

The logo for Shmuel De-Leon Energy Ltd is a green rectangular box. On the left, the text "Shmuel De-Leon" is stacked above "Energy Ltd" in a white, sans-serif font. On the right side of the box, there is a faint, light-colored image of a battery or energy storage device.

Shmuel De-Leon
Energy Ltd

Samsung Galaxy Note7 Case – Battery Safety Issues Impact on Business

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Samsung Galaxy Note7 Smartphone Recall



- Recall date: October 13, 2016
- Name of the product: Samsung Galaxy Note7 smartphones
- **Hazard:** The lithium-ion battery in the Galaxy Note7 smartphones can overheat and catch fire, posing serious fire and burn hazard to consumers.
- Units: 1.9 Millions

Source: US Consumer product safety commission

Samsung Note7 Incidents/ Injuries

- 96 reports of batteries in Note7 phones overheating in the U.S.,
- Samsung has received 13 reports of burns and 47 reports of property damage associated with Note7 phones.



The Galaxy Note 7 implicated in dramatic Jeep and house fires, reports say



Source: US Consumer product safety commission

iPhone Mobile Phone Battery Explosion 2016



An Apple iPhone 6 exploded in cyclist's pocket

“I saw smoke coming out of my back pocket... I was completely bewildered about what it was. All of a sudden I felt a surging pain in my top right leg. I heard a kind of a snap and I could feel the thing melting through my shorts”.



Moli Energy – Lithium Metal Battery Explosion - 1989

- Moli Energy Canada was the first to mass produce lithium metal rechargeable 18650 cells on 1988
- Used in Cellular phones in Japan
- Explosion of a cellular phone battery in the face of a customer lead to a recall of 1.5M cells in 1989
- Shown to be safe in the lab
- Root Cause – Lithium metal plating during charge – Dendrites that led to a short circuit and thermal run away
- The recall and compensation to injures lead to bankruptcy of the company



Sony Laptop Battery recall 2006

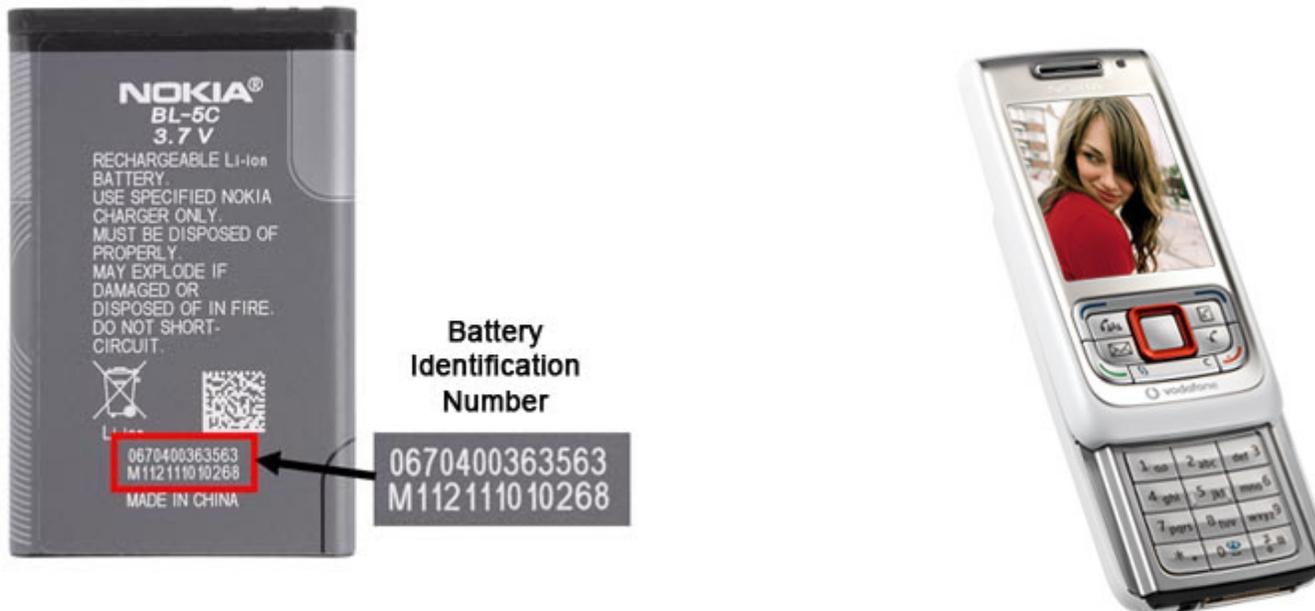


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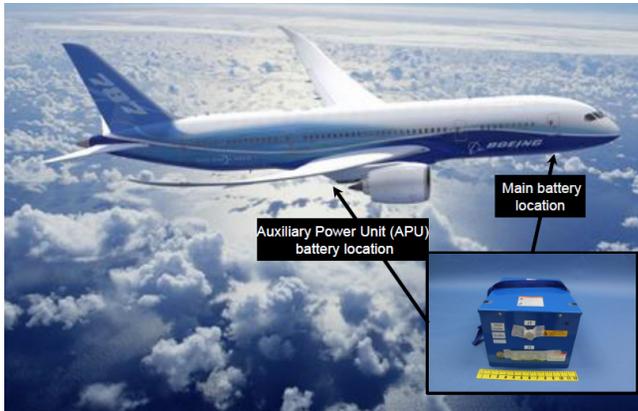
Cost for Sony: 1B\$ estimate
7 million 18650 cells affecting 6 PC makers
These lithium ion batteries can overheat, posing a fire hazard to consumers

Nokia Recall Cell-phone Batteries 2007



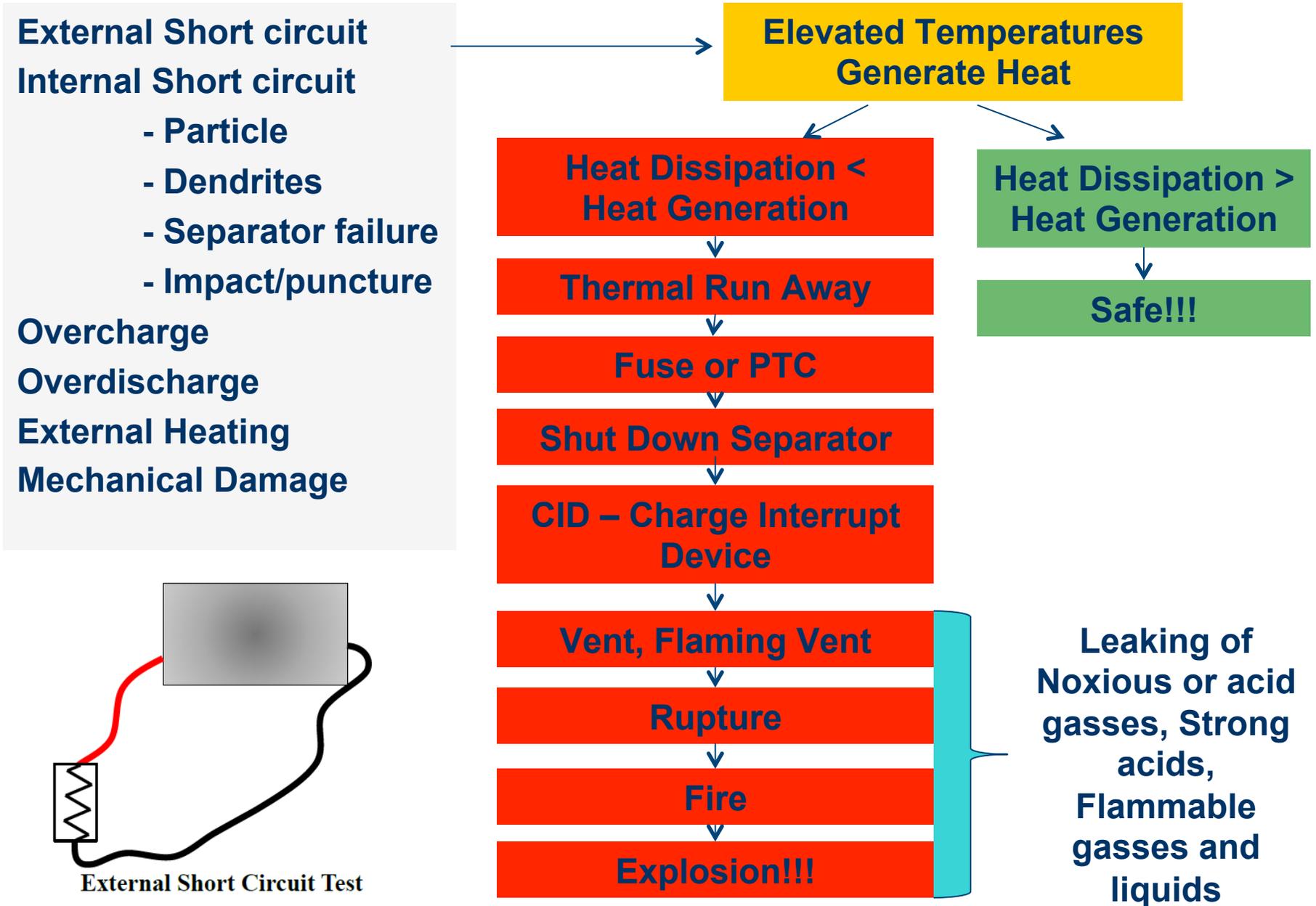
Cost for Nokia: 150M\$ estimate
BL-5C Panasonic batteries to have internal short circuit
These lithium ion batteries can overheat, posing a fire hazard to consumers

Boeing Dreamliner Battery Fire 2013



Cost for Boeing: 600 M\$ estimate
Expected smoke event: 1 every 10 millions flights hours
Cause: Internal short circuit in one cell

Why that is happened?



What Cause the Samsung Galaxy Note7 Safety Problems

- **Samsung didn't disclose officially the battery safety root cause – All what described here is my personal assumption**
- **Samsung used a high energy cathode for maximizing the battery energy density**
- **Thin separator was used for freeing volume for more active materials**
- **Charging the battery cause some sort of lithium metal plating as a dendrites**
- **On some cases lithium dendrites penetrate the thin separator and cause Internal short circuit, heat and safety event**

The Samsung Note 7 Battery Hold an Impressive 3,500mAh Despite its Slim Profile



Alternative Root Cause

- Another assumption based on the observation that most of the reported safety event happened during charging but at the end of the charge
- As we all know the end on the charge is more risky and most of the charging profiles CCCV reduce the charging current at the charge end
- It may be possible having the charging algorithm is faulty and lead to over charge
- On my opinion the chances for that are small because it can be reparable by software update which was not selected by Samsung as a solution



Samsung Reaction

- **2/9/2016 First recall of Galaxy Note7 used Samsung Korea made batteries and replaced it by Galaxy Note7 used ATL china made batteries (ATL was selected by Samsung as a battery sub-contracture producer)**
- **15/9/2016 After reports of the same safety events with the Galaxy Note7 used ATL china made batteries Samsung halted that recall**
- **Then Samsung stop marketing the Note7 and to concentrate on full worldwide recall for not taking any extra risks for customers safety**
- **We should wait for Samsung final root cause after completing internal investigation**

Samsung took the responsibility

What Should We Learn?

- **Battery safety event damage is huge and in most cases is not proportional to the battery cost**
- **Damage is higher when the device market is larger**
- **The damage is huge as well as when the device mission is critical (Kike in Space or Military)**
- **Companies with no deep pockets will may close business because of battery safety event damage**
- **Batteries are not just another component and there is a need to understand them from all aspects including the safety before designing them into a device**



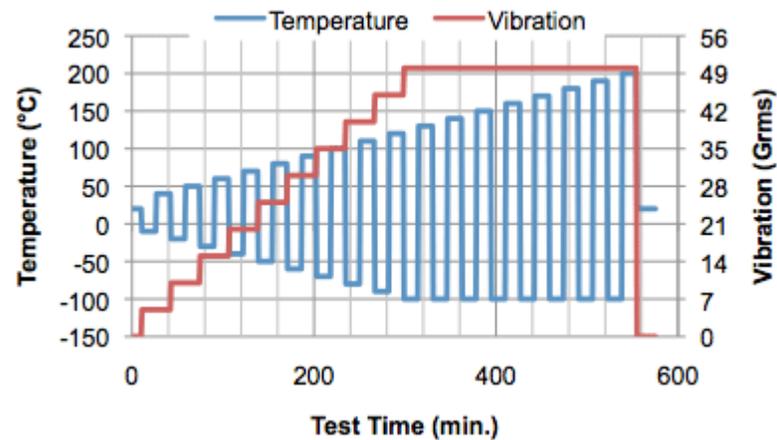
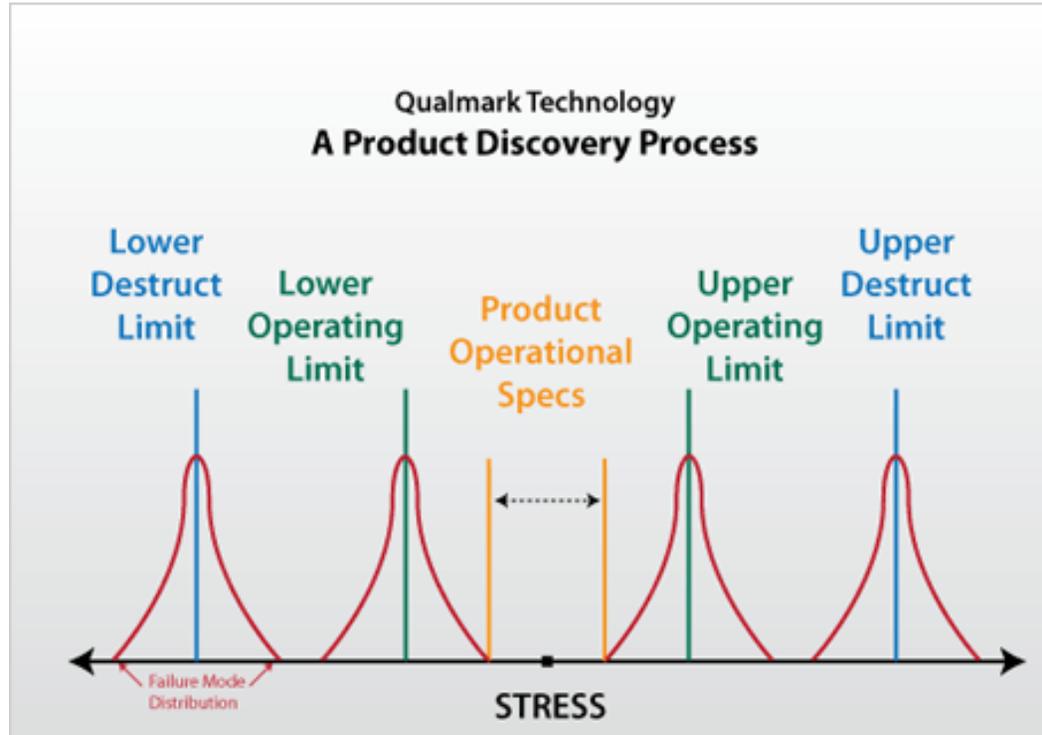
Recommendations

Since Samsung battery validation process didn't find the problem we recommend:

- Cells/batteries makers should review improve their cells/ batteries safety validation process
- Testing for specs are not sufficient
- HALT-HASS testing technics can add to the cells/ batteries robustness and make them safer
- Based on the potential damage to run the battery safety validation on 2 separate independent labs
- Running several months pilot before marketing starts

In the race for performance we never should forget Safety!!!

Halt-Hass



Halt-Hass Machine



<http://www.qualmark.com/what-we-do/testing-standards/battery-testing>

Thank You for Your Attention



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1. Public web sources.
2. Shmuel De-Leon Battery/Energy Sources DataBase ® (Includes 29000 cell PDF data sheets) <http://www.sdle.co.il/Default.asp?sType=0&PageId=45580>