Propagation test report

LiFePO4 battery module

Project 2024-541705Q

Report date: 13-08-2024
Test date: 31-06-2024
Test laboratory: Mlab Testing
Doejenburg 144N
4021 HR, Maurik
Netherlands

Test location: Brandweertrainingscentrum Kleefse Waard
Westervoortsedijk 73
6827 AV Arnhem
Netherlands

Tests performed by: M.C. Mooij 

Content

1. General information

1.1 Customer information

Netherlands

1.2 Equipment Under Test (EUT)

The EUT is a LiFePO4 battery pack designed only for use in energy storage systems. The test is performed on a single module being placed inside the enclosure as in normal use.

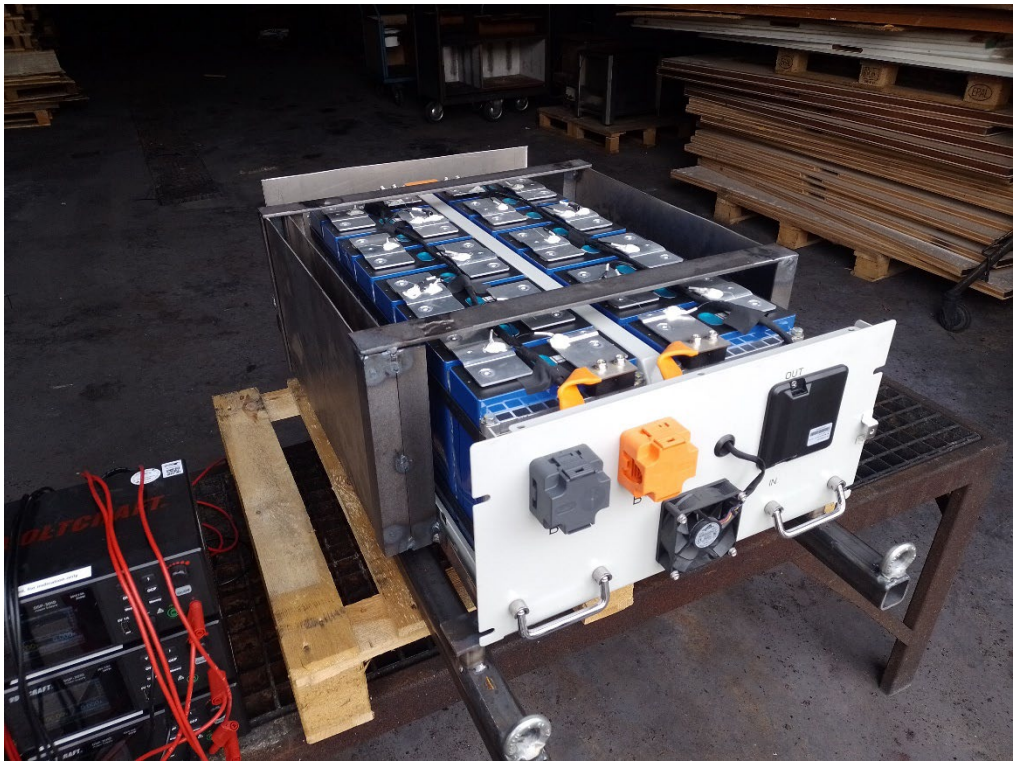


Figure 1 – EUT overview

Figure 2 – EUT front view

Figure 3 – cell overview

1.3 EUT Specifications

Manufacturer:	BSL batteries
Brand:	BSL batteries
Nominal Voltage:	48 Vdc
Capacity:	13,3 kWh / 280 Ah
Cell configuration	1P15S
Size (LxWxH)	Approx. 420x745x226 mm
Weight:	Approx. 100 kg

1.4 Applied standard

The propagation test is performed according to IEC/EN 62619:2022 clause 7.3.3

1.5 Report history

Report revision	Dated	Remarks
2024-541705Q Rev.01	13-08-2024	Initial report

2 Propagation test according to IEC/EN 62619:2022

2.1 Test description

7.3.3 Propagation test (battery system)
a) Requirement
This test evaluates the ability of a battery system to withstand a single cell thermal runaway event so that a thermal runaway event does not result in the battery system fire.

b) Test
The battery system is fully charged and then left until the cells stabilize in an ambient temperature of 25 °C ± 5 °C. One cell in the battery system (hereafter target cell) is e.g. heated by laser until the cell enters into thermal runaway.

After thermal runaway in the cell is initiated, the triggering source is turned off and battery system is observed for 8 h. See Annex B for an example test procedure by laser.

Other methods than the laser to initiate thermal runaway in one cell are allowed. See Annex C.

The battery system may be modified to facilitate the thermal runaway of the target cell. The modification should be minimized and it shall not affect the thermal properties of the battery system.

The method used to initiate a thermal runaway in the target cell shall be described in the test report.

c) Acceptance criteria
No external fire from the battery system, no battery system case rupture. If the battery system has no outer covering, the manufacturer shall specify the area for fire protection.

NOTE Fire or battery system case rupture caused by the target cell is acceptable because the first thermal runaway is intentionally made for the test purpose as a trigger.

2.2 Test method

The trigger cell is overcharged to 3,9 Vdc and is surrounded by fully charged cells (100% SoC). The cells are placed in the battery as in normal use.
A metal pin is placed on top of the trigger cell and the penetration of the steel pin is made by means of an impact on the steel pin.

A set of thermocouples are placed near and around the trigger cell to monitor temperature rises during the thermal runaway event.

When the thermal runaway event starts the top cover is placed back to simulate the module being installed in a rack.

Figure 4 – EUT prepared

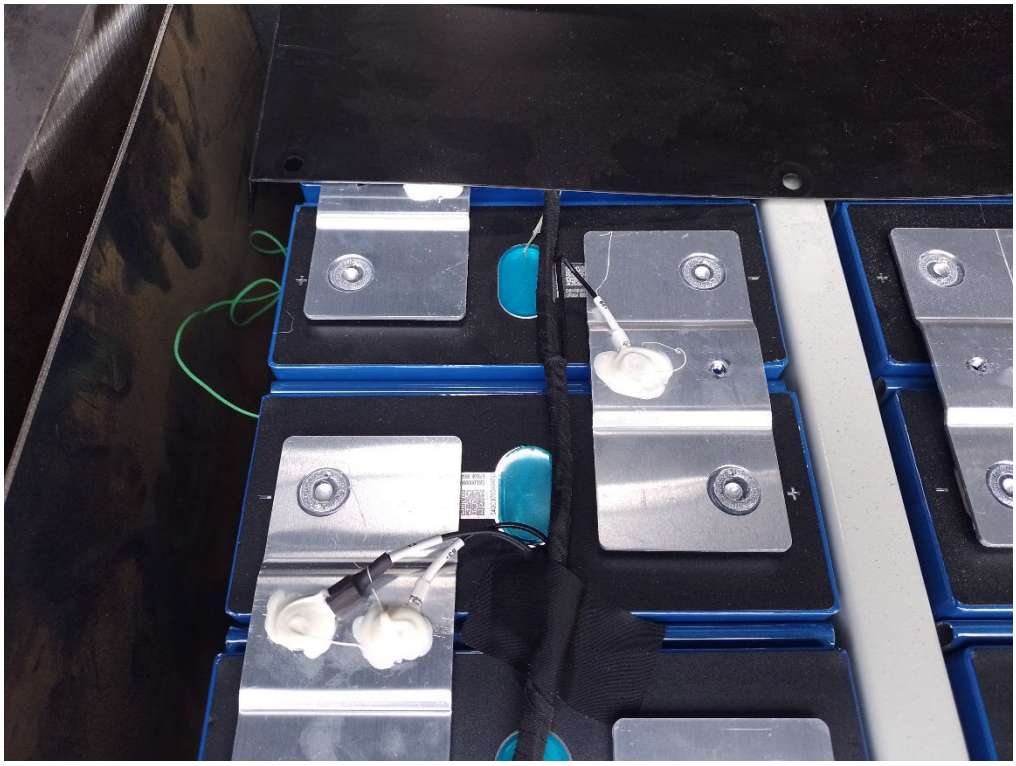


Figure 5 - Sensor location between trigger cell and neighbour cell

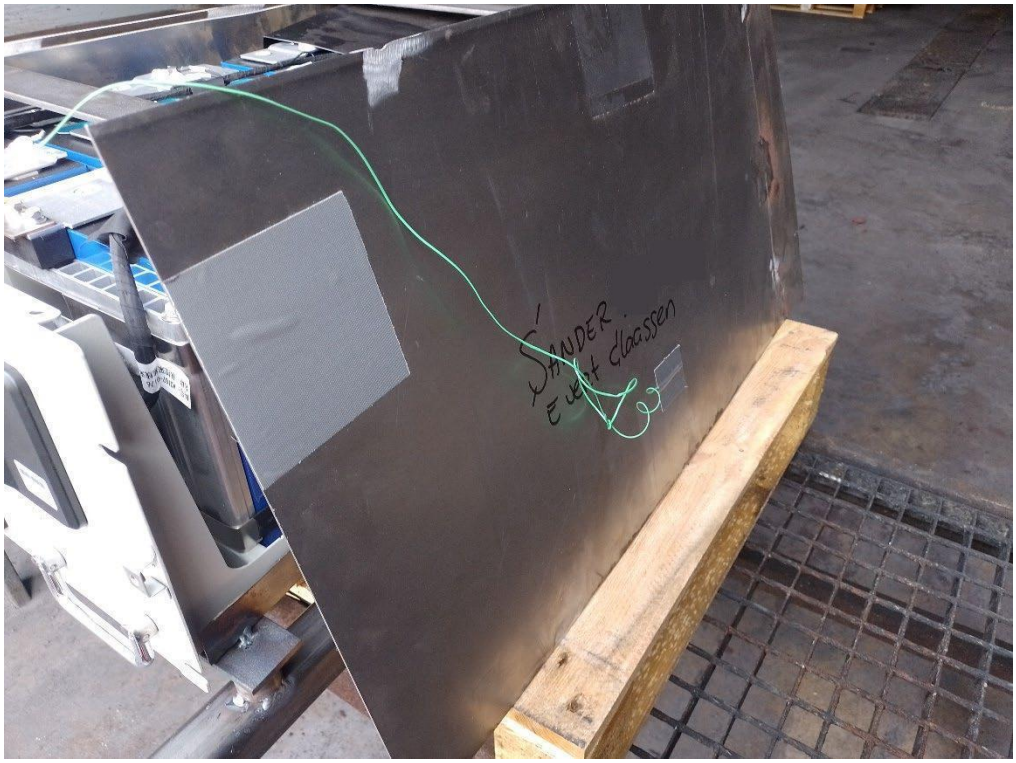


Figure 6 - Top cover with temperature sensor

3 Results

3.1 Nail penetration

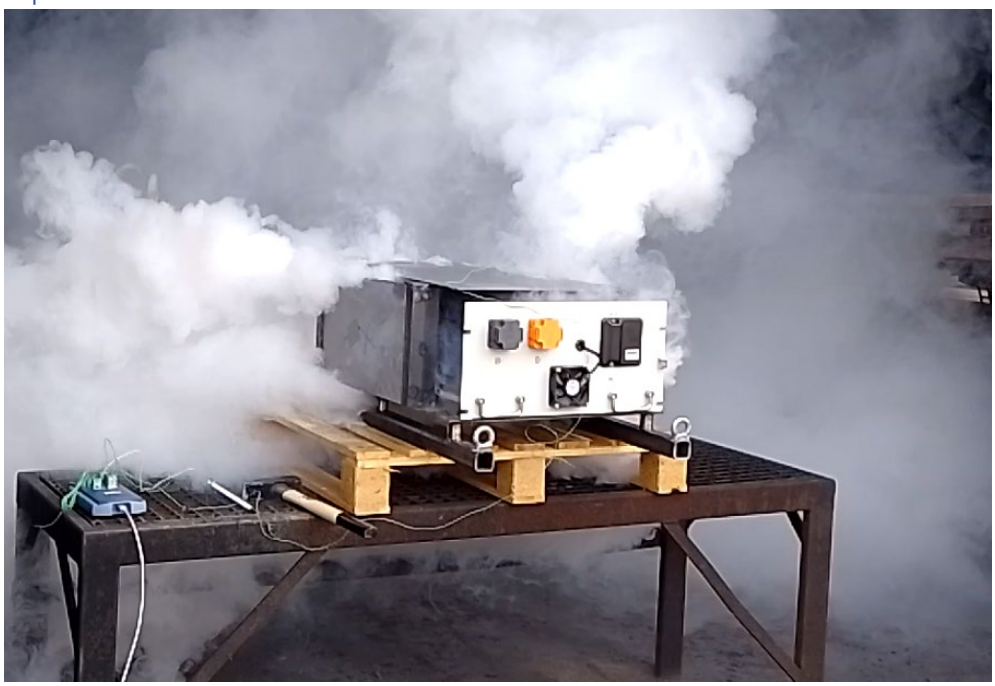
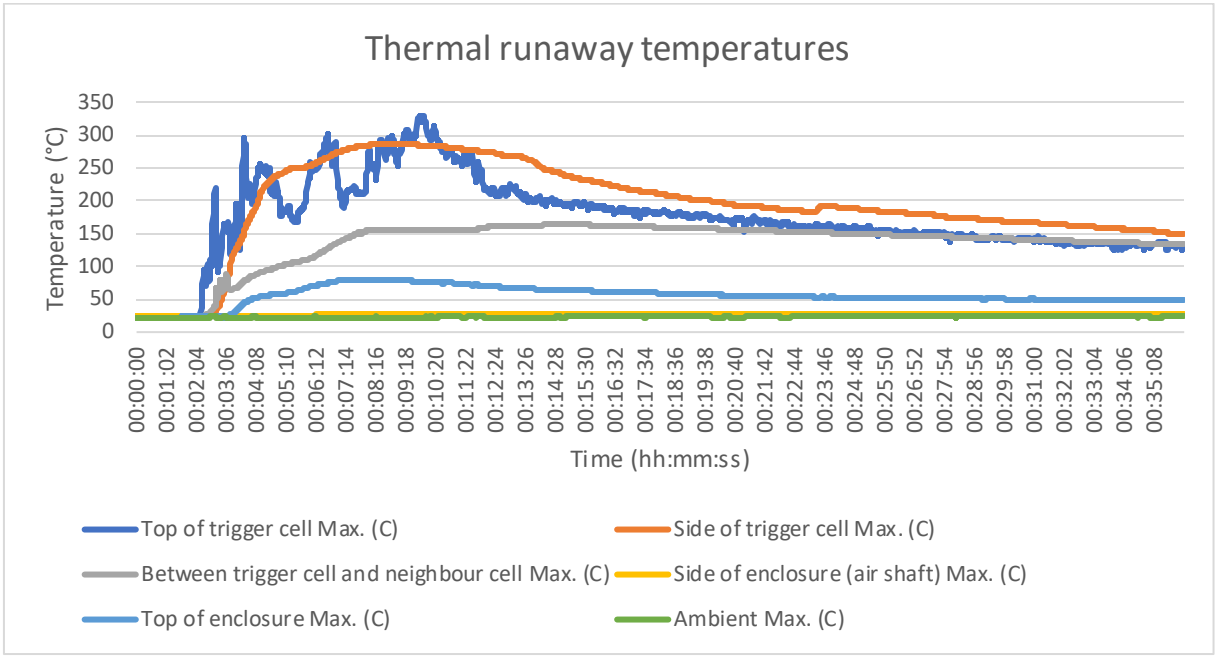


Figure 7 - Thermal runaway of cell



Graph 1 - Temperature development thermal runaway

3.2 Observations

1. The trigger cell went into thermal runaway after nail penetration
2. Large amount of flammable and toxic gases were emitted from the trigger cell
3. The thermoplastic cover above the cells was partially molten but didn't catch fire
4. The wiring loom did not catch fire or was molten
5. No fire was observed
6. No explosion was observed
7. No cell-cell propagation was observed. The surrounding cells were intact.

3.2.1 Measured maximum temperatures

Location	Absolute temperature (°C)	Delta temperature (Δk)
Top of trigger cell	330,1	307,5
Side of trigger cell	286,6	263,9
Between trigger cell and neighbor cell	163,8	141,2
Side of battery enclosure	27,4	4,7
Top of battery enclosure	80,8	58,2

Table 1 - Measured maximum temperatures

Figure 8 - Result after thermal runaway

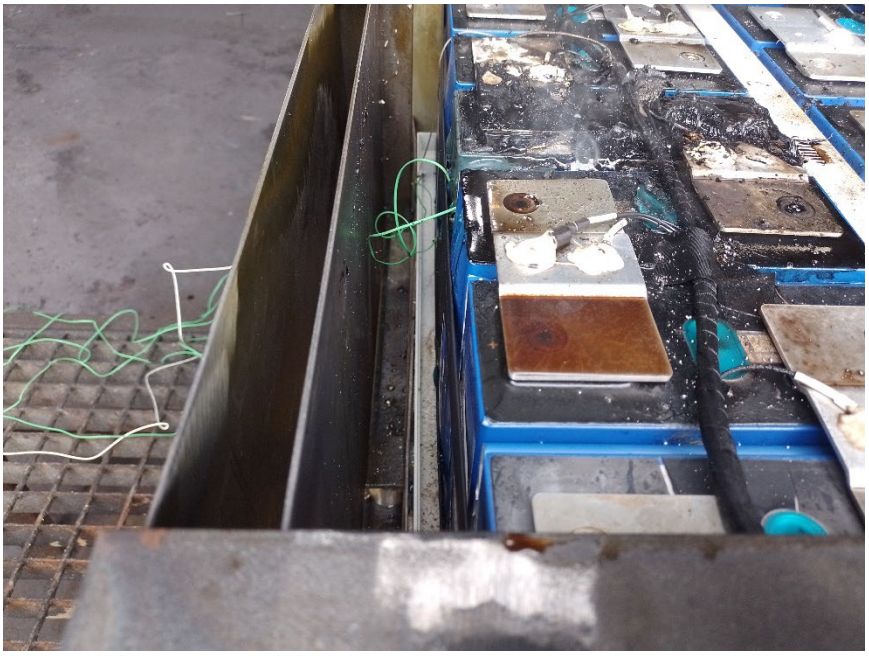


Figure 9 - Result after thermal runaway (bulged cells)

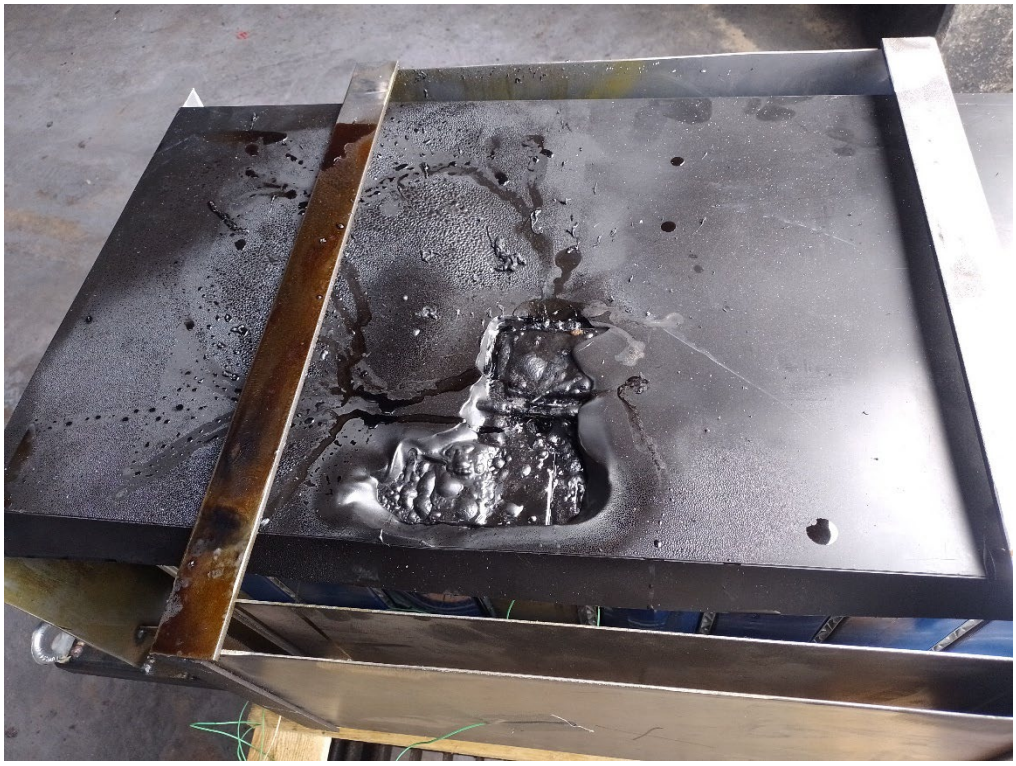


Figure 10 - Plastic cover above cells

4 Conclusion

4.1 General

The conclusion based on the performed tests and their results is that when the trigger cell is put into thermal runaway (by means of nail penetration) it did not lead to fire, explosion or cell-cell propagation.

4.2 IEC/EN 62619:2022 results

The test results are in compliance with the criteria set in IEC 62619:20222 (see clause 2.1 of this report).
No external fire from the battery system, no battery system case rupture. No cell-cell propagation.

4.3 PGS37-1 compliance

M9 of PGS37-1 states that a fire propagation test must be successfully completed according EN 62933-5-2 or UL9540A.

The EN 62933-5-2 standard refers to the EN 62619 standard for performing the fire propagation test:

8.2.5 Fire hazards (propagation)

Category "C-A" electrochemical accumulation subsystems shall be tested and validated in accordance with the requirements of IEC 62619:2017, 7.3.3.

Since the fire propagation test is performed according to EN 62619 standard with a positive result, the requirements from PGS 37-1 M9 are met as the results are showing that any in case of a thermal runaway of a cell there is no fire or explosion.

5 Used test equipment

5.1 Equipment used

Equipment number	Description	Brand	Type	Calibration date	Calibration due date
T-001	Temperature / datalogger	Pico	USB TC-08	22-10-2023	22-10-2024
E-001	Multimeter	Metrahit	M205A	11-04-2024	11-04-2025

5.2 Environmental conditions

Unless otherwise stated, all tests are performed withing the below given ranges:

Temperature	Relative humidity range
15°C – 25°C	30% - 80%

END OF TEST REPORT