CellBlock®
Fire Containment Systems

Certificate of Test

Project:	MBR0221 Test of Modular Battery Rack	**Date:**	January 25, 2022
		Document No.:	MBR0221
		Project Manager:	Dylan Vandemark
		Date of Testing:	January 24, 2022

Description: Fire containment and suppression test of CellBlock FCS Safe Charge Battery Rack (Product Number CBSCBR7040) on a 1064 watt-hour battery fire.

Purpose: To demonstrate the capacity of the CellBlock FCS Small Safe Charge Battery Rack to contain and suppress high energy lithium battery fires i.e. prevent progation and consuption of batteries in proximity, and contain explosive ejecta and flames. Outcome to inform best practice storage and charging protocols for e-mobility batteries in compliance with IFC 2024.

Test Sample Identification: Test assembly is a e-mobility battery comprised of 110 count 18650 cylindrical cells with an aggregate energy of 1064 Wh at 100% SOC.

Test Equipment: 90 watt heater tape, Type-K thermocouples, CellBlock FCS Safe Charge Battery Rack.

Procedure: Type-K thermocouple and heater tape were attached to the battery assembly on an outside cell and the battery housing was resealed. The battery assembly was placed in a cubicle of the battery rack. Type-K thermocouples were attached to an adjacent battery in an immediately adjacent cubicle, and to the immediate battery above. Heat was applied to the ignition cell at a rate of 0.2°C/second until cell ignition was acheived. Once discharge of the ignition cell was acheived, the ignition source was removed. Temperature was monitored and collected using type K thermocouples and TC-08 DAQ in one second intervals in eight 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 and suppression ability relative to minimizing the risks from thermal runaway and reducing propagation to adjacent batteries.

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Results: The test sample battery was heated until rapid disassembly (thermal event). First cell discharged at approximately 417 seconds; smoke and audible venting were observed. CellBlockEX deployed from shelf at approximately 417 seconds. Visible smoke and evolved pressure continued to exit the rack from underneath the cover throughout that duration. No projectiles were found to have exited the cover, however brief flashovers from flamable gas were observed. The test sample was left to cool before opening for forensic inspection. Upon inspection, it was found that the entire test sample battery was consumed. Propagation and damage was prevented to batteries in proximity. In accordance with established acceptance criteria the test was positive in that:

- No projectiles exited the cover
- Propagation was prevented to all adjacent batteries
- The maximum temperature of adjacent batteries was found to be 82.86°C.
- The maximum temperature of the containment cover was found to be 19.35°C.
- The structural integrity of the rack and cover remained uncompromised and subsequently reusable
- After introduction of CellBlockEX to the fire and in conjunction with the integral safety features, the thermal event was subdued and approachable from a fire fighting procedure standpoint

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VP of Product Development

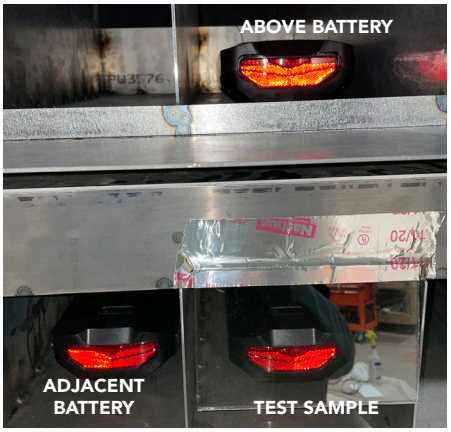
List of Attachments:

Attachment 1: Test Photos
Attachment 2: Thermocouple Data

Pre test - test sample, thermocouples attached.

Pre test - test sample assembly with 90 watt heater tape attached.

Pre test - test sample installation



Pre test - test sample configuration

Pre test - cover installation

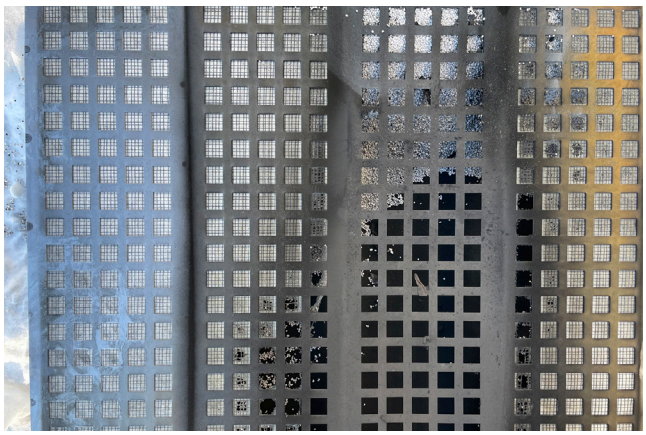
Post test - test sample cubicle and immediately adjacent battery

Post test - fully consumed test sample

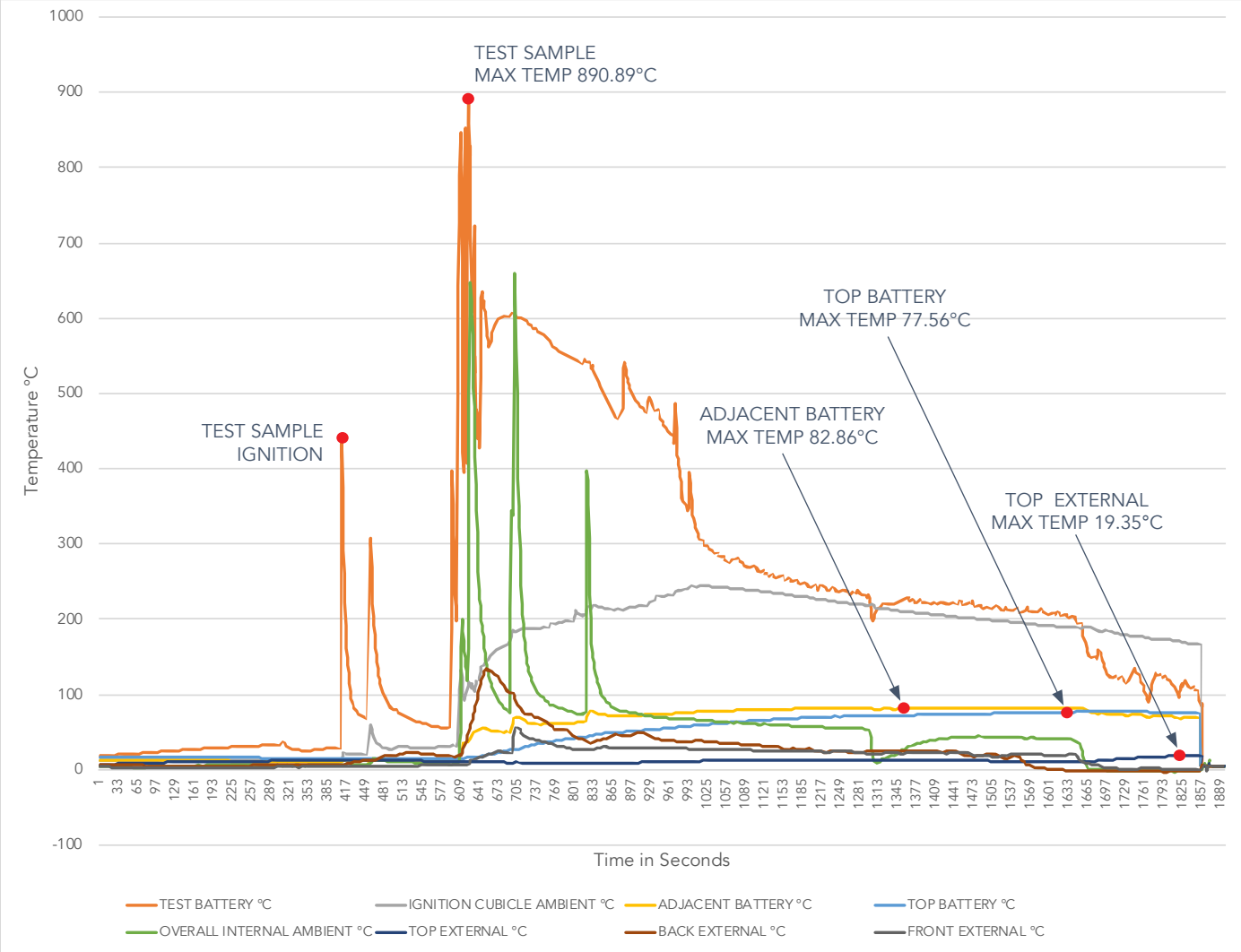
Post test - removal of immediately adjacent battery

Post test - Immediately adjacent battery and above battery

Post test - Immediately adjacent battery and above battery



Post test - bottom of shelf/deployment system



Thermocouple data

TEST SAMPLE MAX TEMP - 890.89°C
ADJACENT BATTERY MAX TEMP - 82.86°C
TOP BATTERY MAX TEMP - 77.56°C
TOP EXTERNAL MAX TEMP - 19.35°C