

BATTERY TESTING & ANALYSIS SERVICES

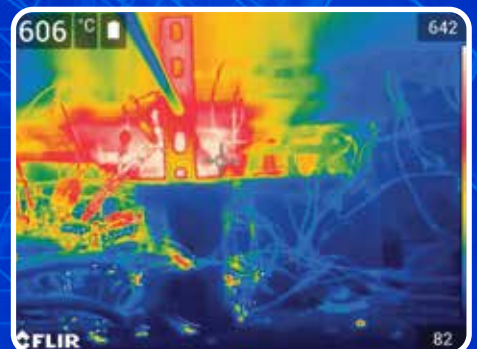
Stress Engineering Services, Inc. offers customized and standards-based battery safety and performance testing for clients in applications and industries including Aerospace, Automotive, Grid Storage, Transportation/Aviation, Oil and Gas, Maritime, Medical and Consumer Products.

Our experts dig deep into complex electrochemical and thermal systems to provide answers to critical questions, such as:

- What steps can be taken to improve the safety of lithium-ion batteries during operation and transportation?
- Which factors have the greatest influence on the probability and severity of a thermal runaway event?
- How can thermal runaway propagation be mitigated using safety-focused module design?

Thermal runaway propagation testing, containment testing, standards development testing, cycle life and performance testing and fire exposure resistance testing are all performed at our state-of-the-art testing facility in Waller, Texas. This expansive facility houses a wide array of equipment used to characterize the cells electrically, along with various chambers for environmental control, abuse testing, external fire testing, and gas analysis and allows for high energy cell-, module-, and unit-level testing in the same location.

In addition to testing to various industry standards, we are engaged in several unique battery safety testing programs developed in collaboration with our clients and industry partners. Our in-house experts in measurement/control and mechanical design add value by providing custom test fixturing and equipment for battery tests. We utilize secure infrastructure to handle CUI and ITAR information for sensitive battery applications and we are ISO 9001:2015 compliant for testing and analysis and ISO 9001 accredited for medical product design.

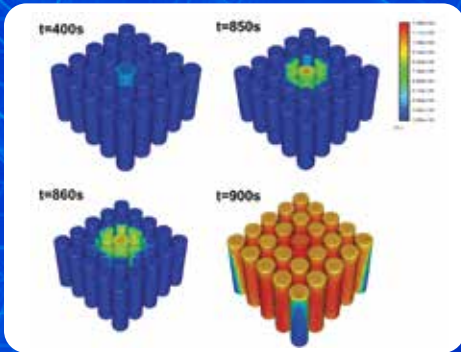


Custom R&D Testing

Standards and Certification

Thermal Runaway Propagation

Performance Validation



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HOUSTON | CINCINNATI
WALLER | CALGARY

Battery Testing Capabilities

- Thermal runaway propagation and containment testing
- Heat-to-vent/heat-to-thermal runaway
- Overcharge, overdischarge, external/internal short circuit
- Nail penetration, crush, drop, shock and vibration
- Combined electrical, thermal, mechanical loading for abuse and performance
- Performance assessment and aging (cycle and calendar) testing

Battery Analysis and Design

- Destructive Physical Analysis (DPA)
- Failure Analysis using CT and SEM
- Coupled thermal runaway propagation modeling using computational fluid dynamics (CFD)
- Finite element analysis (FEA) of battery components

Battery Safety Research and Development

- Battery packaging characterization and safety assessment under off-nominal conditions
- Multicell thermal runaway propagation studies
- Cell-level assessment of thermal behavior at various state-of-charge
- Research studies of energy storage systems hazards

Data Acquisition and Sensing

- Standard and custom data acquisition including:
 - Thermal: thermocouples, thermistors, heat flux
 - Electrical: OCV/CCV, high current, IR/impedance
 - Mechanical: load/pressure transducers, strain gages
 - Video: multi-view video, infrared thermography, digital image correlation, high-speed videography
- High-rate data collection (10+ kHz) of dozens of channels
- Vent gas collection and composition analysis via GC
- Real-time quantitative gas analysis via solid-state sensors

Standards and Certification Testing

- UL 1642, UL 2054, UL 2580, UL 9540A
- UN/DOT 38.3, UNECE R100, SAE J2464, SAE AS6413 (G-27)
- RTCA DO-227a, DO-311a, MIL-STD-810G
- Development of upcoming standards