

Lithium Batteries



Laptop Computer Battery

Rating: 14.8V, 4000mAh (14.8V, 4000mAh)



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Lithium Batteries

Lesson Learned

February 2017

“Lithium battery - smoking”

The following is an edited version for distribution of a recent incident.

I. Summary of events

On March 11 2330 (local) one of the visiting scientists noticed an odd smell on the main deck and reported it to the off-going OOD and watchstander. They found smoke and nasty fumes on the starboard side main deck, aft of the main lab. After further investigation, a lithium battery was discovered smoking on the fantail from a rapid discharge (shorting out) of the battery pack. Due to the degree of smoldering, one of the scientists took the recommended course of action to jettison the battery over the side without further incident. The entire response was less than 10 minutes and no larger effort of personnel was needed or made. ❖

Background

The scientists' procedure for disposing recovered Lithium batteries is to vent outside for a couple of hours before disassembling packs inside the lab space. The water-tight boxes were left open and one was just under the ladder coming down from the D1 deck. The quick search located one of the recovered battery boxes smoking with the box half full of seawater; the ship took some sea spray overnight and water came down the ladder and filled the box enough to short the batteries. The chief scientist, well versed in lithium battery issues, Figure 1, saw the state of the smoldering battery emitting smoke and nasty fumes and recommended to jettison it over the side. The OOD approved and it went over the side.

No flames were observed...but the chemical chain reaction/ thermal runaway had started on this battery pack and a little while longer there would have been a full-fledged fire. The scientists have a lithium battery spill kit and a class D (combustible metals) extinguisher aboard. The Safety Data Sheet (SDS) for the batteries is available and indicates "avoid contact with water", including the warning for firefighting: "DO NOT USE WATER", Figure 2. This was a very good example of why there is so much scrutiny about lithium batteries in transportation, Figure 3. ❖

Immediate Causes

Shorting of Lithium battery in seawater caused overheating and began thermal runaway.

Contributing Causes

The battery boxes were supposed to be brought inside at the end of the workday and disassembled; but they were forgotten. End of project fatigue and/or lack of familiarity with procedures (a couple technicians new to the program) were likely also factors.

Root Causes and Corrective Action:



Training or Authority



Figure 1 – Lithium batteries differ in size, shape and composition.

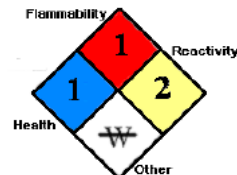


Figure 2 –SDS NFPA rating



Figure 3 – Lithium-ion battery failure. (Fire potential avoided by jettisoning overboard.)

Types of Lithium batteries

Lithium-metal batteries



Technology

- Usually, **non rechargeable** batteries used in watches, calculators, cameras ...
- Cells contains lithium metal (highly reactive)

Associated Risk

- Capable of self-ignition (thermal runaway)
- May worsen an independent, controllable fire event
- Violent release of a flammable electrolyte mixed with molten lithium metal (large pressure pulse)

Fire fighting

- Halon 1301 or water are **not effective** at extinguishing a lithium metal cell fire

Lithium-ion / Lithium-polymer batteries



- Usually **rechargeable** batteries used in mobile phones, laptops, cars, cordless devices, ...
- Cells contains ionic lithium

- Capable of self-ignition (thermal runaway)
- May worsen an independent, controllable fire event
- Generation of heat and pressure, resulting (for Li-ion only) in a spray of flammable electrolyte

- Halon 1301 is **effective** in controlling the open flame and the spread of the fire to adjacent materials
- Halon 1301 is **not effective**, but **Water is effective** at stopping the propagation of thermal runaway within the shipment

Figure 4 - Differences between Lithium-metal batteries and Lithium-ion.



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Lithium Batteries – Failure



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Best practices

Top 5 reasons for Lithium battery failures (After cheap batteries)

1. Charging

- Use only good/reliable chargers
- Don't leave unattended – swelling, hissing or smoking
- Utilize balanced charge
- Charge within limits (proper charge rates)
- Establish dedicated charging stations – isolated, charging bags, etc.
- Always inspect batteries – remove at signs of failure

<https://youtu.be/kZsqzAx-Svs?t=56s>

<https://youtu.be/LIWUYSDWjfk?t=1m56s>



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Best practices

Top 5 reasons for Lithium battery failures (After cheap batteries)

2. Impact

- Protect batteries from physical damage
- <https://youtu.be/LIWUYSDWjfk?t=4m43s>
- <https://youtu.be/LIWUYSDWjfk?t=12m9s>

3. Short circuit

- Protect connections
- Insulate workspaces
- Remove jewelry



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Best practices

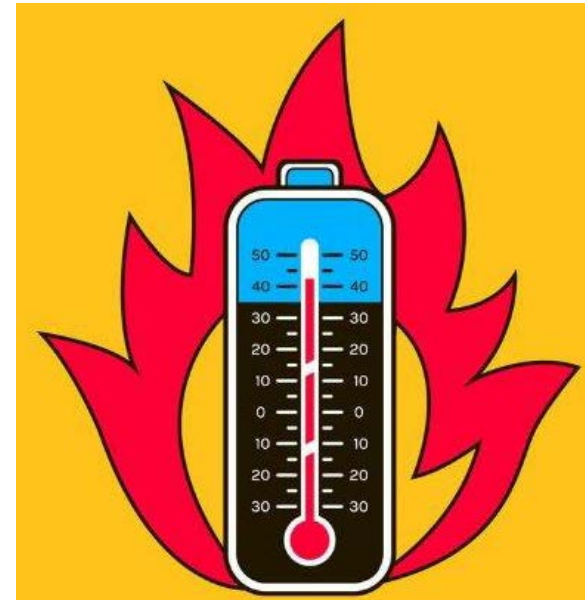
Top 5 reasons for Lithium battery failures (After cheap batteries)

4. Heat

- Protect batteries from overheating >140 degrees results in compromise

5. Stress

- Use only as intended
- Let batteries cool between use/charge/use



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