



SOUTHWEST RESEARCH INSTITUTE

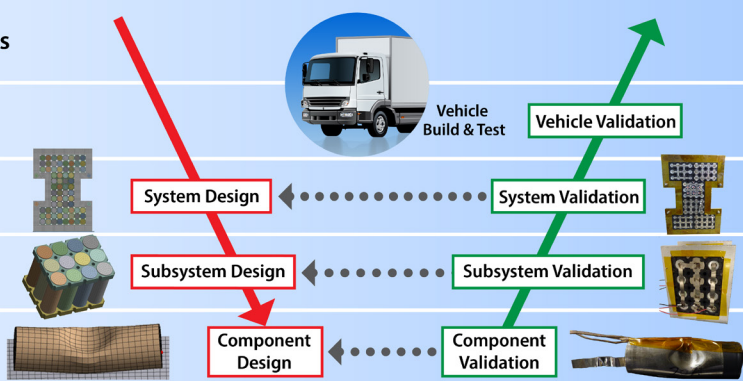
Requirements

Vehicle

System

Subsystem

Component



Battery Systems Design, Analysis & Integration

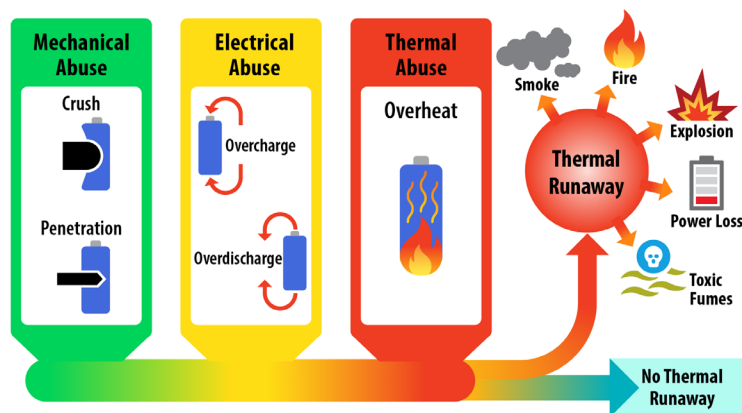
The Powertrain Engineering Systems Department at Southwest Research Institute® (SwRI®) encompasses a multidisciplinary team of engineers and researchers with full capabilities in automotive design, analysis, and integration. The team supports industry and government in developing battery solutions at module, pack, and vehicle levels.

Battery design and analysis is supported by real-world testing conducted by SwRI's Energy Storage Technology Center (ESTC) to validate the effects of normal and extreme conditions such as thermal responses from charge/discharge, thermal runaway propagation, and mechanical penetration or crush failure.

Battery Systems Engineering

SwRI helps customers carry out electrification programs from cell to vehicle:

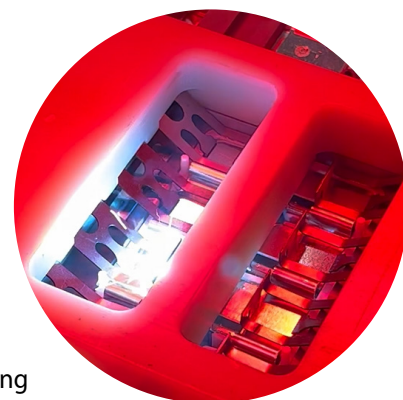
- Cell-to-vehicle requirements tracking
 - Customer strategic vision & requirements
 - Battery system requirements
 - Concept studies of parallel/series arrangement
 - Hazard, safety & regulatory requirements
 - DFMEA
- Characterization of cell performance
- Fault handling & control system actions

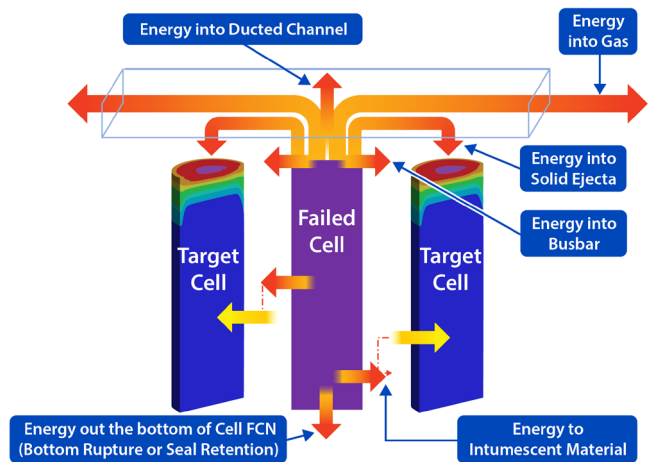
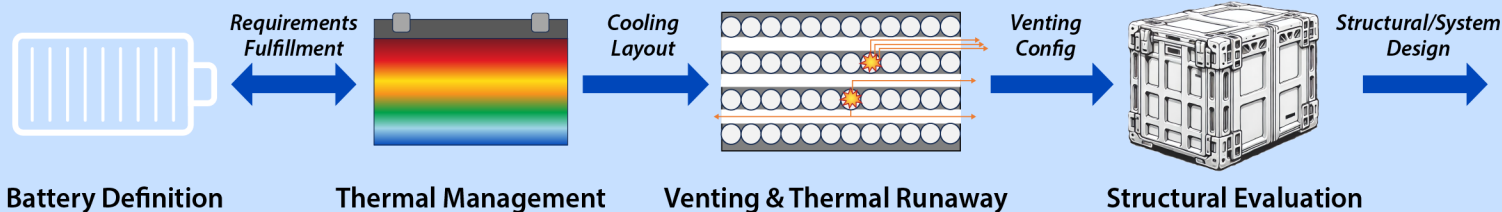


Battery Systems Design

Battery design capabilities are custom-tailored to the client's needs:

- Targeted cooling solutions for thermal management
 - Bottom plate, side plate & intra-cell ribbon cooling
 - Immersion cooling (SwRI development)
- Design and implementation of structural materials
 - Module & pack structure
 - Balanced use of thermally insulative & conductive spacer materials for thermal management & mitigation of thermal runaway
 - Phase change materials
 - Fire-resistant vs. intumescent materials
- High-voltage safety
 - Design for high-voltage creepage & clearance
 - Hazard analysis
 - Arc flash
- Vent gas solutions
 - Channel routing
 - Overpressure redundancies
 - Burst disc release
 - Active or passive gas evacuation
- Fabrication processes
 - Busbar fixturing & welding
 - Laser weld development
 - Stack up, tolerancing & clearances
- Off-the-shelf & custom solutions

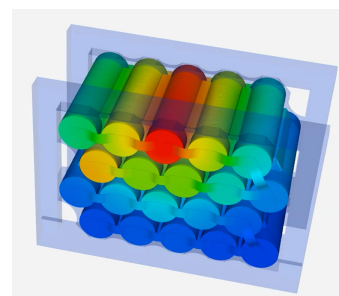
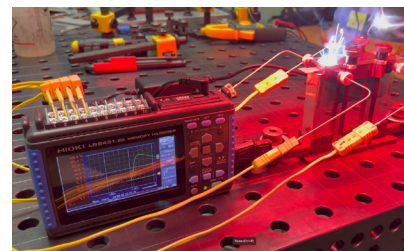




Battery Simulation & Analysis

Battery simulation and analysis capabilities include:

- Mechanical abuse modeling
 - Nail penetration & ballistics
 - Crush
- Thermal abuse modeling
 - Cell overheating & venting
 - Runaway initiated from mechanical abuse
- Cell thermal characterization
 - Heat generation & temperature gradient
 - ECM, 1-D & 3-D modeling
- Vent gas & solid particle release modeling
- 1-D & 3-D battery cooling simulation
 - Pressure losses & pump specification
- Structural assembly evaluation
 - Shock/drop/impact & vibration
 - Testing standards applied to simulation
- Multiple configurations
 - Cell-level, module, pack & vehicle



Battery Systems Integration

SwRI's team of engineers and technicians is highly experienced at integrating innovative solutions into customer installations:

- Final vehicle integration & installation
 - Military
 - On-highway
 - Industrial/construction
- Complete packaging
 - Batteries
 - Pack structure
 - Cooling
 - Vent gas solutions
 - Wiring & electronics
 - Control systems

For more information,
please contact:

Chris Hennessy

Executive Director, R&D
210.522.3079
chris.hennessy@swri.org

Adherence
to standards:
UN 38.3
ISO 26262
and more

Powertrain Systems Engineering

battery.swri.org

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Southwest Research Institute® is a premier independent, nonprofit research and development organization. With ten technical divisions, we offer multidisciplinary services leveraging advanced science and applied technologies. Since 1947, we have provided solutions for some of the world's most challenging scientific and engineering problems.

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210.522.2122

ask@swri.org



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