US Proposal
Thermal Propagation

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Thermal Safety

• REESS Thermal Safety – Areas of Concern

  – Fire Exposure -External
    • Canadian test results indicate risk is similar to ICE system risk
    • Addressed by Task Force 5 efforts

  – Thermal Propagation (Field Examples)
    • Internal cell short circuit (Dreamliner)
    • External short circuits (BAE Bus Systems)
    • Abuse Conditions (Tesla road debris incidents)
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Dreamliner Lessons

• Nail Penetration (qualification test) used to assess internal short circuits during development.
  – This was inadequate.
• The actual failure exceeded the capabilities of the containment system
  – Plane filled with gases and smoke.
  – The single cell failure propagated to other cells.
• The corrective actions included more robust test methods, increased separation of cells, and improved containment and venting.
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BAE Hybrid Bus

– Failure Overview
  • Debris and moisture intrusion caused shorts between chassis and high voltage bus
  • Multipoint loss of isolation resulted in an external short circuit which produced thermal events.
  • Fuses inadequate to prevent thermal activity.

– Corrective actions
  – Install isolation detection system tied to a contactor interrupting the main conductive path
  – Improve isolation methods
  – Better protection for debris and moisture intrusion.
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Tesla Model S Field Incidents

– Incident Overview
  • Metallic object run over and locally crushed multiple cells in the REESS.
  • System recognized event and warned driver to take protective measures.
  • Effluents and fire limited to intended exit paths.
  • Fire not present in occupant compartment.
  • Compartmentalization of modules prevented propagation beyond adjacent modules.

– Corrective actions
  – Install better battery protection
  – Raise vehicle ride height
Objective and Purpose

The purpose of this procedure is to assess the vehicle level safety performance from a REESS originated thermal event. The procedure will initiate a credible thermal event inside of the battery enclosure and evaluate the performance at the vehicle level.
Risk Areas and Safety Need

A thermal event inside of a REESS may occur as a result of several types of events including:

- internal cell short circuit
- external short circuits
- abuse conditions.

The thermal event can result in expulsion of effluents and toxic gases along with heat and fire which can potentially harm the vehicle occupants.
Proposed Test Procedure – Development Guidelines

– Performed at the vehicle level
  • The impact to the occupant space is the main safety concern
    – Heat
    – Toxic/explosive gases
    – Occupant egress - Time and Path conditions
  • Vehicle level risks to surroundings maintained at appropriate level (rapid energy releases)
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Proposed Test Procedure – Development Guidelines

– Methodology
  • Develop procedures to initiate a credible thermal event inside of the REESS battery to promote propagation
    – Current procedures for Single Cell Thermal Runaway (SCTRI) have been developed. Still need refining.
    – Additional research underway to refine the procedures in the area of the thermal initiation

– Currently used cell-level initiation methods appear to be unreliable or inappropriate for use in the vehicle level performance test procedures

– Boundary Conditions
  • Heat rate and total heat input to a single cell or a group of cells needs to be appropriate for the cell type/size being tested.
Proposed Test Procedure – Development Guidelines

– Pass Fail Criteria

• Still under Development – Needed requirements
  – Cabin exposure levels need to be established
    » Heat
    » Toxic and explosive gases
  – Egress time requirements
  – Safe egress path requirements
  – Risk to surroundings from rapid energy release
Proposed Test Procedure – Research Timetable

– Basic procedure developed and provided to the EV Safety Working Group
  • Initiation methodology not complete
– Initiation Research Underway
  • Will be discussed in the NHTSA research presentation
  • Refine Pass/Fail criteria
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