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PED / Lithium batteries

Thermal Runaway and Fire Propagation of On-board Li-ion Batteries

A Really Controlled Risk?

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Context of the presentation

Increase in incidents involving portable electronic devices (PEDs) on board airplanes

- Common interest of DGAC/STAC and DGA Aeronautical Systems
- 2017 : launch of a joint test campaign with the following objectives:
  - study the phenomenon of thermal runaway on a PED,
  - assess the propagation factors of this runaway,
  - measure the impact and possible consequences on the aviation sector.

Need to study the means to deal with the threat

- Analysis of existing solutions (launch last quarter of 2020)
- Draw lessons for adaptation of intervention techniques and procedures

Context of the presentation

Many air carriers have Fire/Smoke containment bags on-board, ready to be used for risk mitigation in case of PED thermal runaway.

Containment bag manufacturers frequently mention that their products are « FAA approved » / « FAA certified » / « meet FAA Standards » / …

FAA has published the InFO 17021 (December 2017) in order to precise that :

- *« There are no FAA test standards for these containment products »*
- *« There is no mechanism in place for the approval of these products »*
- *« FAA does not support any manufacturer procedure that suggests moving a burning, smoking or hot device »*

Objectives of the works



- Are containment bags easy to use ?

- Are they efficient and safe ?

Are they easy to use ?

Equipment have been entrusted to a flight crew training center

→ produce videos about the use of these containment products

However…

Ergonomics assessment

What we have seen :

- Opening/Closing of bags and pouches (Velcro or zip)
- Handling of the equipment (especially with gloves)
- Limited space environment in a cabin or a cockpit

→ All of them were observed during a non real thermal runaway condition and on ground

→ Use of these products in a cabin / cockpit environment needs to be improved

Standards :

- What about a timed test for the handling of the equipment ?

Are containment bags efficient and safe ?



- Several types of containment bags commercially available (no manufacturing standard, nor test standard…)

- Efficiency / Performances are not known (Smoke / Fire containment)

- Effects (or risks…) in case of thermal runaway inside containment bags are not known :
  - Possible danger of concentrating the flammable gases released from lithium batteries in a confined space,
  - Over-pressure / explosion risk ?

Fire containment bag testing

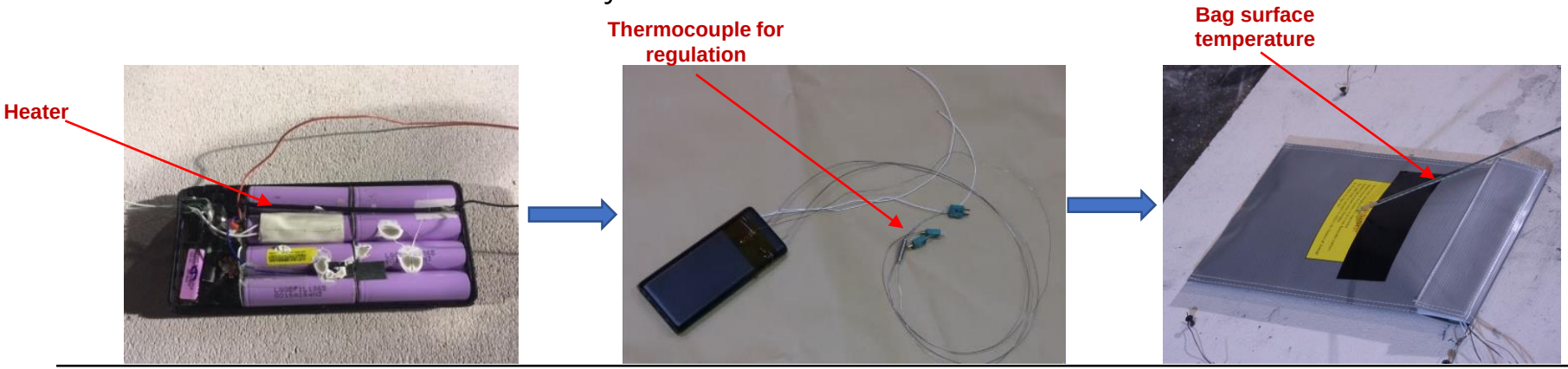
Method

The source is a powerbank commonly encountered

- Li-ion 8 cells powerbank 26 800mAh (100 Wh limit authorized for passengers)
- Thermal runaway is initiated by heating a single cell at 20°C/min (according to DO311A)

The powerbank is put into the bag at the beginning of the test

- We do not handle the battery when the heater is switched on



Fire containment bag testing

Method

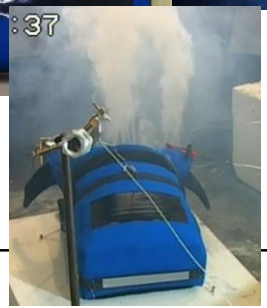
Several containment bag are tested, all available on the market and currently used in aircrafts (bags have been given by operators)

Pouch bag

Fire containment bag

Gaz containment bag

Mineral fire extinguishing agent



Fire and gaz containment bag

Summarize / Discussion

For <u>all</u> tests

- No warning signs
- Relative projections protection
- Not smoke proof

For <u>some</u> tests

- The rise in pressure causes the mechanical rupture of the casing ➔ flames
- Generation of a dangerous gas mixture due to released vent gases in a confined volume ➔ risk of explosion
- Cell to cell propagation ➔ Risk of spread over time

In <u>real</u> life

- Thermal runaway event is too sudden to be contained
  - only cell-to-cell propagation may be contained
- Can be tricky/dangerous to manipulate a PED experiencing a thermal runaway

Summarize / Discussion

<u>Any procedures including the usage of containment bags should take into account the following points :</u>

To our knowledge, no text regulates the manufacture and use of this equipment

- Some equipment are tagged « FAA certified » or « FAA compliant », but :
  - FAA nor international authorities did not certify, nor gave advice on the bag itself
  - That only means that bags are made of materials that are compliant to FAA standards
- Ergonomic tests have shown that handling can be a challenge
- No standard test procedure with batteries exists
- Equipment tested from 50$ to 2000$

Benefit/risk ratio is unknown

- very quick evolution of a thermal runaway event : PED should not be handle when thermal runaway is in progress
- risk to generate a flammable (or explosive) mixture / projection risk

Discussion / Suggestion

- Compared to the powerbank tested in these tests (100 Wh), The power of a tablet is lower (18 to 50 Wh max ?). That does not mean that potential effects are reduced :
  - Battery technologies are different : pouch cells vs cylindrical cells
  - A lower volume of released gas could generate flammable/explosive mixture inside the bag

  ➔ Would need to be studied

- The use of fire containment bags should be subjected to recommendations / clarifications
- Deployment time should be taken into account

- Particular attention must be paid in case of single pilot aircraft (fighter jet, leisure flying…)
- **Recommendation : to not store the containment bags close to passengers area / crew members area / or close to a critical aircraft circuit**

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Many thanks for your attention

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