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**How Lithium Ion Batteries Grounded the Dreamliner**

Official report on Boeing 787 fires tells a cautionary tale about advanced batteries

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Technology

At 10:21 a.m. on Jan. 7, 2013, about a minute after all 183 passengers and 11 crew members from Japan Airlines Flight 008 disembarked at Boston's Logan International Airport, a member of the cleaning crew spotted smoke in the aft cabin of the Boeing 787-8.

A mechanic then opened the aft electronic equipment bay of the plane, parked at the airport gate, and saw billowing smoke and flames coming from the batteries for the 787's auxiliary power unit (APU). He tried to use a fire extinguisher, but the blaze didn't go out.

Firefighters arrived at the scene at 10:37 a.m., and using a thermal imaging camera, they looked through the smoke in the equipment bay and saw a softball-sized glow. Responders attempted to extinguish the heat source with Halotron, a fire suppressant.

The flames went out, but another firefighter saw that the batteries were still giving off heat and appeared to rekindle. The batteries hissed, leaked fluid and popped, giving one firefighter a minor burn on his neck.

By 12:19 p.m., firefighters had declared the event "controlled," having removed the APU battery after extinguishing it with further doses of Halotron.

The culprit was a lithium-ion battery manufactured by GS Yuasa, which was found to be under a condition known as a thermal runaway, in which the heat from a failing cell causes itself and surrounding cells to fail, thereby generating more heat.

The incident was troubling because Boeing had delivered the aircraft to the airline just 18 days prior. In that time, the plane logged 22 flight cycles without incident. Five days later, another 787, this one operated by All Nippon Airways, made an emergency landing in Japan after pilots received a battery malfunction warning.

These two events led the U.S. Federal Aviation Administration to ground the entire 787 fleet, the first time the agency had given such an order for a line of aircraft since 1979.

Earlier this month, the U.S. National Transportation Safety Board released its report on the Japan Airlines fire. The agency faulted Boeing, GS Yuasa and FAA for shortcomings in their respective roles in the 787 grounding.

Though the aircraft are now flying again with safety retrofits, the episode highlights some of the emerging concerns around cutting-edge clean technologies, particularly those that store large amounts of energy. Saving electrons for later is important for applications like electric vehicles, and denser batteries mean vehicles can go farther with less weight, a major consideration for fuel-conscious airlines. Storing electricity is also crucial for smoothing over peaks and valleys in output from wind and solar.

Batteries, especially the lithium-ion variety, are largely filling this role. But doing so at larger scales and with new systems requires additional scrutiny and training for the unique challenges posed and the growing pains that may arise.

"Smaller cells have the tendency to reject heat faster," explained Ahmad Pesaran, energy storage group manager at the National Renewable Energy Laboratory. With larger cells and more of them packed together in batteries, managing heat becomes all the more important.

**Quality-control problems suspected**  
Last year, a spate of fires in the all-electric Tesla Model S car prompted concern among auto safety experts ([Greenwire](https://www.eenews.net/greenwire/stories/1059990212/), Nov. 8, 2013).

However, Pesaran noted that jet fuel and gasoline are more energy-dense than batteries and carry fire risks, as well. For the most part, the public has grandfathered these problems and regulatory agencies have a well-established protocol for dealing with problems that arise from hydrocarbons ([ClimateWire](https://www.eenews.net/climatewire/stories/1059956921/), Nov. 30, 2011).

In its assessment, the NTSB report criticized the battery manufacturer for faults in production. Though fire destroyed much of the afflicted cell, investigators said they suspected that a defect was introduced during production, causing a short-circuit. The report called for GS Yuasa to improve quality control and to test its batteries under more severe conditions.

NTSB also called out Boeing for assuming that an internal short-circuit within a battery would not cause a fire or affect other cells. This assumption meant that Boeing did not "incorporate design mitigations to limit the safety effects that could result in such a case," the report stated.

The report cited FAA for not requiring a thermal runaway test for the battery system for certifying aircraft components.

**NTSB remains agnostic about lithium-ion batteries**  
The scope of the report targeted regulations surrounding the 787 to see where procedures could improve, but NTSB was agnostic about the battery system. "We did not take a position on [lithium-ion] energy storage systems; instead, we made focused recommendations about how any new technology is certified for use in aviation," said Peter Knudson, a spokesman for NTSB, in an email.

"We concur with the report's probable cause finding—a short circuit within one battery cell led to venting and cell-to-cell propagation that caused the battery failure," said Doug Adler Jr., a Boeing spokesman, in an email. "We remain confident in the comprehensive improvements made to the 787 battery system following this event, and in the overall performance of the battery system and the safety of the airplane."

GS Yuasa did not respond to a request for comment at time of publication.

Tammy Jones, a spokeswoman for FAA, said in an email that the battery fires helped the agency better understand the hazards of lithium-ion batteries. "The FAA already has implemented many of the NTSB's recommendations about modifications in testing, safety standards and design as part of the 2013 certification of the 787's redesigned battery system," she wrote.

Earlier this year, FAA also expressed concerns about transporting lithium-ion batteries in aircraft. Consumer batteries like those in laptops and cellphones could pose an explosion risk should a thermal runaway occur when batteries are packed close together, tests showed.

However, in an industry as sensitive to fuel prices as airlines, engineers are still trying to further electrify aircraft operations, like taxiing on the ground, to reduce fuel consumption. One proposal involves charging batteries with regenerative braking on landing ([ClimateWire](https://www.eenews.net/climatewire/stories/1059968510/), Aug. 8, 2012). As a result, plane builders are still looking for more advanced batteries, but lithium-ion remains attractive.

"Lithium-ion batteries are definitely going to get better," said the National Renewable Energy Laboratory's Pesaran. "For weight, volume and life expectancy, there aren't many options better than lithium-ion, currently."

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