

September 25, 2014

Aircraft Serious Incident – JA804A (Boeing 787-8)

Operated by All Nippon Airways Co., LTD.

Occurred at Takamatsu Airport, Japan on January 16, 2013

1 Actions to be taken by the FAA

The internal short circuit test by nail penetration method under the simulated on-board configuration with the battery ground wire demonstrated a thermal runaway, while the test without the ground wire did not.

Given the facts and analyses of other tests combined, in the serious incident the very likely sequence of scenario for the main battery thermal runaway is as follows:

- ◆ Cell 6 was the initiator of the thermal propagation;
- ◆ Cell 6 and the brace bar contacted with each other allowing high currents to flow through the battery box to cause arcing; and
- ◆ Arcing bolstered the thermal propagation leading to the thermal runaway.

It is very likely that the engineering test conducted during the developmental phase did not develop into thermal runaway because the battery box was not grounded with the ground wire. This demonstrates that it was inappropriate to exclude the internal short circuit test from the safety assessment based on the test result which was not conducted simulating the actual airplane configuration.

There is a possibility that present standards for airplane LIB do not appropriately address the electric environment although they stipulate environmental conditions such as temperature, humidity, inertia, and so on. In addition, the FTA in the safety assessment provided to the JTSB lacked the assessment of the thermal propagation risk.

The probability of LIB vent with smoke was estimated to be less than one out of ten million flight hours in the type certification; however, in reality three events of cell heat generation have occurred in less than 250,000 flight hours, resulting in the rate far exceeding the estimate. The calculation of failure rate in the type certification, which was done based on the failure records of similar LIB, was probably inappropriate.

In addition, contactor opening not expected in the design is very likely associated with cell venting; therefore, the necessity for risk reassessment on the loss of all electric power should be examined.

The JTSTB, in light of the serious incident investigation, makes the following safety recommendations that the Federal Aviation Administration of the United States of America should take the following mitigation actions.

The FAA should:

- a. Provide instruction to airplane manufactures and equipment manufactures to perform equipment tests simulating actual flight operations.
- b. Review the technical standards for LIB to ensure that the electric environment is appropriately simulated, and if necessary, amend the standards.
- c. Review the LIB failure rate estimated during the 787 type certification, and if necessary, based on its result, review the LIB safety assessment.
- d. Review the TC for its appropriateness on heat propagation risk.
- e. Assess the impact of contactor opening after the cell vent on the flight operation and take appropriate actions, if necessary.

2 Measures to be Taken to Instruct The Boeing Company as a Designer and Manufacturer of the 787

Although this investigation could not conclusively identify the mechanism of the internal short circuit, low temperature during overnight stay possibly contributed to the internal short circuit as the three battery incidents (this serious incident inclusive) occurred in the midst of cold January and low temperature is said to be favorable for lithium metal deposition. In addition, there are reports of cell contamination deriving from manufacturing, which may be related to the cause of the battery event. Furthermore, this investigation found the unexpected BCU operation and contactor opening which are outside the design envelope in relation to the charging control.

In light of these facts, the Federal Aviation Administration should supervise Boeing to:

- a. Continue the study of internal short circuit mechanism considering the effects of non-uniform winding formation and other factors deriving from manufacturing process; and continue efforts to improve LIB quality and its

reliability, reviewing the LIB operational conditions, such as temperature.

- b. Improve BCU and contactor operations which are not intended in the design envelop.