AI2013-4

# AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

**ALL NIPPON AIRWAYS CO., LTD.**
**J A 8 6 7 4**

**October 25, 2013**

Japan Transport Safety Board

The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board (and with Annex 13 to the Convention on International Civil Aviation) is to prevent future accidents and incidents. It is not the purpose of the investigation to apportion blame or liability.

Norihiro Goto
Chairman,
Japan Transport Safety Board

Note:

This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.

# AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

| | |
|---|---|
| Operator: | ALL NIPPON AIRWAYS CO., LTD. |
| Type: | BOEING 767-300 |
| Registration number: | JA8674 |
| Type of serious incident: | ENGINE INTERIOR DAMAGE |
| Time and date of outbreak: | AT 09:19 , JULY 8, 2011 |
| Occurrence Point: | AT AN ALTITUDE OF APPROX. 8,500M<br>ABOUT 79KM TO THE NORTHWEST<br>OF TOKYO INTERNATIONAL AIRPORT |

September 27, 2013

Adopted by the Japan Transport Safety Board

| | |
|---|---|
| Chairman | Norihiro Goto |
| Member | Shinsuke Endoh |
| Member | Toshiyuki Ishikawa |
| Member | Sadao Tamura |
| Member | Yuki Shuto |
| Member | Keiji Tanaka |

## 1. PROCESS AND PROGRESS OF THE INVESTIGATION

On July 8, 2011, the Japan Transport Safety Board designated an investigator-in-charge and two investigators to investigate this serious incident.

An accredited representative of the United States of America, as the State of Design and Manufacture of the aircraft and engine involved in this serious incident, and that of Singapore, as the State of Engine Parts Repair, participated in the investigation.

Comments from parties relevant to the cause of the serious incident were invited. Comments on the draft report were invited from the relevant States.

## 2. FACTUAL INFORMATION

| | |
|---|---|
| **2.1 History of the Flight** | On July 8, a Boeing 767-300, registered JA8674, operated by All Nippon Airways Co., Ltd. (hereinafter referred to as “the Company”) took off from Tokyo International Airport for Toyama Airport as a scheduled Flight 883 at 09:08 JST (UTC+9 hours).<br>At 09:19 while flying at an altitude of approximately 8,500m, a loud noise accompanied by vibration was heard from No.1 Engine (the left engine; hereinafter referred to as “the Engine”); therefore, the flight crew they shut it down and returned to Tokyo International Airport. The Aircraft made an uneventful landing at the airport at 09:51 after obtaining a priority in the air traffic control. |

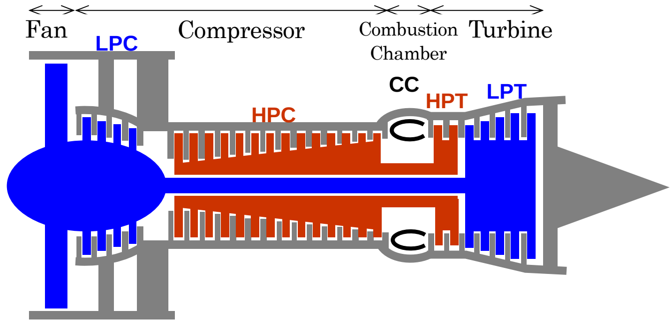
<table>
<tr><td>2.2 Injuries to Persons</td><td>None</td></tr>
<tr><td>2.3 Damage</td><td>

(1) Extent of Damage: Minor damage (major damage to inside of the engine)

(2) Damage to inside of the Engine

The High Pressure Turbine (hereinafter referred to as “HPT”) is composed of two stages. Out of 74 second stage HPT blades, the blade 69 (hereinafter referred to as “the Blade”) was separated at a distance of 1.3 inches (1 inch = about 25.4mm) from the bottom in the shank and lost. Other blades exhibited damage on the blade tips.

The Low Pressure Turbine (hereinafter referred to as “LPT”) is composed of five stages. The LPT blades exhibited damage along the full axial length of the LPT module.




Schematic Diagram of the Engine

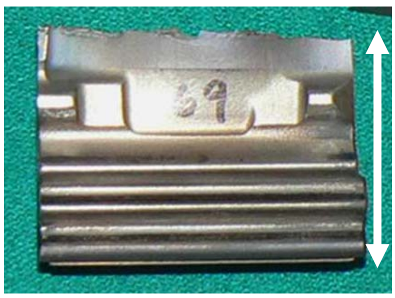

Image of the second stage HPT blade

The meanings of the abbreviations are as follows:

LPC: Low Pressure Compressor, HPC : High Pressure Compressor

CC: Combustion Chamber

HPT: High Pressure Turbine, LPT : Low Pressure Turbine



1.3 inches

Blade 69 (side view)

Blade 69 (top view)

</td></tr>
<tr><td>2.4 Personnel Information</td><td>

(1) Pilot In Command Male, Age 52

Airline Transport Pilot Certificate (Airplane) December 14, 2006

Type rating for Boeing 767 November 25, 2003

Class 1 Aviation Medical Certificate Validity : Until September 5, 2011

(2) First Officer Male, Age 64

Airline Transport Pilot Certificate (Airplane) September 15, 2009

Type rating for Boeing 767 May 27, 1992

Class 1 Aviation Medical Certificate Validity : Until September 9, 2011

</td></tr>
</table>

## 2.5 Aircraft Information

(1) Type: Boeing 767-300

Serial number: 25661; Date of manufacture: May 19, 1994

Certificate of airworthiness: No. 99-057

Validity: During a Period in which the aircraft is maintained in accordance with the Maintenance Management Manual

(2) Engines

| | No.1 Engine | No.2 Engine |
|---|---|---|
| Type | General Electric CF6－80C2B2F | |
| Serial number | 702720 | 702681 |
| Date of manufacture | May 2, 1992 | February 27, 1992 |
| Total time in service | 55,536 hours and 50 minutes | 44,633 hours and 23 minutes |
| Total cycles in service | 23,373 cycles | 27,411 cycles |

## 2.6 Additional Information

(1) Measurement of the shank wall thickness of the second stage HPT Blades

The measurement of the shank wall thickness of the second stage HPT blades showed that the wall thickness of the Blade was 0.037 inches whereas average thickness of other blades was 0.08 inches (0.065 to 0.1 inches).

In view of this result, the Company removed the blades which have the same purchase and repair history with the Blade from the operating engines for shank wall thickness measurement. This resulted in finding another blade which exhibited thin shank wall thickness (hereinafter referred to as “the Similar Blade”).

(2) Detailed Examinations of the second stage HPT Blades

The engine manufacturer (hereinafter referred to as “the Manufacturer”) conducted detailed examinations of the second stage HPT blades and the Similar Blade. The results are as follows:

1) Visual examination of the second stage HPT blades

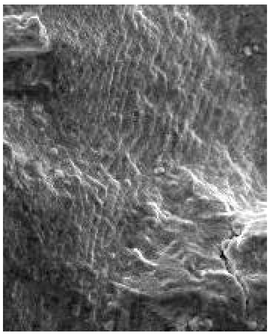
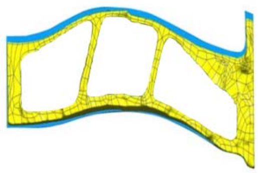
The part markings are cast into the shank. It was confirmed that the markings on the Blade and the Similar Blade were less legible than those of other blades, indicating that the surfaces of the Blade and the Similar Blades had been eroded. (See the pictures of blades below)

The Blade

The Similar Blade

Other blades

2) Fracture Surface Examination of the Blade

| | |
|---|---|
| | Traces of fatigue propagation were observed on the fracture surface of the Blade.<br>The shank wall thickness was thinner than the minimum design value of 0.055 inches.<br>High-temperature corrosion was observed on the internal surface of the fracture part, but it was limited within the outermost aluminide coating and did not penetrate into the base material. The component material analysis of the Blade showed no abnormality.<br><br>Fracture surface<br>3) Three-dimensional measurement and comparison with the reference data<br>Three-dimensional measurement of the Blade was done to compare with the reference data. The comparison showed that there were variations in wall thickness in the outer parts of the shank (the parts shown in blue in the diagram in the right) whereas there were no such variations in the interior of the shank.<br><br>The diagram of three-dimensional measurement<br>4) The repair history check of the Blade<br>In April 2008, the Blade was sent to a certificated repair facility*1 for overhaul. Grit blasting*2 (hereinafter referred to as "Blasting") was performed for cleaning as part of the repair work, but no crack in the shank was reported.<br>5) The repair history check of the Similar Blade<br>The repair history of the Similar Blade showed that during the last repair, the Similar Blade and the Blade received the Blasting on the same day.<br>6) Maintenance manual and a work order document<br>In the maintenance manual, no minimum wall thickness was specified for the second stage HPT blade shank. In addition, there was non-specific instruction on a pneumatic pressure for Blasting in the work order document provided by the repair facility, suggesting that possible excessive Blasting occurred depending on the pneumatic pressure used.<br>The work order document with the non-specific instruction had been used from February 2008 to until it was revised in June 2009.<br>7) Manufacturing process for the second stage HPT blades<br>The second stage HPT blades are manufactured by casting. The examination of equipment, jigs used at the time of manufacturing of the Blade and the corresponding production record revealed no abnormality. In addition, no abnormality has been reported regarding the shank wall thickness of the blades manufactured in the same lot as the Blades (except the Similar Blade). |

*1 "certificated repair facility" is the facility that had been reviewed and approved about overhaul instructions and procedures for the CF6-80C2 HPT stage 2 blade by the Manufacturer.

*2 "Grit blasting" is a process to remove foreign materials from a metallic surface (of a part) to be coated by blasting the surface with minute grit particles. The usual practice for performing grit blasting is to perform it in accordance with manufacturers' standards because there is no public standard for grit blasting.

# 3. ANALYSIS

| | |
|---|---|
| 3.1 Involvement of Weather | None |
| 3.2 Involvement of Pilots | None |
| 3.3 Involvement of Aircraft | Yes |
| 3.4 Analysis of the Findings | (1) Cause of the Fracture of Blades<br>1) Identification of the blade that fractured first<br>Judging from the fact that the Blade had the least amount of the remaining part and the existence of fatigue propagation cracks, it is highly probable that the Blade was the first one to separate.<br>2) Cause of the Blade Fracture<br>It is probable that as the shank wall was thinner than the minimum design value, fatigue caused by the stress during the engine operation generated cracks and they propagated leading to the fracture of the Blade.<br>(2) Cause of the Thinner Shank Wall<br>With the reasons listed below, it is possible that the thinning of the shank below the minimum design value was caused by excessive Blasting during the repair work at the repair facility:<br>・ The non-specific instruction in the work order document lead to the excessive Blasting by the worker.<br>・ The shank exhibits the sign of being eroded on its surface.<br>・ The second stage HPT blades are cast, and no abnormality was reported on the shank thickness for the blades produced in the same lot of the Blade.<br>・ The Similar Blade and the Blade received the Blasting on the same day. |

# 4. PROBABLE CAUSES

It is highly probable that this serious incident was caused by the separation of a second stage HPT blade via fatigue mechanisms during service, followed by the liberated blade fragment in the shank (post-separation) resulted in secondary downstream impact damage for entire axial length of the LTP.

The possible contributing factor to the fatigue propagation was increase in stress because of the reduction in wall thickness caused by excessive grit blasting during the last repair.

# 5. SAFETY ACTIONS

(1) Safety Actions Taken by the Company

Immediately after this serious incident, the Company decided to perform measurement of the shank wall thicknesses of all the blades when second stage HPT blades are removed from the same type engines.

In addition, during the initial phase of the investigation the Engine Center of the Company, even before the presentation of the Manufacturer's opinion, removed the engines of the same type from the operating aircraft, which incorporated blades purchased around the same time as the Blade and had the same repair history, and measured the wall thickness of the blade. This action resulted in the discovery of the Similar Blade facilitating the finding of the probable cause.

(2) Safety Actions Taken by the Manufacturer

The Manufacturer specified the minimum shank wall thickness, measured the shank wall thicknesses of all blades sent to the Manufacturer-designated repair facility for maintenance and continued monitoring the measurements beginning in October 2011.

In December 2011, the Manufacturer individually sent information on the incident to operators that owned blades which might have been subjected to excessive Blasting.

The monitoring found another blade with a thin shank wall. The Manufacturer issued a Service Bulletin dated September 20, 2012, recommending operators to check the blades for serial numbers of the possible problematic blades and to measure the wall thicknesses of all second stage HPT blades.