

SAE G-27 LITHIUM BATTERY PACKAGING OVERVIEW

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October 4th, 2016

World Rechargeable Battery Regulatory Forum

Seoul, Republic of Korea



What is SAE G-27 Lithium Battery Packaging Group?

The committee was established at the request of ICAO

- Develop Aerospace Standards (AS) for a minimum performance standard to safely ship lithium batteries as cargo on aircraft
- G-27 Committee Structure - Balanced:
 - Government / Regulatory Authorities
 - Airline industry
 - Battery industry
 - Packaging and testing industry
 - Consultants/academia
 - Industry Associations

ORIGINAL GOAL: Complete and Publish Standard in 2016

- **Aggressive** timing for SAE (or any consensus based standards organization)
- Core Writing Team established to expedite framework and text

SAE G-27 Committee Overview

~190 Experts at Committee Level

- Large interest across industry in this standard
- Global participation
- Challenge for scheduling meetings and having open discussions
 - Heavy reliance on electronic feedback/comments
 - WebEx Meetings hosted for overviews
 - Minimal dialogue
 - Face to Face meetings attempted, coordinated with other industry events
 - Low participation rate

20 Writing Team Members

- Core cross-industry team to focus on quickly developing standard quickly
 - Boeing, Airbus, Cathay Pacific, Lufthansa, FedEx, GM, Daimler, Saft, Energizer, Viking Packaging, UL, RECHARGE, BAJ, IFALPA, FAA, ICAO, EASA, CAAS
- 1 Week in Montreal Creating Original Draft (March)
- 1 Week in Atlantic City revising original draft and committee feedback (June)
- Probably one more week this fall...

G27 SAE Alignment



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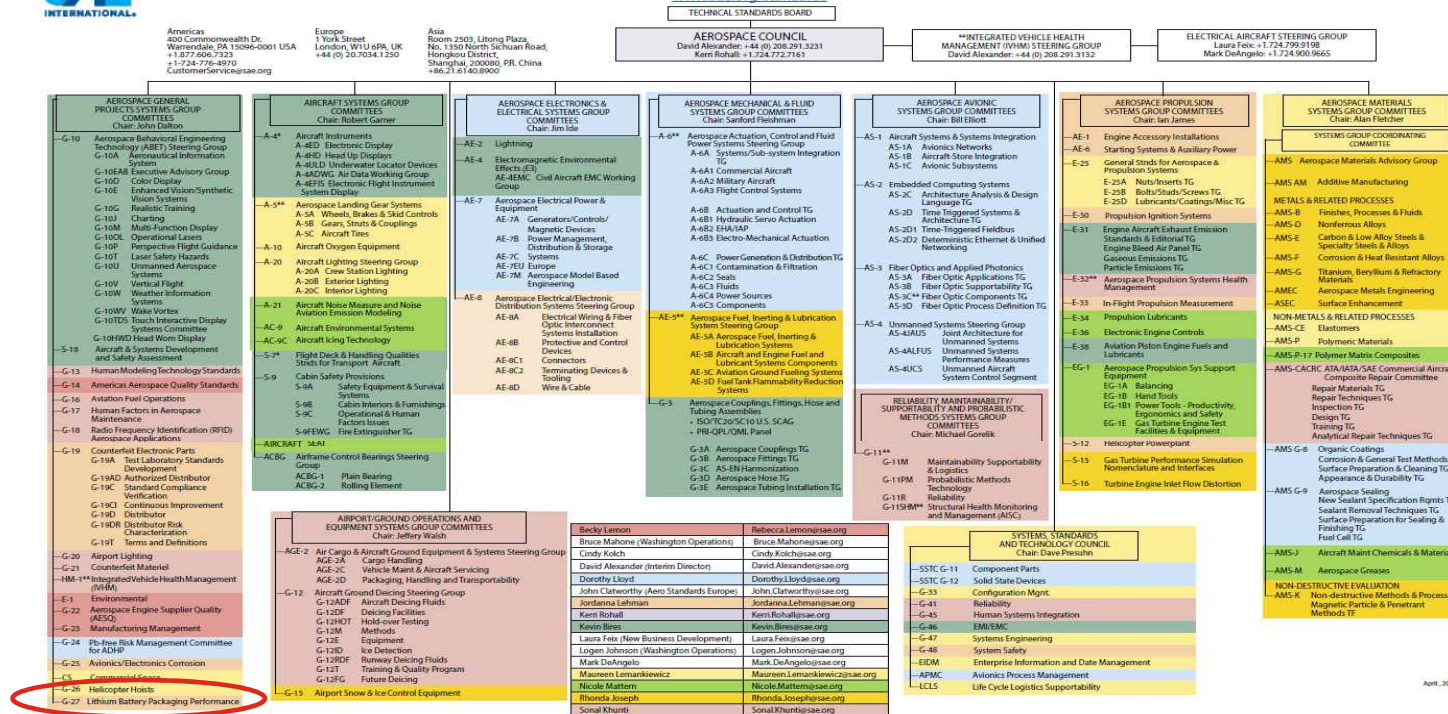
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SAE Aerospace Council Organization Chart

www.sae.org/standards

Click on a committee number to access an SAE StandardsWorks committee homepage.



https://www.sae.org/exdomains/standardsdev/global_resources/InteractiveAeroOrgChart.pdf



•Initiated January 2016

Uncontrolled Fire in Cargo Compartment

- Hazardous flames exceed fire suppression systems

Critical overpressure in Cargo Compartment

- Accumulation of hazardous vapors may create a pressure pulse
- Damage to cargo blowout panels
- Dilutes fire suppression
 - Uncontrolled Fire



FAA "The aircraft hazards of flammable gasses produced by lithium batteries in thermal runaway", ICAO presentation, 07/2015.

Battery Package Test Premise

Specific Test Standard still under development and in draft phase! This presentation is only to inform the industry of the thought process involved in the development of the standard.

Test assumes one cell goes into thermal runaway

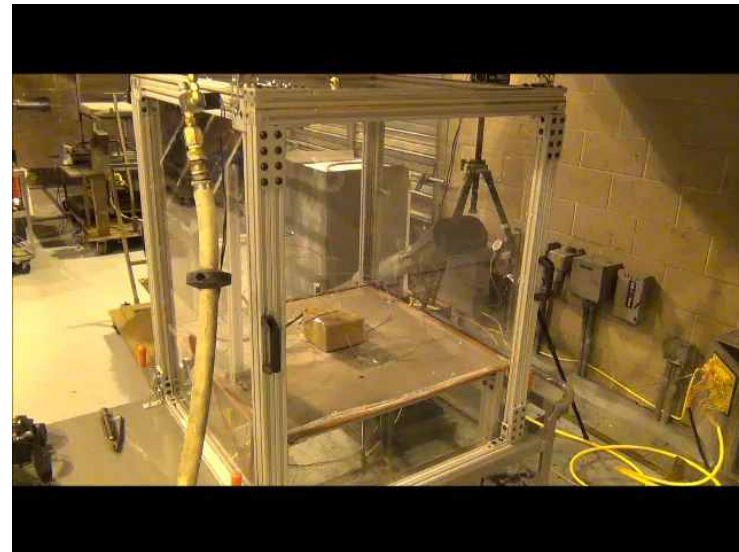
Package must contain all hazards:

- Hazardous Flames
- Hazardous Fragments
- Hazardous Vapors
- Maximum External Package Temperature

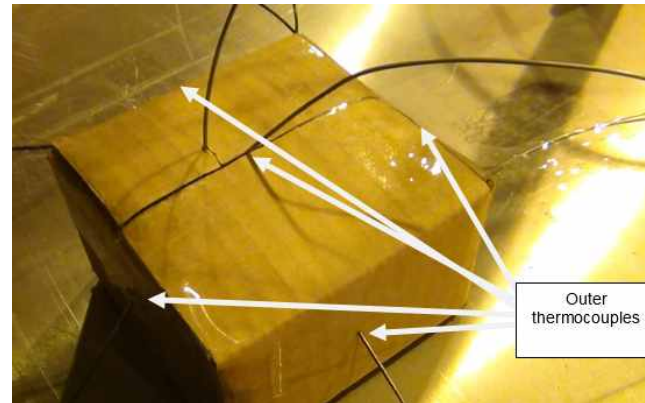


Proposed Test Setup

- 1. Test Package containing lithium cells placed in a sealed test chamber with ignition source**
 - Chamber Volume 0.3 cubic meters
- 2. Initiate a single cell in package into thermal runaway**
 - Preferred method: Thermal ramp (5 to 10°C per Sec up to 200°C)
- 3. Upon thermal runaway, stop heating of cell**
- 4. Observe:**
 - Hazardous Flames emanating from package
 - Ejection of fragments from package
 - Ignition of vapor
 - Maximum external package temperature



Example Test Setup



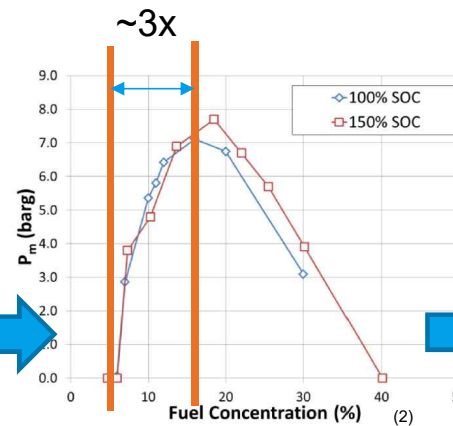
Test Chamber Description

Test Chamber Functions:

1. Contain vapors exiting packaging
2. Provide ignition source
3. Volume represents minimum amount of gas to create an overpressure pulse in a cargo compartment
 - Based on FAA testing of “representative” gas from 18650’s.
 - Ignition in this chamber signifies Lower Flammability Limit has been reached
 - The LFL for chamber volume represents the smaller volume concentration that would be explosive.



~50 L = Hazardous Pressure Pulse⁽¹⁾



= 150 L LFL % of Gas

Adjustment to allow that not all gases would collect in one location

2x

= 300L (0.3 m³) Chamber Size

Complications / Issues

What is hazardous flame? No flame or small self-extinguishing flame allowed outside package

Chamber size adjustments for each test

- “Representative Gas” for explosive mixture

Which cell do you set into thermal runaway?

- Center / Corner?

How do you induce single cell thermal runaway in a pack?

- Minimize disturbance of neighboring cells
- Alternate methods besides thermal ramp rate

Traceability/Reporting

- How do you document what’s been tested?
- When do you need to retest
- Availability of documents?

External Fire Hazard?

- Combine hazard controls with operation controls?

G-27 Proposed Timing - Updated



THANK YOU!

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