

AI2015-7

**AIRCRAFT SERIOUS INCIDENT
INVESTIGATION REPORT**

**ALL NIPPON AIRWAYS CO., LTD.
J A 7 0 1 A**

October 29, 2015



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

ENGINE INTERIOR DAMAGE
ALL NIPPON AIRWAYS CO., LTD.
BOEING 777-200, JA701A

AT AN ALTITUDE OF APPROXIMATELY 32,600 FT,
ABOUT 90 KM WEST OF TOKYO INTERNATIONAL AIRPORT
AT AROUND 08:44 JST, DECEMBER 13, 2013

October 9, 2015

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

The Japan Transport Safety Board (JTSB) designated an investigator-in-charge and one investigator on December 13, 2013 to investigate this serious incident. An accredited representative of the United States of America, as the State of Design and Manufacture of the aircraft involved in the serious incident, participated in the investigation. Comments were invited from parties relevant to the cause of the serious incident and relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight	<p>On Friday December 13, 2013, at around 08:29 Japan Standard Time (JST: UTC + 9 hrs), a Boeing 777-200, registered JA701A, operated by All Nippon Airways, Co., Ltd., took off from Tokyo International Airport for Fukuoka Airport on scheduled Flight 243 of the company.</p> <p>While climbing up FL400 of cruising altitude after liftoff, at an altitude of approximately 32,600ft, the flight instrument indicated the engine thrust decrease of the No.2 Engine (the right engine; hereinafter referred to as “the Engine”) and an increase in its exhaust gas temperature (EGT); accordingly, it was shut down, and then the aircraft returned to Tokyo International Airport and landed at 09:15 after obtaining a priority in the air traffic control.</p> <p>This serious incident occurred at about 90 km west of Tokyo</p>
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International Airport (Latitude 35° 35' 23" N and Longitude 138° 49' 00" E) at around 08:44, on December 13, 2013.

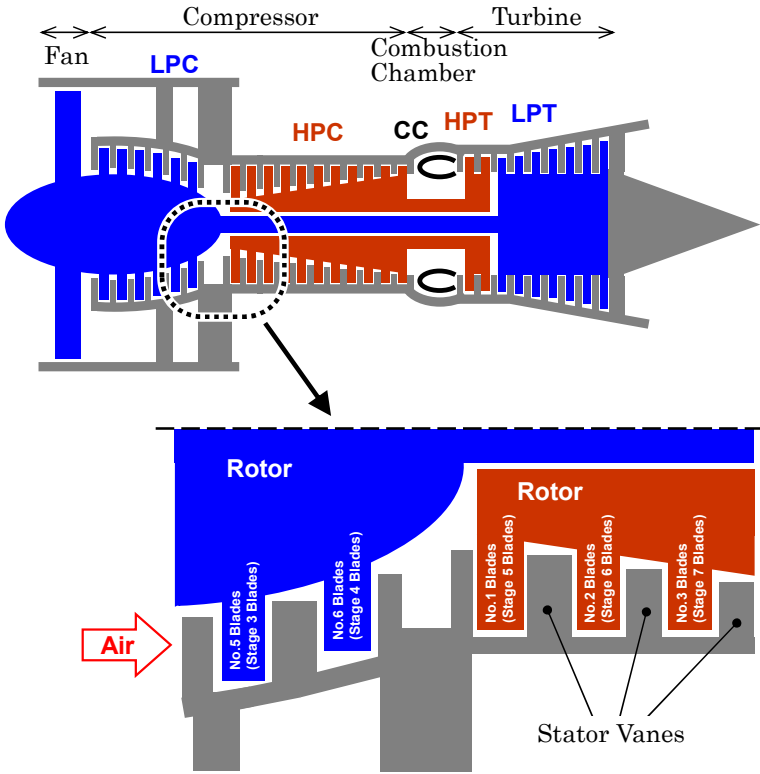
2.2 Injuries to Persons
None

2.3 Damage to Aircraft
Extent of Damage: Slightly damaged (major damage to inside of the engine)

(1) Engine Interior Damage

The Engine is a two-spool turbopfan engine and consists of Fan, Low Pressure Compressor (LPC), High Pressure Compressor (HPC), Combustion Chamber (CC), High Pressure Turbine (HPT), and Low Pressure Turbine (LPT).

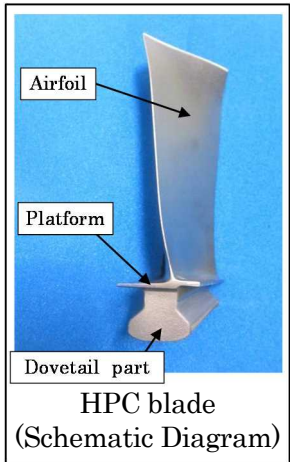
The description of the stage of each blade of LPC and HPC in this report was expressed the number of the stages from each front to be plain. Additionally the number of the stages by notation method of the engine manufacturer was expressed within a parenthesis.



PW4074 Engine (Schematic Diagram)

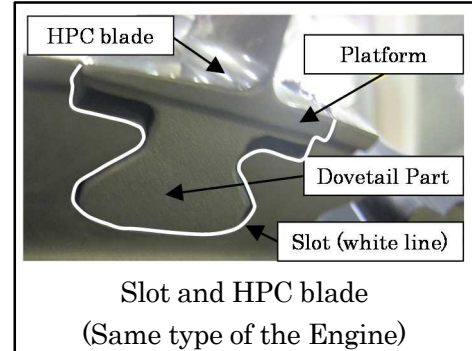
1. Fan and LPC

The Fan has one stage, and the LPC is made of six stages in total. There was no damage in the fan blades and the first stage (stage 1.1) through the fifth stage (stage 3) blades of LPC in the fore. In the sixth stage (stage 4) blades of the LPC, all of the blades exhibited trailing edge damage including nicks, dents, tears.



2. HPC

The HPC is made of 11 stages in total. The first stage blades of HPC (stage 5) were severely damaged around the entire periphery of disc, and all the blades were either fractured at the airfoil roots, or missing from the grooves for installing the blades on the disk (hereinafter referred to as “slot”). All the blades of the second stage (stage 6) blades of HPC were fractured at the airfoil roots. There was also a damage in the area aft the second stage blades of HPC that were probably caused by the fractured blades of the first and the second stage blades of HPC.



3. Area aft the combustion chamber

The damage by the fractured blades in the front stages and abnormal combustion were also observed in the area aft the combustion chamber.

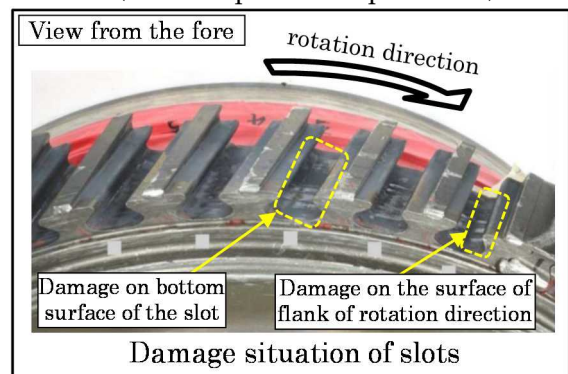
(2) Breakage situation around the first stage blades of HPC

1. The first stage disk and blades of HPC

Forty HPC blades are installed on the first stage disk of HPC. These blades are installed by setting the dovetail parts of the blades into the slots, and fixed by swaging the pin-shaped blade lock fittings inserted between the bottoms of the dovetail parts and the disk. In addition, silicon rubber had been applied on the installed parts.



With regard to the situation of the first stage disk and blades of HPC of the Engine, the blades had fallen off from their 16 slots; on the contrary, the parts of the blades (dovetail parts and platforms) were remaining in 24 slots, but the airfoils were fractured on the platforms. In 16 slots among the 24 slots where parts of the blades were remaining, the blade lock fittings were missing, whereas



	<p>the blade lock fittings were remaining in eight slots.</p> <p>There was a damage on the surface of flank of the slots in the disk rotation direction where the blades had fallen off; besides, there were severe scratch marks on the bottom surfaces of the slots.</p> <p>The blades in which their blade lock fittings were missing have shifted toward the rear of the slots, and there was a severe damage at the edges of the blade platforms by coming into contact with the rear stator vanes. Besides, traces of installing the blade lock fittings and traces of applying the silicon rubber were remaining.</p> <p>2. Abnormal damage slot in the first stage disk of HPC</p> <p>Among the slots in the first stage disk of HPC where the blades fell off, there was one slot which has an abnormal damage that was different from other slots. In the said slot, the damage was on the reverse flank of the slot rotation direction, and there was almost no damage on the bottom surface and the surface of the flank of the slot in the rotation direction.</p> <div data-bbox="877 622 1458 1003" style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Damage situation of slot with abnormal damage</p> </div>																					
<p>2.4 Personnel Information</p>	<p>(1) PIC Male, Age 62 Airline transport pilot certificate (Airplane) April 2, 1991 Type rating for Boeing 777 November 5, 2009 Class 1 aviation medical certificate Validity : April 2, 2014</p> <p>(2) First Officer Male, Age 47 Airline transport pilot certificate (Airplane) November 6, 2008 Type rating for Boeing 777 September 13, 2004 Class 1 aviation medical certificate Validity : September 28, 2014</p>																					
<p>2.5 Aircraft Information</p>	<p>(1) Type: Boeing 777-200 Serial number: 27938, Date of manufacture: July 9, 1997 Certificate of airworthiness: 98-052 Validity: During the period in which the aircraft is maintained in accordance with the Maintenance Management Manual</p> <p>(2) Engines</p> <table border="1" data-bbox="507 1711 1442 2119"> <thead> <tr> <th></th> <th>No.1 Engine</th> <th>No. 2 Engine</th> </tr> </thead> <tbody> <tr> <td>Type</td> <td colspan="2">Pratt & Whitney PW4074</td> </tr> <tr> <td>Serial number</td> <td>P777093</td> <td>P777075</td> </tr> <tr> <td>Date of manufacture</td> <td>February 13, 1998</td> <td>May 12, 1997</td> </tr> <tr> <td>Total time in service</td> <td>29,072 hr 24 min</td> <td>33,661 hr 02 min</td> </tr> <tr> <td>Total cycles in service</td> <td>22,419 cycles</td> <td>24,176 cycles</td> </tr> <tr> <td>Total time in service after overhaul</td> <td>3,774 hr 40 min</td> <td>5,057 hr 12 min</td> </tr> </tbody> </table>		No.1 Engine	No. 2 Engine	Type	Pratt & Whitney PW4074		Serial number	P777093	P777075	Date of manufacture	February 13, 1998	May 12, 1997	Total time in service	29,072 hr 24 min	33,661 hr 02 min	Total cycles in service	22,419 cycles	24,176 cycles	Total time in service after overhaul	3,774 hr 40 min	5,057 hr 12 min
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2.6 Additional Information	<p>The analysis result and views by the engine manufacturer with regard to the first stage disk of HPC, the first stage blades which remained in the disk slots and the recovered damaged blades are as follows.</p> <ul style="list-style-type: none"> • No abnormalities were found in the first stage blades of HPC and on the slots where the blade lock fittings were installed. • Overall, the fracture surfaces of the blade airfoil sections showed that a force exceeding the elastic limit was applied suddenly, and showed more intense secondary damage. • There were no clear cracks found on the blades in the observation by microscope. • The slots of the first stage disk of HPC in which the fractured blades were installed could not be determined. • The fractured first stage blades of HPC were recovered between the first stage and the second stage of HPC. Although there were blades with partial damage to the parts of the platforms and the dovetails found from among these blades, there were no specific characteristics left to determine the cause of damage due to the severe secondary damage. • Seriously damaged first stage blade of HPC which were collected between the second stage and the third stage of HPC had major damage in the dovetail part. It is somewhat likely that the damage at the dovetail part of the blade was the origin of the breakage, but even if this damage was the origin, the cause of this case could not be determined from the obtained evidence due to the severe secondary damage. • The damage of the dovetail parts in the first stage blades of HPC or the malfunction by losses of the blade lock fittings is not known in the same type of engine, but we will monitor the operation status of them and take actions as needed.
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3. ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilots	None
3.3 Involvement of Aircraft	Unknown
3.4 Analysis of the Findings	<p>(1) Cause of engine interior damage</p> <p>From the breakage situation, it is highly probable that the engine interior damage was caused by the damage of the first stage blades of HPC around the entire periphery.</p> <p>It is somewhat likely that the first stage blades of HPC around the entire periphery were damaged because one of the blades in the first stage blades of HPC was damaged at the dovetail part and fell off from its slot.</p> <p>With regard to the damage at the dovetail part of the first stage blades of HPC, its cause could not be determined due to the severe damage.</p>

(2) Origin of the engine interior damage

On the first stage disk of HPC, severe scratch marks were found on the bottom surfaces and the surfaces of flanks of the slots in the rotation direction in all the slots, except for one slot with an abnormal damage. However, the damage on the bottom surfaces and the surfaces of flank of the slots in the rotation direction that were found in other slots were not found in the said slot.

With regard to the situation of the damage that the fractured blades caused to the structure of the slots, it is somewhat likely that the situation will be different between the blades which became the origin and the secondary fractured blades, thus it is somewhat likely that the blade installed in the said slot was the origin.

4. PROBABLE CAUSES

It is highly probable that the serious incident occurred because the engine interior was damaged due to the damage of the blades around the entire periphery of the first stage disc of HPC (stage 5) of the No.2 Engine (the right engine) during the flight.

With regard to the damage of the blades around the entire periphery of the first stage disc of HPC, it is somewhat likely that one of the blades was damaged at the dovetail part and fell off from the slot.