Committee on Transportation and Infrastructure
U.S. House of Representatives
Washington, DC 20515

Bill Shuster
Chairman

Nick J. Rahall, II
Ranking Member

Christopher P. Bertram, Staff Director

James H. Zoia, Democrat Staff Director

June 7, 2013

SUMMARY OF SUBJECT MATTER

TO: Members, Subcommittee on Aviation
FROM: Staff, Subcommittee on Aviation
RE: Subcommittee Hearing on "Lessons Learned from the Boeing 787 Incidents"

PURPOSE

The Subcommittee on Aviation will meet on Wednesday, June 12, 2013, at 10:00 a.m. in 2167 Rayburn House Office Building to receive testimony in order to explore and discuss "lessons learned" as a result of the Boeing 787 battery incidents that occurred in January 2013. The Subcommittee will hear from the Federal Aviation Administration (FAA) and The Boeing Company (Boeing) on actions taken as a result of and lessons learned from the 787 battery incidents.

BACKGROUND

Summary of Incidents and Response

On January 7, 2013, cleaning personnel discovered smoke while working on a Japan Airlines (JAL) Boeing 787 that was parked at a gate at Boston Logan International Airport. The aircraft had recently landed at the airport after a flight from Narita, Japan. The aircraft had been deplaned of passengers and crew when the cleaning crew boarded the plane and reported smelling smoke. When a mechanic opened the aft electronic equipment bay, he found heavy smoke and fire coming from the front of the auxiliary power unit (APU) battery[1] case (*Figure 1*).[2] He indicated that the fire had two distinct flames that were about three inches in length at the two connectors on the front of the battery case.[3] The mechanic was unsuccessful in extinguishing the fire. Airport firefighters extinguished the fire about an hour and forty minutes after initial notification.[4]

[1] The auxiliary power unit battery provides power to start an APU during ground and flight operations. The APU battery is one of two lithium ion batteries used on the 787. While lithium ion batteries have been used on planes prior to the 787, the 787 uses larger batteries for some main electrical functions on the aircraft.
[2] National Transportation Safety Board (NTSB) Interim Factual Report, NTSB Case Number: DCA13IA037, page 1 (March 7, 2013).
[3] Id. at 2.
[4] Id. at 4.

In response to the JAL 787 battery fire at Boston Logan International Airport, the National Transportation Safety Board (NTSB) sent a "go-team" to investigate the incident. The lithium-ion battery cells involved in the fire were transported to the NTSB forensics lab in Washington, D.C., for further investigation. Both the FAA and Boeing are parties to the ongoing NTSB investigation.

In the days following the JAL 787 battery incident, several other incidents were reported on 787 aircraft in commercial service. These incidents were not related to the 787 batteries. However, these incidents, along with the JAL 787 battery incident, prompted the FAA on January 11, 2013, to order a comprehensive review of the 787's critical systems, including the design, construction, and assembly of the battery components of the aircraft.

On January 15, 2013, an All Nippon Airways 787, during a domestic flight in Japan, experienced a problem with its main battery (*Figure 1*).[5] According to the carrier, the main battery in the forward cargo hold triggered an emergency warning to the pilot. This warning was followed by a second warning light in the cockpit that indicated smoke. According to passengers and crew, there was an odd smell in the cockpit and cabin. The pilot decided to make an emergency landing and evacuate all passengers and crew via inflated chutes. While there was no fire when the plane landed, there was discoloration and signs of leakage in the main battery.

Following the battery incident aboard the All Nippon Airways 787, the Japan Transport Safety Board (JTSB) opened an investigation into the incident and both Japanese air carriers operating 787 aircraft (Japan Airlines and All Nippon Airways) voluntarily grounded their fleet of 787's on January 16, 2013.

Later that same day, the FAA issued an Emergency Airworthiness Directive (AD) to address a potential battery fire risk in the 787, which required operators to temporarily cease operations.[6] At the same time, the FAA announced that it would work with the manufacturer and air carriers to develop a corrective action plan to allow the U.S. 787 fleet to resume operations as quickly and safely as possible. Aviation regulatory agencies of other countries in which the 787 operated quickly followed suit, with temporary groundings ordered in Japan, the European Union, India, Qatar, Ethiopia, Kenya, and Chile. Boeing responded by sending teams of investigators and engineers to both incident sites to compile information and, in coordination with the FAA, devise a solution to return the 787's back to service. In April, the NTSB held a two-day investigative hearing in connection to its investigation of the January 7, 2013 JAL 787 battery incident. The NTSB's final report should be complete by the end of the year.

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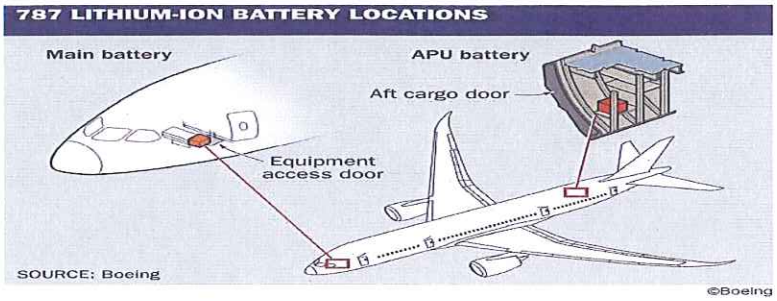
[5] The main battery provides power to selected electrical/electronic equipment during ground and flight operations for normal and failure conditions.

[6] Boeing Model 787-8 FAA Emergency Airworthiness Directive, AD #: 2013-02-51, January 16, 2013.

FIGURE 1:



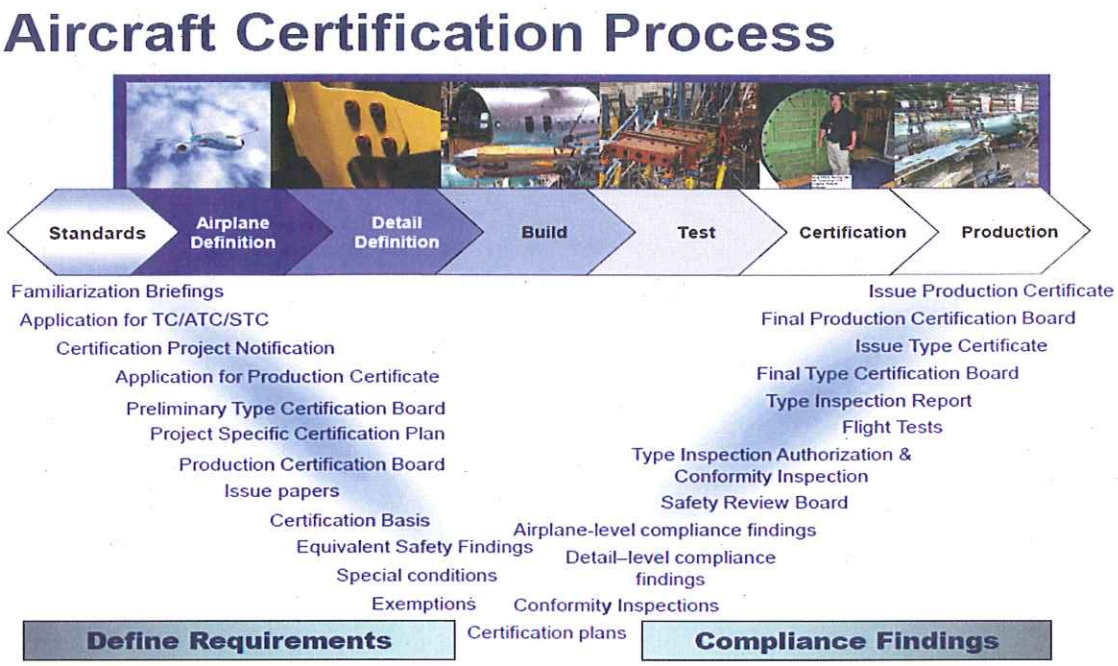
Aircraft Certification

In exercising its discretion, the FAA has devised a system of compliance review that involves certification of aircraft design and manufacture. Under this certification process, the duty to ensure that an aircraft conforms to FAA safety regulations lies with the manufacturer and operator, while the FAA retains responsibility for overseeing compliance. Thus, the manufacturer is required to develop the plans and specifications and perform the inspections and tests necessary to establish that an aircraft design comports with the regulations; the FAA then reviews the data by conducting a risk based review of the manufacturer's work. If the FAA finds that a proposed new type of aircraft comports with minimum safety standards, it signifies its approval by issuing a type certificate.

When a new design of aircraft is being proposed, such as the Boeing 787, the designer must first apply to the FAA for a type certificate. The applicant must show that the aircraft, aircraft engine, or propeller concerned meets the applicable existing airworthiness requirements. The regulations also provide for the issuance of special conditions when the Administrator finds that the existing airworthiness standards do not contain adequate or appropriate safety standards because of novel or unusual design features of the product to be type certificated. In the interest of safety, rapid technological advances presently being made by the civil aircraft industry require that the FAA be able to issue special conditions to address truly novel or unusual design features that it has, as yet, not had an adequate opportunity to include in the airworthiness standards through the general rulemaking process. For example, in the Boeing 787's case, the lithium-ion battery is a newer technology that is not specifically covered by existing regulatory standards. Therefore, the FAA developed special conditions that ensured a comparable level of safety with the standards that were in place at the time of certification. In order to receive a type certificate, the applicant must conduct a series of tests and reviews to show that the product is compliant with existing standards and the special conditions. This includes lab tests, flight tests, conformity inspections, and detail- and airplane-level compliance findings, all of which are subject to FAA oversight.

Along with seeking a type certificate, the applicant can simultaneously seek a production certificate from the FAA. A production certificate is an approval by the FAA to manufacture duplicate products of the type design approved by the type certificate. Before approving a production certificate, the FAA will review the manufacturer's quality control systems against regulatory and policy requirements. The holder of the production certificate is responsible for the quality of all parts, even those that are not specifically manufactured by the production certificate holder. In other words, a manufacturer may not produce all the parts on their aircraft, but they are responsible for the quality of each item on the plane.

FIGURE 2:



Source: FAA

In order to ensure that all parts meet quality standards, the FAA also has the ability to grant a company Organization Designation Authorization (ODA). The ODA allows a company to set up an organization of airworthiness representatives (AR's) who act on behalf of the FAA. The company and the FAA develop a procedures manual, which is the guiding document on the procedures, processes, and practices for the company. The AR's are authorized by the FAA and usually carryout routine certification actions. The FAA inspectors have the authority to perform any of these activities themselves should they wish to, or they can delegate the responsibility to the AR. AR's are approved by the FAA after going through a review process and are responsible for ensuring the manufacturers' compliance to FAA standards. The FAA has multiple processes that must be met to ensure that a new aircraft meets the standards of aircraft design and manufacturing. Boeing does have an ODA.

Boeing applied for a type certificate for the 787-8 airplane in March 2003. More than eight years later, in August 2011, the 787-8 airplane received transport-category approval from the FAA. Because the 787 was utilizing new and novel lithium-ion battery technology for the main and APU batteries, the FAA also issued special conditions for the 787 lithium-ion battery installation in October 2007.[7]

On January 11, 2013, in response to the JAL 787 battery incident and to other reported issues, the FAA announced it was going to conduct a comprehensive review of the 787's critical systems, including the design, construction, and assembly of the battery components of the aircraft. In particular, the FAA indicated that "…the purpose of the review was to validate the work

[7] 25-359-SC, 72 Federal Register 57842 (October 11, 2007); became effective on November 13, 2007.

conducted during the certification process and further ensure that the aircraft meets the FAA's high level of safety."[8] The FAA has coordinated closely with Boeing in conducting the 787 critical systems and certification review and the work is ongoing.

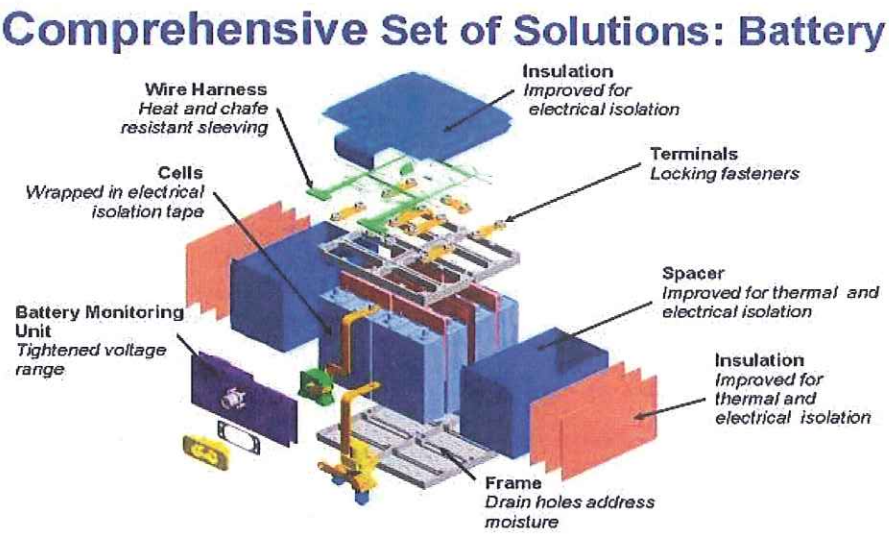
Return to Service

The January 16, 2013 airworthiness directive ordered the temporary cessation of 787 operations. The emergency AD specifically directed air carriers, before further flight, to "…modify the battery system, or take other actions, in accordance with a method approved by the Manager, Seattle Aircraft Certification Office."[9] The FAA indicated that it would work with the manufacturer and operators to develop a plan to allow 787's to resume operations as quickly and safely as possible. While the NTSB investigation was ongoing, the FAA and Boeing determined to move ahead with a comprehensive solution plan. They understood the sequence of events (a short circuit in one cell that propagated to other cells), but the actual cause of the short circuit remained unknown. That having been said, Boeing was able to narrow the cause of the short circuit to four or five potential causes. On February 17, 2013, Boeing submitted a comprehensive certification and design plan to the FAA for its review and approval. The plan included the following mitigation actions:

- At the battery cell level: They made design changes to the battery cells to reduce the chance of a short circuit (*Figure 3*),
- At the battery level: They proposed design changes to stop propagation from cell-to-cell (reduce the chance for cell-to-cell contact and the buildup of moisture) (*Figure 3*); and
- At the aircraft level: They improved the battery containment components to allow the venting of gases outside of the plane in the event of a battery short circuit (this was intended to do three things; prevent gases from entering the cabin; reduce the chance of cell-to-cell propagation; and preclude the possibility of a fire)(*Figure 3*).

[8] FAA Press Release, "FAA Will Review Boeing 787 Design and Production", January 11, 2013.
[9] Boeing Model 787-8 FAA Emergency Airworthiness Directive, AD #: 2013-02-51, January 16, 2013.

FIGURE 3:



Source: Boeing

The FAA approved the initial plan on March 12, 2013, which allowed Boeing to make alterations to the batteries on a 787 aircraft for test flight. On March 25, 2013, the FAA authorized a series of test flights. After the tests proved successful, Boeing submitted a final certification plan for the upgraded batteries to the FAA on April 8, 2013.

After further review by the FAA, the final plan was approved on April 19, 2013, and a modified AD was issued on April 26, 2013. The modified AD allowed for 787 aircraft to return to commercial service upon completion of the steps outlined in the certification plan. The AD and the updated certification plan did not affect the 787's original type and production certificates; the battery update as outlined in the certification plan is not considered a major design change and therefore does not require an amended type certificate.

Following the issuance of the AD allowing 787 aircraft to return to commercial service, other aviation regulatory authorities that had similar orders lifted them. Ethiopian Airlines was the first to return their aircraft to service on April 28, 2013. As of June 5, 2013, all 50 787's have received the battery modification, and have been returned to their respective operator and returned to commercial service. Delivery of the 787 has resumed as well, with all newly delivered aircraft containing the modified battery as prescribed by the AD.

Lessons Learned from Boeing and FAA Reviews

In the five months that have passed since the 787 battery incidents, the Committee on Transportation and Infrastructure has closely monitored all actions taken by the FAA, the NTSB, and Boeing. Below are some, but not all, of the lessons that have been learned so far.

- **Lithium-Ion Battery Testing:** The incidents advanced the understanding of lithium-ion batteries and their use in airplanes. Specifically, while the initial certification testing was extensive and reflected state of the art practices at the time, the FAA and Boeing developed additional testing methods. Boeing, the FAA, and industry stakeholders have also identified

ways to enhance the battery's design and manufacturing processes, and these enhancements have been incorporated into Boeing's comprehensive battery solution.

- **Communication:** While the "multi-tiered supplier" dynamic is not new to the Boeing 787, the FAA has determined that it needs to spend more time improving communication horizontally and vertically to ensure a clear traceability of all required changes down the supplier chain and to ensure that all instructions are clearly communicated along the chain.

WITNESS LIST

Panel 1

Ms. Margaret Gilligan
Associate Administrator for Aviation Safety
Federal Aviation Administration

Panel 2

Mr. Mike Sinnett
Chief Engineer for the 787 Program
Boeing