Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2011-149
Final

Smoke Event, VH-PRX, Sydney Airport 25 November 2011

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Abstract

On 25 November 2011, a Saab Aircraft Company S340B was being operated on a scheduled passenger service from Lismore to Sydney, New South Wales (NSW). During the taxi to the gate after arrival at Sydney, a cabin crew member noticed smoke coming from near a passenger seat and instructed the passenger to throw the source of the smoke into the aisle. The cabin crew member then discharged a fire extinguisher onto what was later identified as a mobile telephone. After several minutes, the smoke cleared.

An Australian Transport Safety Bureau (ATSB) investigator travelled to Sydney airport to commence an investigation into the event. The mobile telephone was transported to the ATSB technical facilities in Canberra for initial examination and then forwarded to the United States for detailed examination at a specialist facility.

The technical examinations found that a small metal screw had been misplaced in the battery bay of the mobile telephone; the screw puncturing the battery casing and causing an internal short circuit leading to heating and thermal runaway. It was probable that the screw had been misplaced during an earlier repair carried out on the telephone. That repair had not been conducted by an authorised service provider.

This investigation highlights the risks associated with the use of non-authorised agents for the repair of lithium battery-powered devices, and reinforces the Civil Aviation Safety Authority (CASA) recommendations that these devices should be carried in the cabin and not in checked-in baggage.

FACTUAL INFORMATION

History of the flight

On 25 November 2011, a Saab Aircraft Company S340B was being operated on a scheduled passenger service from Lismore to Sydney, NSW. During the taxi to the gate after arrival, a cabin crew member noticed smoke originating from near passenger seat 3A and instructed the passenger in that seat to throw the source of the smoke into the aisle. The cabin crew member then discharged the fire extinguisher onto what was later identified as a mobile telephone. After several minutes, the smoke cleared.

Mobile telephone details and history

Figure 1: Incident mobile telephone

Manufacturer: Apple Inc.

Model: A1332 (iPhone 4)

Serial Number: 700349NSA4S

Battery type: Lithium-ion

The mobile telephone owner reported that it was purchased approximately 1 year prior to the incident. The owner also reported that approximately 6 months after purchase, the screen was replaced after it was damaged. The owner could not recall the name of the facility that performed the servicing; however, indicated that it was not an authorised Apple service provider.

Lithium-ion batteries and thermal runaway

Lithium-ion batteries are a family of rechargeable battery using lithium-based anodes. Lithium batteries are commonly used in consumer electronic devices due to their high specific energy. This energy also makes them prone to thermal runaway events when short circuited or exposed to heat.

Thermal runaway refers to a situation where an increase in temperature influences internal battery conditions in a manner which causes a reaction to further increase the temperature. This process can occur very rapidly and can cause combustion of the battery and surrounding materials.

Previous occurrences

There is no previous record in the ATSB's databases of self-ignition involving mobile telephones or other portable electronic devices on an aircraft in Australia.

Examination of the mobile telephone

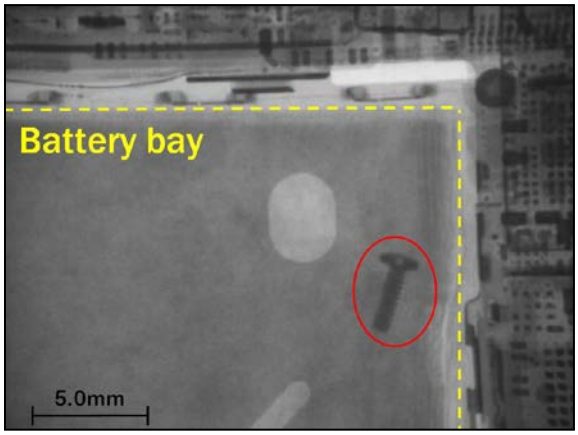
Initial examination

After the incident, the mobile telephone was transported to the ATSB. On receipt, it was noted that one of the screws from next to the 30-pin connector at the base of the telephone was missing (Figure 2). The screw socket thread at this location was visually examined and found to be in good condition.

Figure 2: Image of 30-pin connector with location from which a screw was missing indicated

Preliminary x-rays performed on the mobile telephone revealed an isolated screw located in the battery section – away from any apparent fixtures associated with the telephone's construction (Figure 3).

Figure 3: Preliminary x-ray of mobile telephone section, screw circled



Detailed examination

The mobile telephone was provided to a specialised examination facility[1] for further examination. A two-stage examination was conducted - consisting of an initial non-destructive CT[2] scan analysis (Figure 4) and subsequent disassembly and destructive inspection. The work was overseen by representatives from the US Federal Aviation Administration (FAA) on behalf of the ATSB.

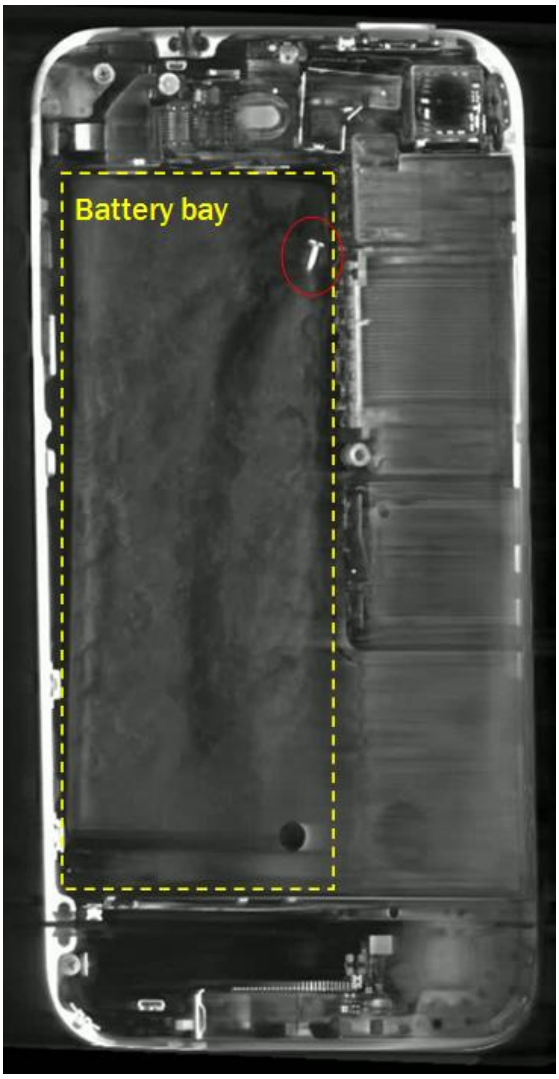
1 Exponent Inc. Located in Menlo Park, California.

2 Computerised X-Ray Tomography.

Examination findings

- The incident mobile telephone had sustained a thermal runaway event within its lithium-ion battery
- The screw that was found in the battery area had precipitated the incident and was most likely from the 30-pin connector
- One of the screws used to fasten the main circuit board was missing
- Two screws that retained a flexible cable were installed incorrectly (swapped locations)
- The main circuit board flexible cable adhesive was disturbed
- The two liquid contact indicators[3] were missing
- A metal clip near the battery was deformed

Figure 4: CT scan image of entire mobile telephone, screw circled



The completed examination concluded that the mobile telephone battery failure was most likely the result of the following sequence of events:

- A screw from the 30 pin connector at the base of the telephone (or an identical item), was misplaced in the battery bay during a repair operation.
- Over time, this screw caused mechanical damage to the battery, resulting in an internal short circuit.
- The short circuit lead to the thermal runaway event.

3 Liquid contact indicators are small pieces of moisture sensitive material, adhered to parts of the electronics which change colour in the presence of moisture.

ANALYSIS

With respect to the mobile telephone battery failure, the ATSB concurred with the findings of the examination facility. The failure was initiated by a screw misplaced in the battery bay during repair.

Mechanical damage caused by the screw and the subsequent internal short circuit resulted in the thermal runaway event.

The other findings from the examination indicated a lack of appropriate quality control on behalf of the unauthorised repair facility. The findings suggested that the repair had not been conducted in accordance with the telephone manufacturer's procedures.

Safety message

This event, while being the first of its type in Australia, reinforces the importance of the Civil Aviation Safety Authority (CASA) recommendations regarding the carriage of lithium batteries in checked baggage. CASA provides more information at http://www.casa.gov.au/dg. The incident also highlights the importance of good maintenance and repair processes, and the risks associated with use of non-authorised repair agents.

FINDINGS

Contributing safety factors

- During repair work at an unauthorised maintenance facility, a screw was misplaced in the mobile telephone battery bay.
- The screw caused mechanical damage to the battery which resulted in an internal short circuit and rapid heating.
- The rapid internal heating within the mobile telephone battery triggered a thermal runaway event, producing a large amount of heating and associated smoke.

SOURCES AND SUBMISSIONS

Sources of Information

Sources of information during the investigation included the:

- Mobile telephone manufacturer.
- Failure analysis facility.

References

- Figure 4 courtesy of the Exponent Inc. video presentation of the telephone CT examination.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the Transport Safety Investigation Act 2003, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the owner of the telephone, the manufacturer of the telephone, the aircraft operator, the Australian Civil Aviation Safety Authority (CASA), the US National Transportations Safety Board (NTSB) and the US Federal Aviation Administration (FAA).

All parties responded to the draft report with no comment.