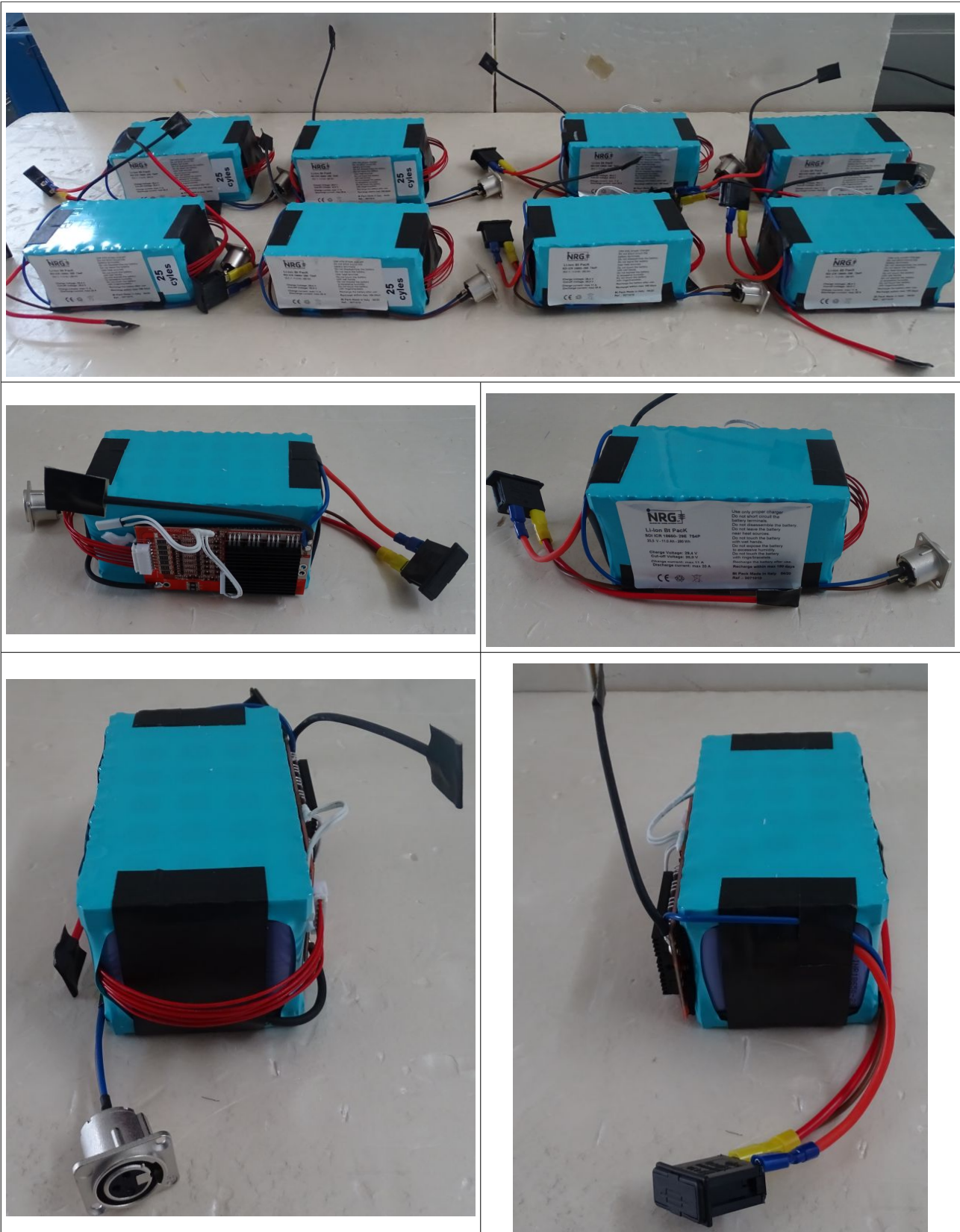
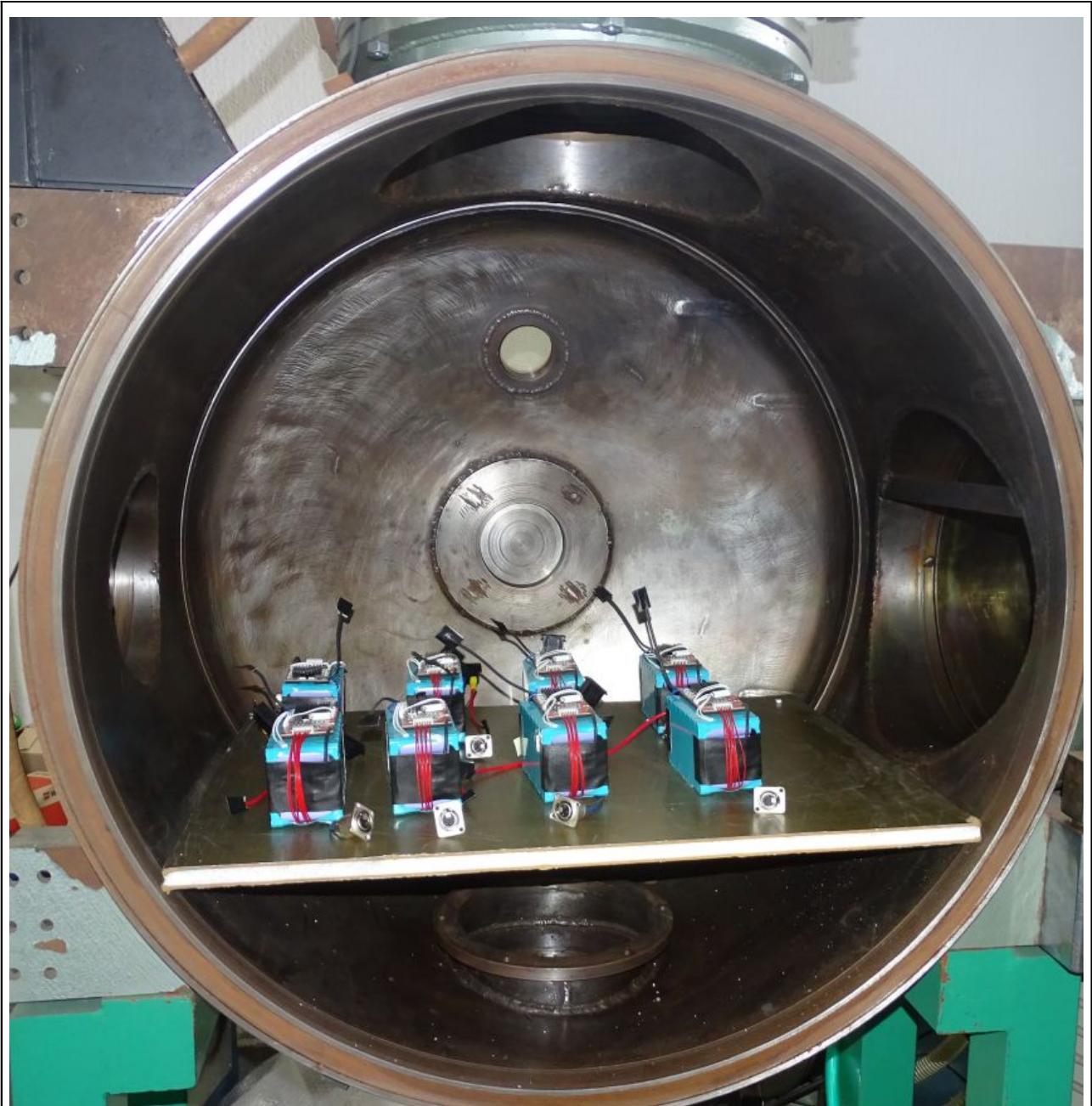


Fig. 1.1  
SDI INR 18650-29E 7S4P



Fig. 1.2  
SDI INR 18650-29E 7S4P In the case

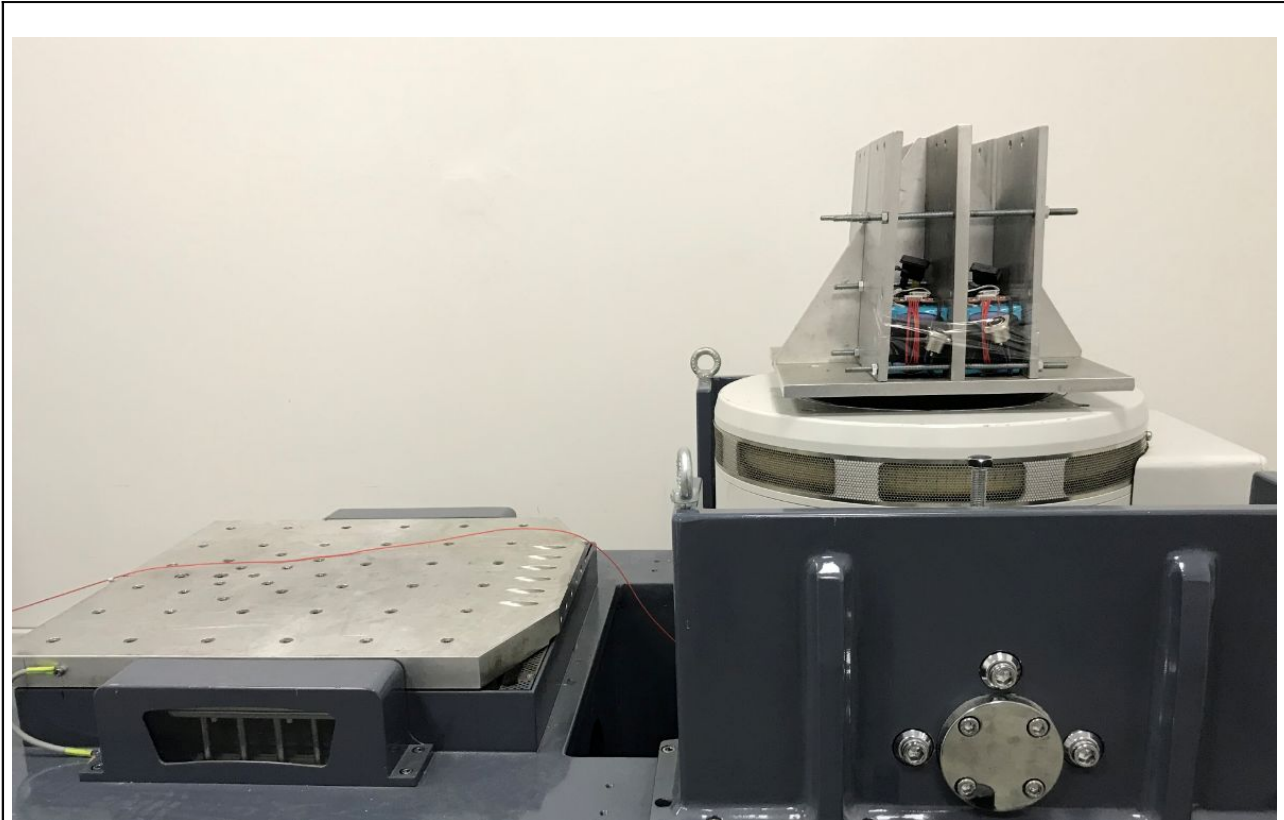
2 PHOTO



*Fig. 2.1  
Batteries in T.1 Ref.1 and Ref.2b Test setup  
(Altitude Simulation test)*

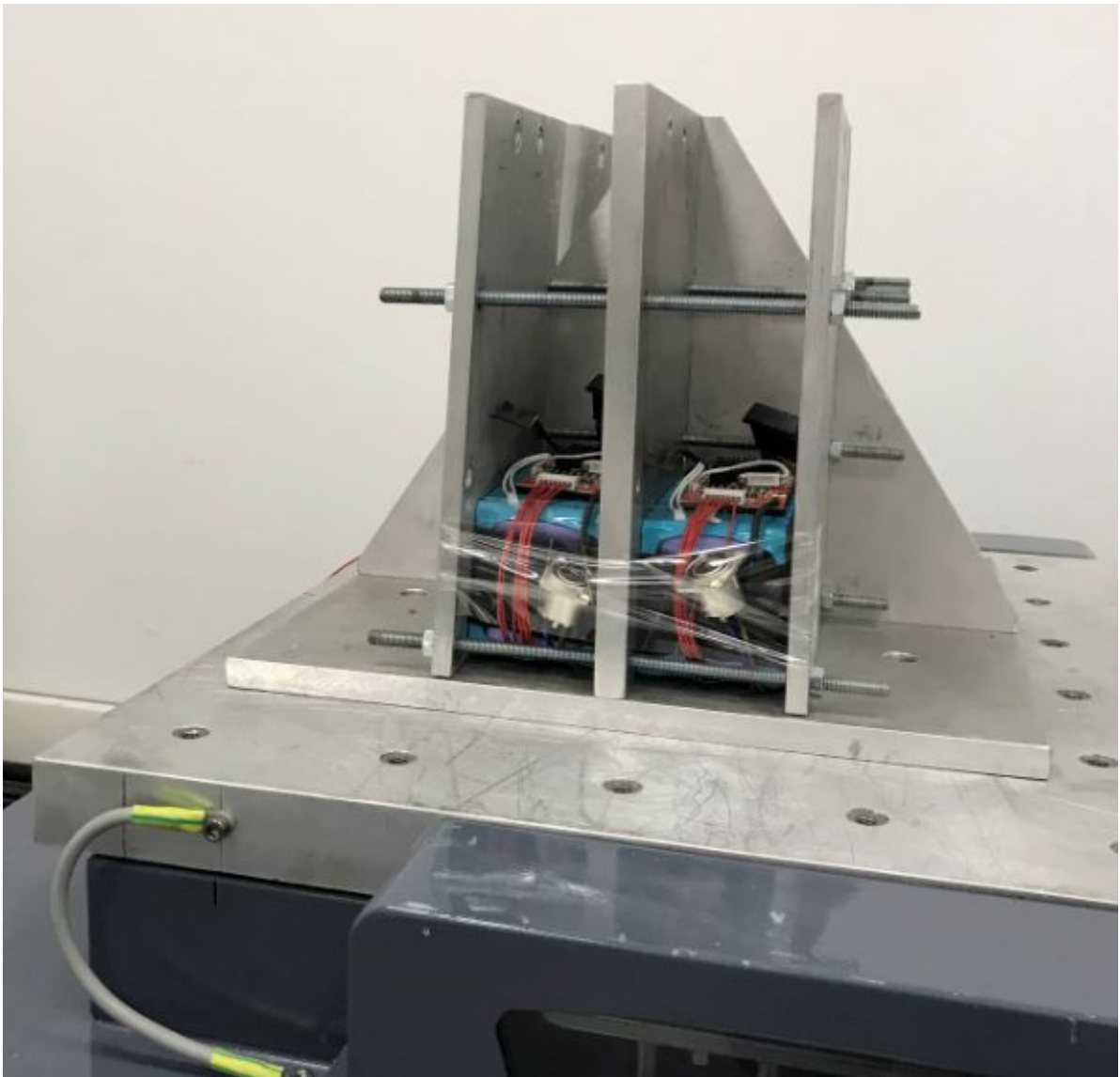


*Fig. 2.2*  
*Batteries in T.2 Ref.1 and Ref.2b, §7.2.2 Ref. 2a Test setup*  
*(Thermal test, case stress)*

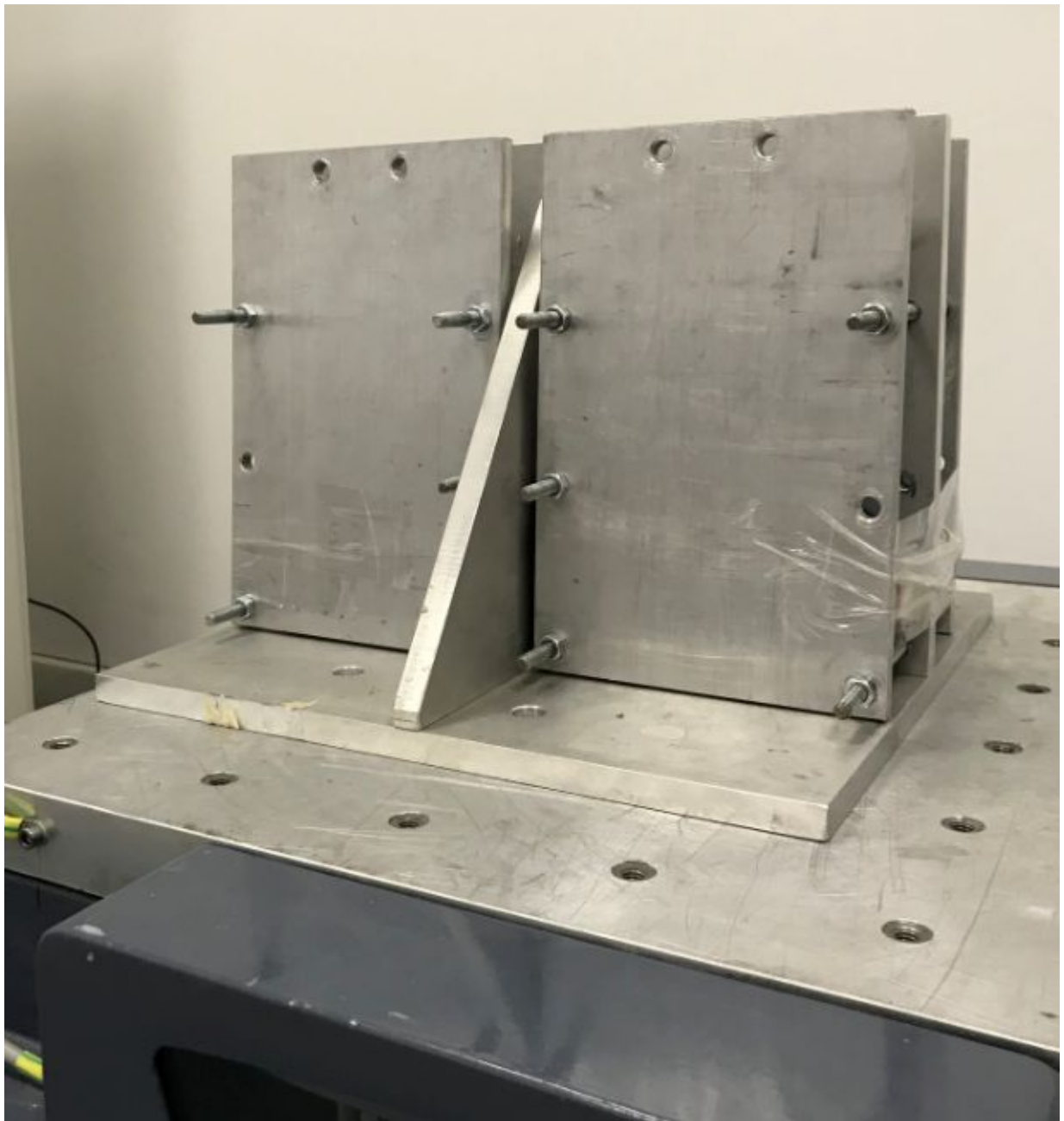


*Fig. 2.3*  
*Battery in T.3 Ref.1 and Ref.2b , §7.3.8.1 Ref. 2A and*  
*T.4 Ref.1 and Ref.2b, §7.3.8.2 Ref. 2A Test setup*  
*(Vibration/Shock test Z-Axis)*

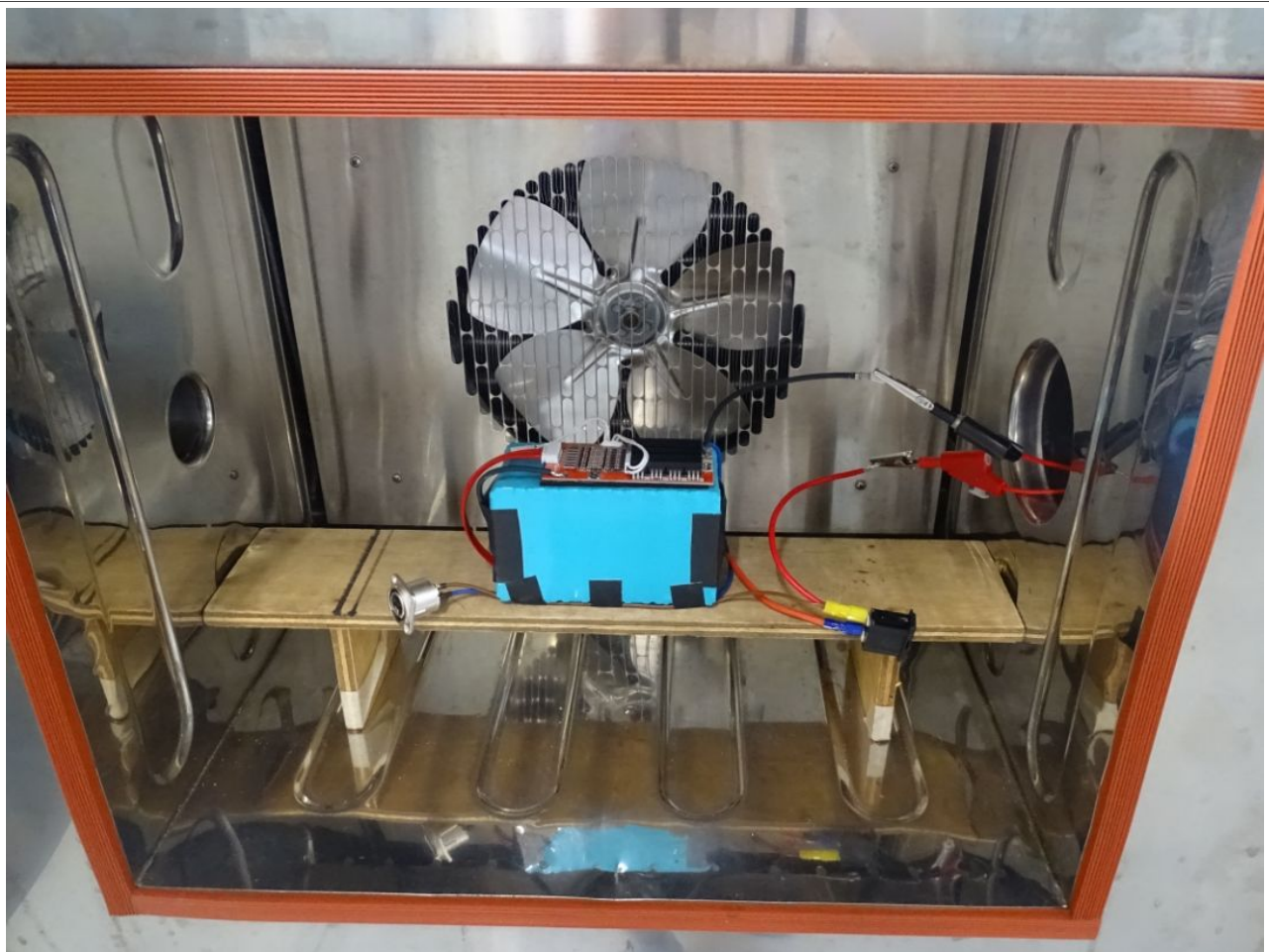




*Fig. 2.4*  
*Battery in T.3 Ref.1 and Ref.2b , §7.3.8.1 Ref. 2A and*  
*T.4 Ref.1 and Ref.2b, §7.3.8.2 Ref. 2A Test setup*  
*(Vibration/Shock test Y-Axis)*



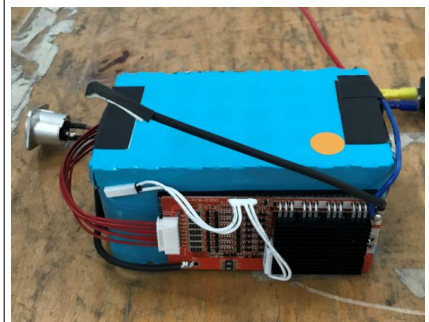
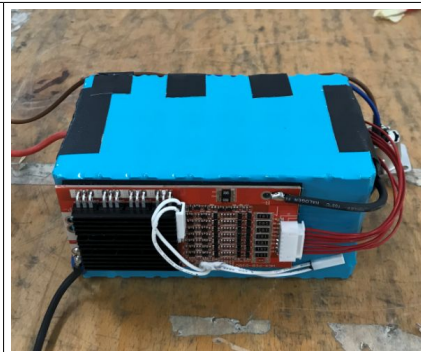
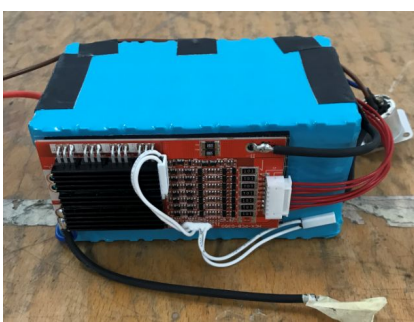
*Fig. 2.5*  
*Battery in T.3 Ref.1 and Ref.2b , §7.3.8.1 Ref. 2A and*  
*T.4 Ref.1 and Ref.2b, §7.3.8.2 Ref. 2A Test setup*  
*(Vibration/Shock test X-Axis)*



*Fig. 2.6  
Battery in T.5 Ref.1 and Ref.2b, §7.3.2 Ref. 2a Test setup  
(External short circuits)*



*Fig. 2.7  
Battery in T.7 Ref.1 and Ref.2b, §7.3.6 Ref. 2a Test setup  
(Overcharge)*



*Fig. 2.8  
Battery in free fall Test setup, before and after test  
(Free Fall)*

### 3 TEST GENERALITY

The following documents are applicable and governed the preparation of the tests performed:

Ref.	Standard / Document Title
1.	<b><i>ST/SG/AC.10/11/Rev.7 Recommendations on the Transport of Dangerous Goods. Manual of tests and Criteria – Seventh revised edition UN Manual of Tests and Criteria – SECTION 38 - CLASSIFICATION PROCEDURES, TEST METHODS AND CRITERIA RELATING TO SUBSTANCES AND ARTICLES OF TRANSPORT - CLASS 9 §38.3 Lithium metal and lithium ion batteries</i></b>
2.	<b><i>a) IEC 62133-2 Rev2 - 2017 Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications – Part 2. and b) EN 62281 - 2017 Safety of primary and secondary lithium cells and batteries during transport</i></b>

The following table gives the summary of all test.

<b>TEST</b>	
<i>T.1 Ref.1 and Ref.2b</i>	<i>Altitude simulation</i>
<i>T.2 Ref.1 and Ref.2b, §7.2.2 Ref. 2a</i>	<i>Thermal test, Case stress</i>
<i>T.3 Ref.1 and Ref.2b, §7.3.8.1 Ref. 2a</i>	<i>Mechanical Vibration</i>
<i>T.4 Ref.1 and Ref.2b, §7.3.8.2 Ref. 2a</i>	<i>Mechanical Shock</i>
<i>T.5 Ref.1 and Ref.2b, §7.3.2 Ref. 2a</i>	<i>External short circuit</i>
<i>T.7 Ref.1 and Ref.2b, §7.3.6 Ref. 2a</i>	<i>Overcharge</i>
<i>§7.3.3 Ref. 2a</i>	<i>Free Fall</i>

Evaluation criteria:

Requirements 1:

- no mass;
- no leakage;
- no venting;
- no disassembly;
- no rupture;
- no fire
- open circuit voltage of each test cell or battery after testing have to be not less than 90% of its voltage immediately prior to procedure<sup>1</sup>.

Requirements 2:

- External cells or batteries temperature have to be less than 170°C and

<sup>1</sup>This requirement is not applicable to test cells and batteries at fully discharged state

- no disassembly;
- no rupture;
- no fire

within 6 hours of test finish

### Environmental Conditions

Temperature =  $(294 \pm 3)$  K

Relative humidity =  $(50 \pm 5)$  %

### Samples under test:

n. 8 samples (4+4): SDI INR 18650-29E 7S4P

four small batteries at first cycle, in fully charged states

four small batteries after 25 cycles ending in fully charged states

8 batteries were tested for test:

*T.1 Ref.1 and Ref.2b*

*T.2 Ref.1 and Ref.2b, §7.2.2 Ref. 2a*

*T.5 Ref.1 and Ref.2b, §7.3.2 Ref. 2A*

*T.3 Ref.1 and Ref.2b, §7.3.8.1 Ref. 2a*

*T.4 Ref.1 and Ref.2b, §7.3.8.2 Ref. 2a*

*T.7 Ref.1 and Ref.2b, §7.3.6 Ref. 2a*

3 batteries were tested for test:

*§7.3.3 Ref.2a*

### Disposition of test and measure

Test and/or measure disposition is compliance with the relative reference standard.

### Test site:

Tests were performed in G.S.D. S.r.l. - PISA Italy

#### 4 SUMMARY OF TEST RESULTS

<i>TEST [REF. 1, REF.2]</i>		<i>RESULT</i>
<i>T.1 Ref.1 and Ref.2b</i>	<i>Altitude simulation</i>	<i>Pass</i>
<i>T.2 Ref.1 and Ref.2b, §7.2.2 Ref. 2a</i>	<i>Thermal test, case stress</i>	<i>Pass</i>
<i>T.3 Ref.1 and Ref.2b , §7.3.8.1 Ref. 2a</i>	<i>Mechanical Vibration</i>	<i>Pass</i>
<i>T.4 Ref.1 and Ref.2b, §7.3.8.2 Ref. 2a</i>	<i>Mechanical Shock</i>	<i>Pass</i>
<i>T.5 Ref.1 and Ref.2b, §7.3.2 Ref. 2a</i>	<i>External short circuit</i>	<i>Pass</i>
<i>T.7 Ref.1 and Ref.2b, §7.3.6 Ref. 2a</i>	<i>Overcharge</i>	<i>Pass</i>
<i>§7.3.3 Ref. 2a</i>	<i>Free Fall</i>	<i>Pass</i>

Extensions:

The results refer only to the sampled EUT and under the specified conditions.



## 5 TEST T.1 REF.1 AND REF.2B: ALTITUDE SIMULATION

According to §38.3.4.1 Ref.1, purpose of this test, is to simulates air transport under low -pressure conditions.

### Procedure:

Apparatus shall be stored at 11,6kPa (or less) for at least 6 hours in ambient temperature ( $20\pm 5^{\circ}\text{C}$ )

### Test Equipment:

<i>EQUIPMENT DESIGNATION</i>	<i>MANUFACTURER</i>	<i>MODEL, TYPE</i>	<i>NEXT CALIBRATION</i>
VACUUM CHAMBER	Officine Galileo	V4aq	JAN 2021
DATA ACQUISITION UNIT	HP	34970A	JAN 2021

Evaluation criteria: Requirements 38.3.4.1 Ref. 1

### Results

*After the test the equipment continued to be full functionally, no malfunction as on requirements were founded. Equipment complied with the test specifications.*

## 6 TEST T.2 REF.1 AND REF.2B, §7.2.2 REF. 2A: THERMAL TEST

According to §38.3.4.2 Ref.1, §7.2.2 Ref.2a purpose of this test, is to assesses cell and battery seal integrity and internal connections Test performs rapid and extreme temperature changes.

### Procedure:

Cells and Batteries are to be stored for at least 7 hours at a test temperature equal to  $72\pm 2^{\circ}\text{C}$  followed by storage for at least 7 hours at a test temperature equal to  $-40\pm 2^{\circ}\text{C}$ .

Maximum time interval between test temperature extreme is 30 minutes.

This procedure is to be repeated 10 times after which all test cells and batteries are to be stored for 24 hours at ambient temperature ( $20\pm 5^{\circ}\text{C}$ )<sup>2</sup>.

### Test Equipment:

<i>EQUIPMENT DESIGNATION</i>	<i>MANUFACTURER</i>	<i>MODEL, TYPE</i>	<i>NEXT CALIBRATION</i>
THERMAL CHAMBER	ACS	CH1200C	JAN 2021
DATA ACQUISITION UNIT	HP	34970A	JAN 2021

Evaluation criteria: Requirements §38.3.4.2 Ref.1, §7.2.2 Ref.2a

### Results

*After the test the equipment continued to be full functionally, no malfunction as on requirements were founded. No physical distortion of the battery case resulting in exposure of internal protective components and cells. Equipment complied with the test specifications.*

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<sup>2</sup>For large cells and batteries the duration of exposure to the temperature extremes should be at least 12 hours.

## 7 TEST T.3 REF.1 AND REF.2B , §7.3.8.1 REF. 2A: VIBRATIONS

According to §38.3.4.3 Ref.1, §7.3.8.1 Ref. 2a purpose of this test, is to simulates vibration during transport.

Cells and Batteries are subjected to sinusoidal vibration with specified sweep and duration as in table below, for each of three mutually perpendicular mounting position of the cell. One of the directions of vibration must be perpendicular to terminal face.

<i>FREQUENCY RANGE</i> [Hz]	<i>SWEEP</i>	<i>DURATION</i> [MINUTES]	<i>REPETITION</i>	<i>TOTAL TIME</i> [HOUR]
7 – 200	logarithmic	15	12	3/axis
7 – 200	traversed			

### Test Equipment:

<i>EQUIPMENT DESIGNATION</i>	<i>MANUFACTURER</i>	<i>MODEL, TYPE</i>	<i>NEXT CALIBRATION</i>
VIBRATING TABLE	DONGLING	ES-10-240	JAN 2021
AMPLIFIER	DONGLING	SDA-10	JAN 2021
ACCELEROMETER REFERENCE	DYTRAN	3055B4	JAN 2021
DIGITAL CONTROLLER	LMS INSTRUMENTS	SC310V	JAN 2021

Evaluation criteria: Requirements §38.3.4.3 Ref.1, §7.3.8.1 Ref. 2a

### Results

*After the test the equipment continued to be full functionally, no malfunction as on requirements were founded. No fire, no explosion, no rupture, no leakage or venting. Equipment complied with the test specifications.*

## 8 TEST T.4 REF.1 AND REF.2B, §7.3.8.2 REF. 2A: SHOCK

According to §38.3.4.4 Ref.1, §7.3.8.2 Ref. 2a purpose of this test, is to simulates possible impact during transport.

Cells and Batteries are subjected to a half-sine shock of peak acceleration, pulse duration as specified in table below for each of three mutually perpendicular mounting position of the cell.

<i>PEAK ACCELERATION</i> [g <sub>n</sub> ]	<i>POLARITY</i>	<i>DURATION</i> [MILLISECONDS]	<i>REPETITION</i>	<i>AXE</i>	<i>TOTAL SHOCK</i>
150	positive	6	3	X	18
150	negative			Y	
				Z	

### Test Equipment:

<i>EQUIPMENT DESIGNATION</i>	<i>MANUFACTURER</i>	<i>MODEL, TYPE</i>	<i>NEXT CALIBRATION</i>
VIBRATING TABLE	DONGLING	ES-10-240	JAN 2021
AMPLIFIER	DONGLING	SDA-10	JAN 2021
ACCELEROMETER REFERENCE	DYTRAN	3055B4	JAN 2021
DIGITAL CONTROLLER	LMS INSTRUMENTS	SC310V	JAN 2021

Evaluation criteria: Requirements §38.3.4.4 Ref.1, §7.3.8.2 Ref. 2a

### Results

*There shall be no leakage, no venting, no rupture, no explosion and no fire during the test. After the test the equipment continued to be full functionally, no malfunction as on requirements were founded. Equipment complied with the test specifications.*

## 9 TEST §7.3.3 REF. 2A: FREE FALL

According to §7.3.3 Ref.2a, purpose of this test: dropping a battery (for example, from a bench top) shall not cause fire or explosion.

Free fall test is conducted at an ambient temperature of  $20\text{ °C} \pm 5\text{ °C}$ , by using cells or batteries that are charged to a fully charged state, in accordance with the first procedure in 7.1.1. Each cell or battery is dropped three times from a height of 1,0 m onto a flat concrete floor or metal floor. The cells or batteries are dropped so as to obtain impacts in random orientations. After the test, the cell or battery shall be put on rest for a minimum of 1 h and then a visual inspection shall be performed.

### Test Equipment:

N.A.

Evaluation criteria: Requirements §7.3.3 Ref.2a

### Results

*After the test: No fire, no explosion.  
Equipment complied with the test specifications.*

## 10 TEST T.5 REF.1 AND REF.2B, §7.3.2 REF. 2A: EXTERNAL SHORT CIRCUIT

According to §38.3.4.5 Ref.1, §7.3.2 Ref.2a, purpose of this test, is to simulates possible external short circuit.

Cells and Batteries have to be temperature stabilized so that its external case temperature reaches  $55\pm 2^{\circ}\text{C}$ .

Short circuit have to be realized with a total external resistance of less than  $0,08\Omega$  at  $55\pm 2^{\circ}\text{C}$ .

This short circuit condition is continued for at least 1 hour after the cell or battery external case temperature returned to  $55\pm 2^{\circ}\text{C}$ .

Cells and batteries must be observed for a further 6 hour for the test to be concluded

### Test Equipment:

<i>EQUIPMENT DESIGNATION</i>	<i>MANUFACTURER</i>	<i>MODEL, TYPE</i>	<i>NEXT CALIBRATION</i>
DATA ACQUISITION / SWITCH UNIT	HP	34970A	JAN 2021
THERMAL CHAMBER	ACS	CH1200C	JAN 2021
DATA ACQUISITION UNIT	HP	34970A	JAN 2021

Evaluation criteria: Requirements §38.3.4.5 Ref.1, §7.3.2 Ref.2a

### Results

*After the test external temperature did not exceed  $170^{\circ}\text{C}$  and there was no disassembly, no rupture and no fire and no explosion within six hours of this test.*

*Equipment complied with the test specifications.*

## 11 TEST T.7 REF.1 AND REF.2B, §7.3.6 REF. 2A: OVERCHARGE

According to §38.3.4.7 Ref.1, §7.3.6 Ref.2a, purpose of this test, is evaluates the ability of a rechargeable battery to withstand an overcharge condition.

The minimum voltage of the test shall be the lesser of two times the maximum charge voltage of the battery or 22V if charge voltage is not more than 18V. The minimum voltage of the test shall be 1,2 times the maximum charge voltage if charge voltage is more than 18V. Battery discharged according to §7.3.6 Ref.1. Tests were conducted at ambient temperature  $20\text{ °C} \pm 5\text{ °C}$ . The duration of the test was 24 hours.

Voltage test: 36 V

### Test Equipment:

<i>EQUIPMENT DESIGNATION</i>	<i>MANUFACTURER</i>	<i>MODEL, TYPE</i>	<i>NEXT CALIBRATION</i>
POWER SUPPLY	AGILENT	6574A	JAN 2021
THERMAL CHAMBER	ACS	CH1200C	JAN 2021
DATA ACQUISITION UNIT	HP	34970A	JAN 2021

Evaluation criteria: Requirements §38.3.4.7 Ref.1, §7.3.6 Ref.2a

### Results

*After the test no disassembly and no fire were and no explosion observed.  
Equipment complied with the test specifications.*

**12 REPORT REVISION HISTORY**

<b>Revision details</b>		
<b>Date</b>	<b>Page No.(s)</b>	<b>Details</b>
2020 May, 28	24	Rev.00 Initial issue