National Highway Traffic Safety Administration

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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

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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.

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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.

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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.

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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

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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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