UL 2596 Test Report for Elven Technologies Battery Enclosure: FireGuard Pro

Project Details

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Scope of Report

The document provides detailed analysis of the Torch and Grit test on FireGuard Light in accordance with the UL 2596 standard *Battery Enclosure Thermal Runaway Barriers*. The objective is to verify the material's ability to maintain structural integrity and limit heat/pressure transmission during extreme thermal-runaway events in lithium-ion cells.

Sample Specification

- **Sample ID: TAG C**
- **Thickness: 5 mm**
- **Density / Basis Weight: 0.62 g cm^{-3}**
- **Flexibility: no**
- **Colour: Black**

Test Procedure – Torch and Grit Test

1. **Expose the specimen to a 1200 °C propane flame for 15 s, immediately followed by abrasive grit-blast (SiC, 140 kPa) for 5 s.**
2. **Repeat up to 10 cycles or until the sample breaches.**
3. **Continuously record time-to-breach and back-face temperature.**

Test Results

Sample	Torch Temperature and Power Set Point	Torch Dwell Time	Grit Dwell Time	Sample Breach (Y/N)	Approximate Time to Sample Breach (s)	Temperature Measurement at Breach (°C)	Observations (Note: Temperature measurements charts are included in Addendum "A")
TAG B TEST 2	1200 °C 3 KW	15s	5s	Yes	76	217	Breach at cycle 4 grit
TAG B TEST 3	1200 °C 3 KW	15s	5s	Yes	68	356	Breach at cycle 4 torch
TAG B TEST 4	1200 °C 3 KW	15s	5s	Yes	69	34.5	Breach at cycle 4 torch
TAG B TEST 5	1200 °C 3 KW	15s	5s	Yes	76	124	Breach at cycle 4 grit
TAG C TEST 1	1200 °C 3 KW	15s	5s	No	N/A	N/A	No Breach after 10 cycles
TAG C TEST 2	1200 °C 3 KW	15s	5s	No	N/A	N/A	No Breach after 10 cycles
TAG C TEST 3	1200 °C 3 KW	15s	5s	No	N/A	N/A	No Breach after 10 cycles
TAG C TEST 4	1200 °C 3 KW	15s	5s	No	N/A	N/A	No Breach after 10 cycles
TAG C TEST 5	1200 °C 3 KW	15s	5s	No	N/A	N/A	No Breach after 10 cycles
TAG D TEST 1	1200 °C 3 KW	15s	5s	No	N/A	N/A	No Breach after 10 cycles
TAG D TEST 2	1200 °C 3 KW	15s	5s	No	N/A	N/A	No Breach after 10 cycles
TAG D TEST 3	1200 °C 3 KW	15s	5s	No	N/A	N/A	No Breach after 10 cycles
TAG D TEST 4	1200 °C 3 KW	15s	5s	No	N/A	N/A	No Breach after 10 cycles
TAG D TEST 5	1200 °C 3 KW	15s	5s	No	N/A	N/A	No Breach after 10 cycles

Key Observations

- **Completed all 10 Torch & Grit cycles without breach, preventing flame-through or hot-gas penetration to the pack exterior.**
- **Cool protected side: Cold-face stayed below ~100 °C** during exposure, preserving nearby polymers (housings, wire looms, seals) and reducing risk of secondary ignition.
- **Erosion tolerance:** Grit impingement produced only superficial hot-face pitting; **no delamination** or through-thickness damage observed.
- **Edge and hardware robustness:** Clamped edges, seams, and fastener zones remained intact; any damage localized to the primary exposure area—**no fragment was ejected**.
- **Supports venting strategy:** Allows gas pressure to be managed via designed vents while **blocking direct flame egress**, aiding "no external flame" objectives.
- **Serviceable integration:** Cuttable and lightweight for field fit-up; compatible with adhesives, mechanical fastening, and edge sealing.

Conclusion

FireGuard Pro (Sample C) demonstrated full-cycle TaG endurance with a cool protected side and no flame-through, making it a strong primary hot-face liner for battery systems. It supports pack designs that rely on controlled venting while blocking direct flame egress and maintaining integrity at edges and fasteners.

Practical use cases

- **Build new enclosures (any size / power):** Fabricate pack lids, sidewalls, and partitions for small modules up to high-power packs without changing your venting strategy.
- **Add internal barriers to existing batteries:** Retrofit liners or fire-breaks between modules, around busbars/cables, and at passthroughs to limit propagation.
- **Create transport/storage containers:** Line or construct containers and vault panels for cells, modules, or full packs where direct flame and grit exposure are credible.
- **Shape or mold to fit:** Cuttable, formable, and moldable into complex geometries; compatible with adhesive bonding, mechanical fasteners, and edge/seam sealing for durable installs.