

CellBlock®

Fire Containment Systems

Certificate of Test

Project:	CellBlock Case CBSTC10078-TY1 Test	Date:	September 30, 2022
		Document No.:	CAS0023-1
		Project Manager:	Dylan Vandemark
		Date of Testing:	September 27, 2022

Description: Fire containment test of CellBlock Case (Product Number CBSTC10078) with 25.56 kWh EV Battery.

Purpose: To establish a performance baseline for CellBlock containment cases with high energy EV battery assemblies in thermal runaway. Expectation of testing is that the performance is scalable to larger assemblies with higher energy ratings. Outcome to inform best practice storage and transportation of EV batteries and emergency firefighting procedures for the purpose reducing risk and consequence of battery fires.

Test Sample Identification: EV Battery assembly comprised of approximately 144 count 49 Ah/177.5 Wh prismatic cells with LCO chemistry at an aggregate energy of 25.56 kWhWh at 100% SOC. Assembly was placed in CellBlock containment case model CBSTC10078 with a CellBlockEX® suppression system within lid. Cells were bolted together with metal struts with no spacing.

Test Equipment: Watlow cylindrical heaters, Type-K thermocouples

Procedure: Battery assembly was placed inside the case oriented upright and centered. Six-cell ignition of thermal runaway was achieved using Watlow cylindrical heaters inserted in the assembly in three locations immediately adjacent to cell walls. Port was installed for wire-pass through and sealed with intumescent sealant. Heat was applied to the cell at a rate of 0.5°C/sec until cell ignition was achieved. Temperature was monitored and collected using type k thermocouples and TC-08 DAQ in 1 second intervals in 8 locations until all readings were below 200°C after ignition. Photos and video were captured of the test sample pre, intra, and post-event.

Acceptance Criteria: Test will be pass/fail on qualitative containment ability relative to fire and ejecta from the thermal runaway and exterior of the case not exceeding a differential temperature (initial and final) of 100° celcius, in conformance of ADR packaging standard P911.

The results and any data provided by CellBlock in any format ("Data") apply only to the sample(s) tested and shall not be considered indicative of the qualities of apparently identical or similar samples. This certificate does not indicate successful or unsuccessful completion of a test or qualification program. CellBlock disclaims all warranties, express or implied, and liability for the performance of the tested sample(s) and use of any Data.

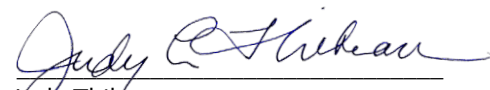
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Results: The ignition cell was heated until rapid disassembly (thermal event). The ignition cells discharged at approximately 1400 seconds; smoke and audible venting observed. Cells continued to discharge for approximately 16 minutes. Visible smoke and evolved pressure continued to exit the container throughout that duration. No flames or projectiles were found to have exited the containment device. The test sample was left to cool before opening for forensic inspection. Upon inspection the battery was found to be fully consumed. In accordance with established acceptance criteria the test was positive in that:

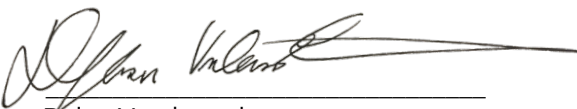
- No flames or projectiles exited the case
- The suppression system deployed immediately upon thermal runaway.
- The adjusted exterior temperatures did not increase more than 44.24° Celcius.
- The external box temperature stayed well below 100°C, in line with P911 requirements.
- The structural integrity of the case remained uncompromised and subsequently reusable.

Prepared by:



Judy Thibeau
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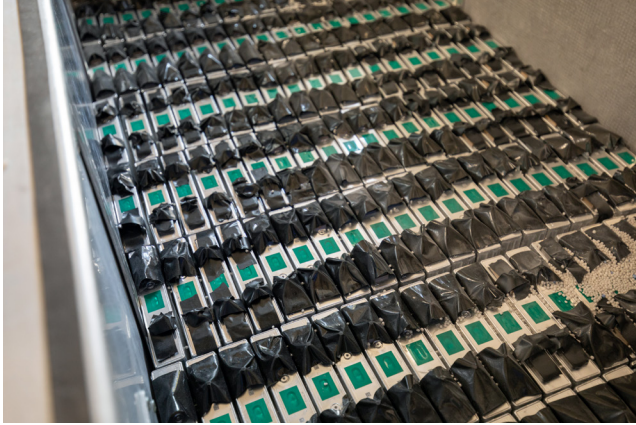


Dylan Vandemark
VP of Product Development

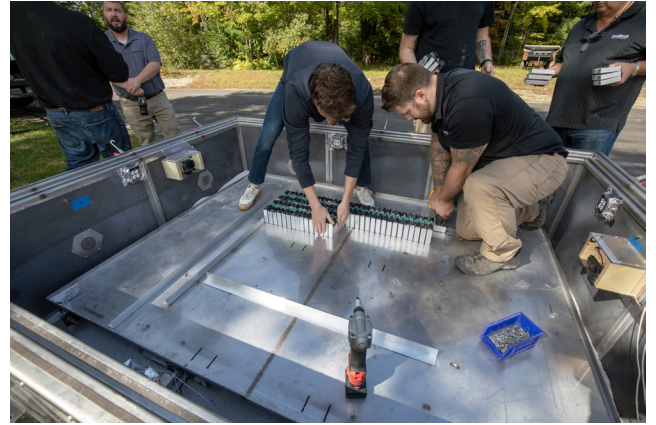
List of Attachments:

- Attachment 1: Test Photos
- Attachment 2: Thermocouple Data

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Pre-test - batteries assembly



Test sample pre-test - batteries assembly installation



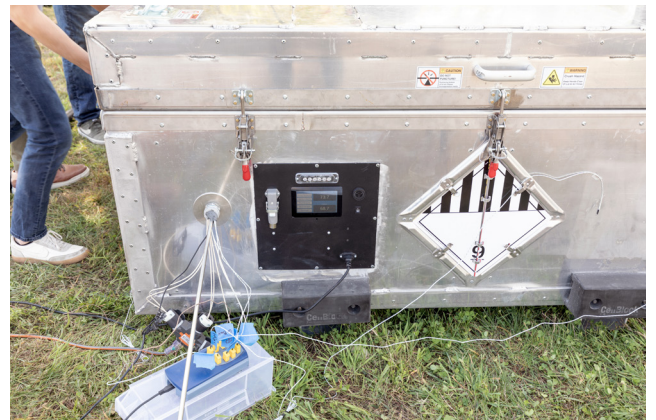
Test sample pre-test - batteries assembly installation



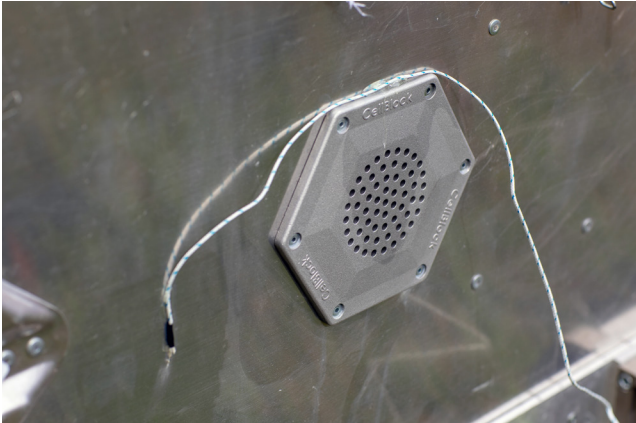
Test sample pre-test, showing placement of cylindrical heater



Test sample pre-test, showing placement of second cylindrical heater



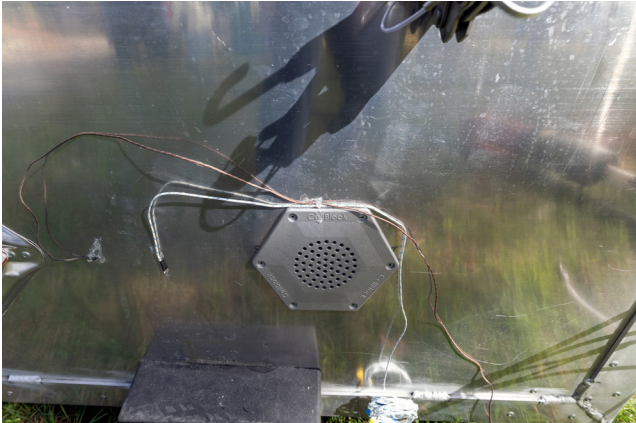
Test sample pre-test.



Case side pre-test. Thermocouples attached.



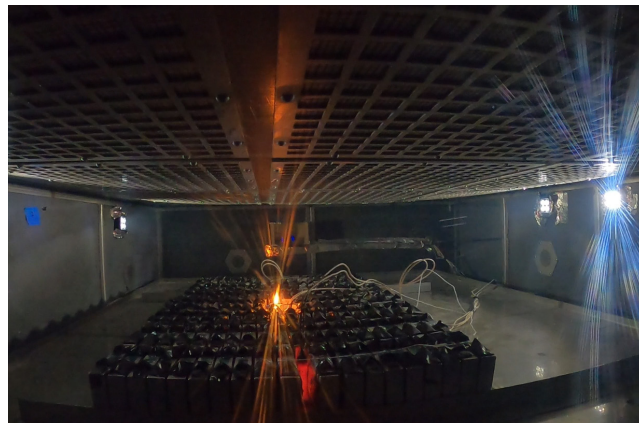
Case top pre-test. Thermocouples attached.



Case side pre-test. Thermocouples attached.



Test - ignition cells heating



Test - ignition cell spark



Test - ignition



Test - explosion



Test - CellBlockEX deployment



Test - CellBlockEX continues to deploy



Post test - interior



Post test - interior



Post test - cells



Post test - cells



Post test - cells



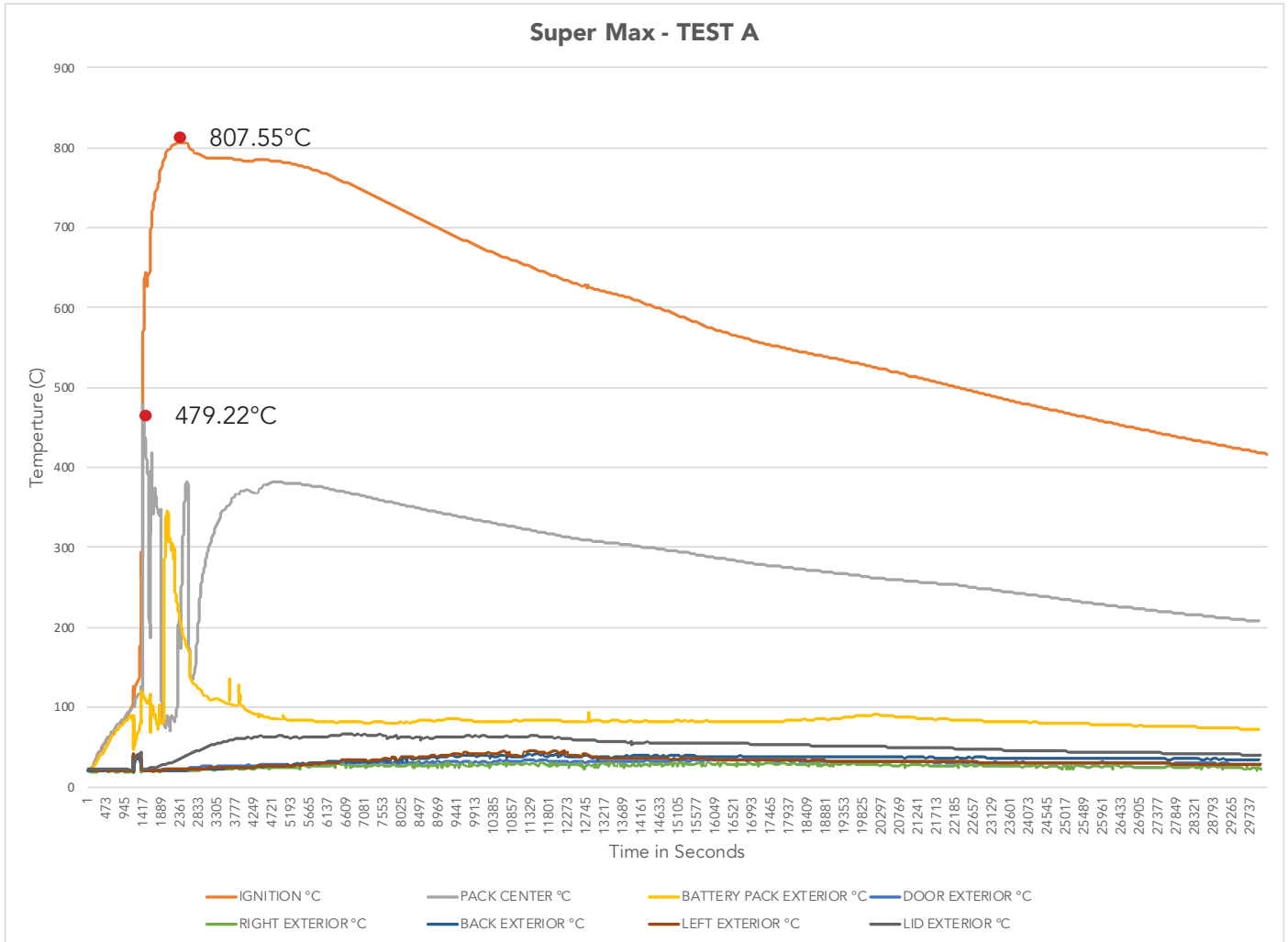
Post test - cells



Post test - fused metal debris



Post test - fused metal debris



Thermocouple data

Interior:

Maximum internal temperature reached 807.55°C at ignition cell.

Maximum internal temperature reached 479.22°C at pack center.

Maximum internal temperature reached 346.28°C at battery pack exterior.

Exterior:

Maximum exterior door temperature reached 38.32°C.

Maximum right exterior temperature reached 41.07°C.

Maximum exterior back temperature reached 42.80°C.

Maximum left exterior temperature reached 46.32°C.

Maximum lid exterior temperature reached 67.22°C.