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 E**
- **Thickness: 5 mm**
- **Density / Basis Weight: 0.31 g cm^{-3}**
- **Flexibility: yes**
- **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 Sample E TEST 1	1200 °C 3 KW	15s	5s	Yes	96	137	Breach at cycle 5 grit
TAG Sample E TEST 2	1200 °C 3 KW	15s	5s	Yes	115	192	Breach at cycle 6 grit
TAG Sample E TEST 3	1200 °C 3 KW	15s	5s	Yes	116	225	Breach at cycle 6 grit
TAG Sample E TEST 4	1200 °C 3 KW	15s	5s	Yes	158	337	Breach at cycle 8 grit, Front side material self ignition observed before breach
TAG Sample E TEST 5	1200 °C 3 KW	15s	5s	Yes	156	318	Breach at cycle 8 grit

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Key Observations

- **Exposure & outcome:** Under a 1200 °C torch (15 s flame + 5 s grit per cycle), five replicates **breached during the grit phase** between **cycle 5 and cycle 8** (≈ 96–158 s total exposure).
- **Back-face temperatures at breach: ~137–337 °C**, indicating solid short-duration thermal shielding prior to through-penetration.
- **Thermal profile before breach:** Protected side stayed markedly cooler than the hot face; no sustained flaming observed on the protected side.
- **Failure mode: Localized pinhole** in the primary exposure zone; **no fragment ejection** and laminate remained largely bonded (no broad delamination).
- **Aggregate planning numbers:** Mean **time-to-breach ≈ 128 s** (median ≈ 116 s); mean **T_back-face ≈ 242 °C** at breach.

Conclusion

The reinforced version provides useful short-duration flame insulation with controlled, non-violent failure characteristics under TaG conditions, but it does not achieve full 10/10-cycle endurance in this configuration. For requirements targeting extended exposure or zero-breach performance, specify a tougher hot-face wear layer, edge/seam reinforcements, or

layered stacking to boost erosion resistance and time-to-breach while preserving the material's thermal protection.

Temperature Profiles