AI2019-7

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

JAPAN AIRLINES CO., LTD.
J A 7 4 3 J

October 31, 2019

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.

Nobuo Takeda
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

CASE EQUIVALENT TO DAMAGE TO ENGINE CASING
JAPAN AIRLINES CO., LTD.
BOEING 777-300ER, JA743J
AT TOKYO INTERNATIONAL AIRPORT, JAPAN
AROUND 11:00 JST, SEPTEMBER 5, 2017

September 11, 2019

Adopted by the Japan Transport Safety Board

Chairman	Nobuo Takeda
Member	Toru Miyashita
Member	Yoshiko Kakishima
Member	Yuichi Marui
Member	Yoshikazu Miyazawa
Member	Miwa Nakanishi

1. PROCESS AND PROGRESS OF THE AIRCRAFT SERIOUS INCIDENT INVESTIGATION

1.1 Summary of the Serious Incident	On Tuesday, September 5, 2017, a Boeing 777-300 ER, registered JA743J, operated by Japan Airlines Co., Ltd., had noise generating from the No. 1 engine (the left engine) along with indication of occurrence of engine failure illuminated on instruments immediately after take-off from runway 34R at Tokyo International Airport, and consequently, shut down the engine and returned to the airport for landing after obtaining a priority from air traffic control. The inspection conducted after landing revealed that multiple stages of stator vanes and turbine blades in low pressure turbine (LPT) of the engine were damaged and a hole was confirmed to have been generated in turbine rear frame.
1.2 Outline of the Serious Incident Investigation	The occurrence covered by this report falls under the category of the case equivalent to “Damage of engine (limited to such a case where fragments penetrated the casing of subject engine)” as stipulated in Article 166-4 (vi) of Ordinance for Enforcement of the Civil Aeronautics Act of Japan (Ordinance of Ministry of Transport No. 56 of 1952), and is classified as a serious incident. The Japan Transport Safety Board designated an investigator-in-charge and two investigators on September 6, 2017 to investigate this serious incident. Analysis of the hole generated in the turbine rear frame associated with the investigation of the serious incident was entrusted to National Institute for Materials Science (NIMS). An accredited representative and an advisor of the United States of America, as the State of Design and Manufacture of the aircraft involved in this serious accident, participated in the investigation. Comments were invited from parties relevant to the cause of this serious incident and the Relevant

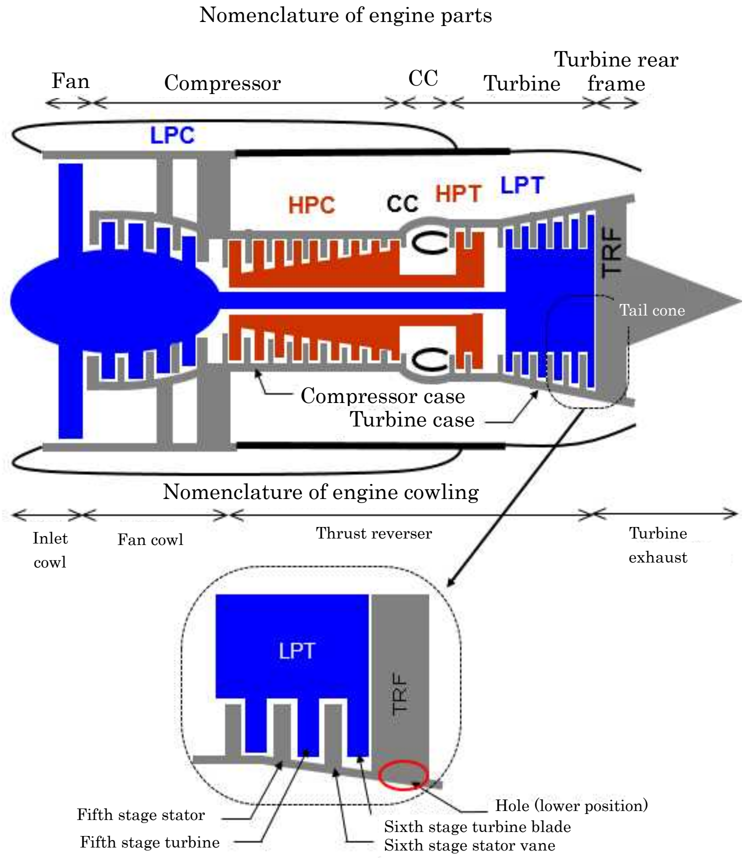
	State.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statements of the flight crew and the local controller of Tokyo airport traffic control tower and the records of FDR (Flight Data Recorder) (see Appended Figure 3), the history of the flight is summarized as below. On September 5, 2017 at 10:59:13 in Japan Standard Time (JST: UTC+9 hours; unless otherwise noted, all times are indicated in JST in this report on a 24-hour clock), a Boeing 777-300 ER, registered JA743J (hereinafter referred to as "the Aircraft"), operated by Japan Airlines, Co., Ltd. (hereinafter referred to as "the Operator") as a scheduled flight 006, commenced take off roll from runway 34R at Tokyo International Airport (hereinafter referred to as "the Airport") bound for John F. Kennedy International Airport. The captain (SIC*1) sat in the left seat as PF (a pilot in charge of mainly aircraft control), the First Officer sat in the right seat as PM (a pilot mainly in charge of monitoring of the aircraft in flying status, cross-checking of operations of PF and performing tasks other than flying) and the captain (PIC*2) sat in the observer seat (seat behind the center console). At 11:00:04, immediately after lift-off, noise was generated from the No. 1 engine (the left engine) (hereinafter referred to as "the Engine") with the engine rpm decreasing, and caution message (ENG THRUST L) indicating reduced thrust was illuminated. At this moment, the local controller sighted that flame occurred behind the Engine. The take-off was continued. During climb, after PF and PM mutually confirmed the engine failure, PM shut down the Engine according to the order from the PF with check list (Eng Svr Damage/Sep L) at 11:00:49. Then an emergency was declared while kept climbing and flight crew decided to return to the Airport after obtaining a priority from air traffic control. Following the procedures, the fuel was dumped off the coast of Tateyama City to make the weight of the Aircraft below the maximum landing weight and returned to the Airport. The Aircraft landed on runway 34L at 12:09. There were 251 persons in total on board, consisting of two captains, 16 crew members and 233 passengers. There was no injury. Runway the Aircraft had taken off from was closed for checking after taking off and many of the engine part fragments were recovered from the runway and from surroundings of the runway (see Appended Figure 4). Besides, it was confirmed that grass area along the side near runway the Aircraft had taken off from was burned (see Appended Figure 1 and 2), which was extinguished by fire department of the Airport. The serious incident occurred near the end of runway 34R (35°33' 12" N, 139° 46' 52" E) and the time of the occurrence was September 5, 2017 around

*1 SIC is an abbreviation of Second in Command and refers to the crew member who holds the high level of command next to PIC among all operating crew members.

*2 PIC is an abbreviation of Pilot in Command and refers to the crew member who is qualified as the captain and holds the final responsibility for the operation and the safety of aircraft.

	11:00.
2.2 Injuries to Persons	None
2.3 Damage to Aircraft	(1) Extent of Damage to the Aircraft: Slightly Damaged The airframe suffered damage from many foreign substances hitting flaperon lower surface, flap inner side fairing, wing lower surface, outer flap lower surface and left horizontal stabilizer front edge. (2) Fractured Left Engine The aircraft is equipped with two-spool turbofan engine (General Electric type GE90-115B) and the engine consists of Fan, Low Pressure Compressor (LPC), High Pressure Compressor (HPC), Combustion Chamber (CC), High Pressure Turbine (HPT) and Low Pressure Turbine (LPT) in the order from the front (see Figure 1). Each of these engine parts is covered by case, and furthermore, the outside of the parts is covered by engine cowling. LPT consists of six stages and each stage consists of a pair of stator vane and turbine blade.  Figure 1: Image of GE90-115B engine LPT fifth stage stator vanes consists of 26 segments making a round circumferential assembly and each segment is formed by six stator vanes. Besides, turbine rear frame (TRF), which is a structural part to attach the engine to the airframe, is attached to the aft flange of the LPT case. The condition of the left engine was as follows: (i) One of LPT fifth stage stator vanes was fractured (see Figure 2). No fracture was confirmed in other stator vanes, and the fractured stator vane airfoil could not be found.

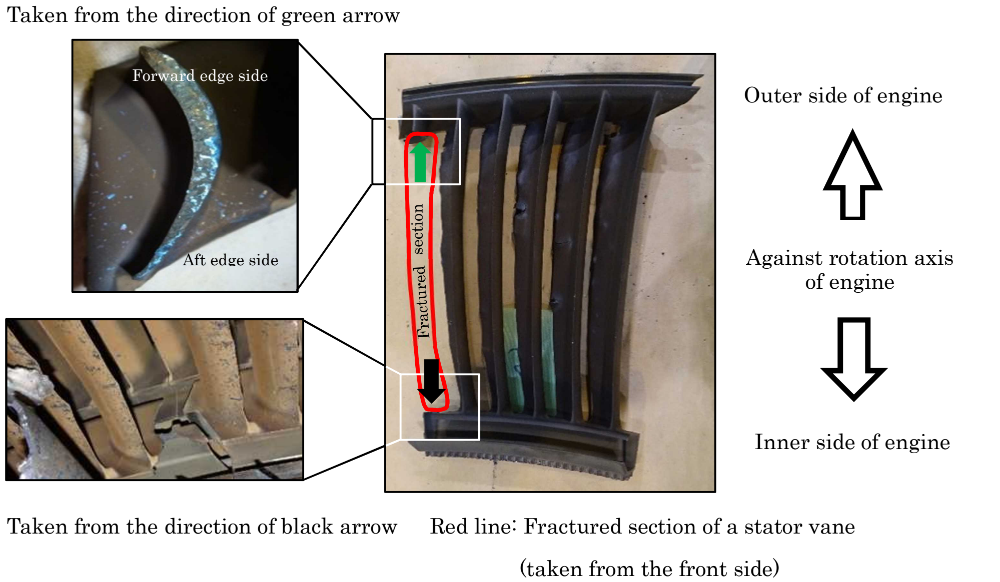


Figure 2: Condition of the fractured stator vane of LPT fifth stage stator vanes segment

Wearing caused by rubbing of adjacent segments was confirmed on slash-face of inner platform of multiple segments of LPT fifth stage stator vanes (see Figure 3 and 7).

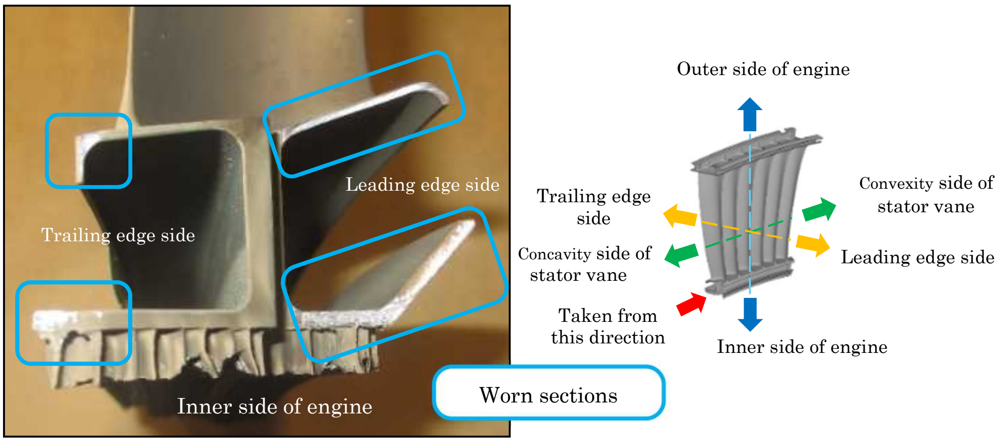
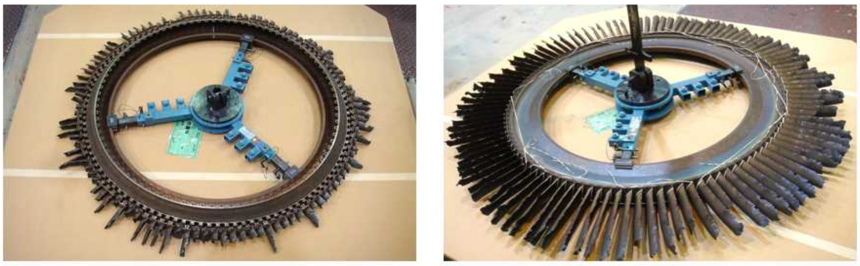
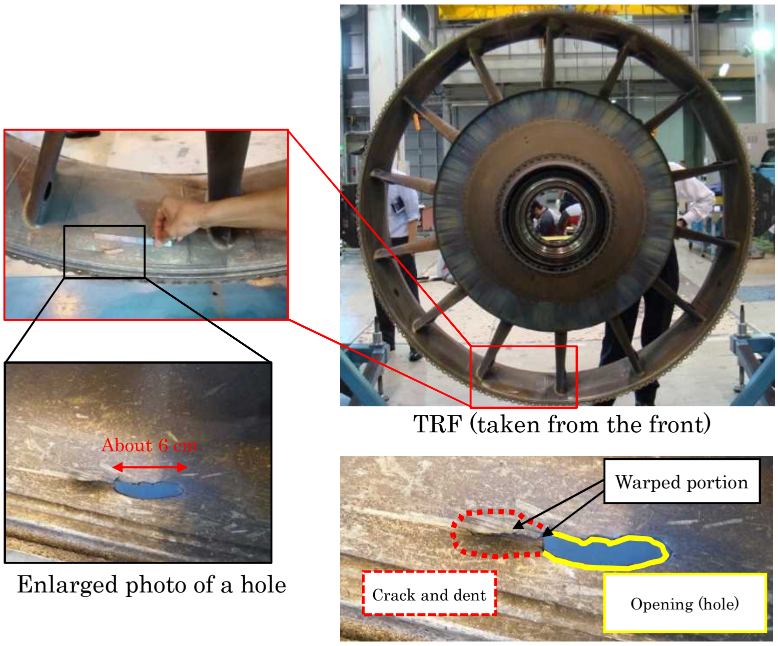


Figure 3: Worn LPT fifth stage stator vane segments

(ii) Fifth and sixth stage turbine blades which were downstream from LPT fifth stage stator vanes were damaged all along the circumference (see Figure 4). Sixth stage stator vane was damaged except for a certain section.

(iii) A hole in size of about 6 cm x about 1 cm, concave deformation (dent) and crack were confirmed on the lower section of TRF attached to the aft flange of the LPT case. (see Figure 5).

(iv) No trace of damage was confirmed forward of the LPT fifth stage stator vanes. Besides, there was no trace of abnormal combustion confirmed inside the engine.

	(v) No damage in engine cowl was confirmed.  Figure 4: Damaged condition of LPT fifth stage disk and blades (left) and sixth stage disk and blades (right)  TRF (taken from the front) Enlarged photo of a hole Figure 5: A hole on TRF
2.4 Personnel Information	(1) Captain (PIC) Male, Age 49 Airline transport pilot certificate (Airplane) June 5, 2003 Type rating for Boeing 777 December 19, 2016 Class 1 aviation medical certificate Validity September 14, 2018 (2) Captain (SIC) Male, Age 61 Airline transport pilot certificate (Airplane) October 4, 1996 Type rating for Boeing 777 May 17, 2012 Class 1 aviation medical certificate Validity March 4, 2018 (3) First Officer Male, Age 46 Commercial pilot certificate (Airplane) November 11, 1997 Type rating for Boeing 777 December 20, 2005 Instrument flight certificate November 30, 1998 Class 1 aviation medical certificate Validity April 29, 2018
2.5 Aircraft Information	(1) Aircraft Type Boeing 777-300 ER

	Serial number 36130 Date of manufacture October 6, 2009 Certificate of airworthiness No. 2009-247 Validity During the period when maintenance management manual approved by the Civil Aeronautics Act of Japan is applied. When the serious incident occurred, the weight and balance of the Aircraft were within the allowable range. Flight time since the last periodical check (C check conducted on February 19, 2017) 2,544 hours 0 minutes (2) Engine

Attached position	No. 1 (left)	No. 2 (right)
Type	General Electric GE90-115B	
Serial number	906-695	906-598
Date of manufacture	August 29, 2009	March 24, 2009
Total flight time	36,340 hours	29,622 hours
Number of cycles	3,797 cycles	3,777 cycles

(3) Major Maintenance Records of Left Engine at the Operator

Based on the service bulletin (SB72-0226), the Operator replaced sixth stage turbine blade on December 4, 2013.

During the C check conducted on February 19, 2017, the Operator checked gear box and bearings as well as HPT first and second turbine blades, second stage stator vanes and fuel filter using a bore scope.

The Operator conducted check of HPT first stage shroud on June 8, 2017.

The Operator conducted operational check of engine control system and metal fragment check of starter on September 2, 2017.

2.6 Additional Information

(1) Detailed Investigation of LPT Fifth Stage Stator Vanes Segments

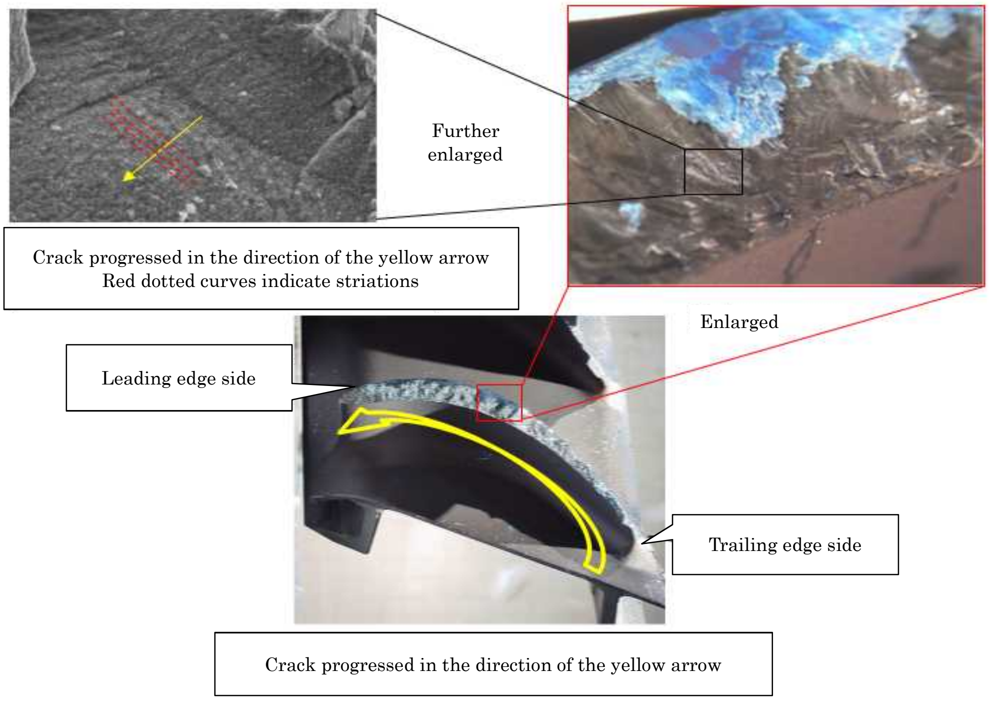
At the facility of the engine manufacturer, detailed investigation (confirmation of records at the time of manufacture, dimensional inspection, metal inspection, x-ray inspection and analysis of fractured surface) of LPT fifth stage stator vanes segments, which had a fractured stator vane, was conducted.

Confirmation of records at the time of manufacturing showed no anomaly. No dimensional anomaly was confirmed except for the fractured section. Metal inspection result showed that the materials used did not have anomaly. X-ray inspection result showed that there existed no anomaly inside the parts.

It was presumed that the wearing confirmed on the slash-face of inner platform of multiple segments of LPT fifth stage stator vanes indicated that arch-binding*3 had likely occurred.

Fractured surface analysis was conducted on the fractured surface of the outer side of engine of the segments, which had the fractured stator vane, using Scanning Electron Microscope (SEM). Result of the fractured surface analysis

*3 Arch-Binding refers to the condition of adjacent segments that are stuck tight, and the free movements of the adjacent segments are impeded.

	confirmed many strip-patterned traces (striations), which indicated fatigue fractures generated by repetitive stress. Besides, arrest lines*4 were periodically confirmed between a mass of striations, which was presumed to have been affected by arch-binding. Although the initiating point of the crack could not be identified, the cracking progressed from trailing edge side to leading edge side, which reached the presumption that the crack initiating point was on trailing edge side. Traces indicating fatigue fractures on the trailing edge side of the fractured surface was erased by collisions of fragments at the time of fracture of fifth stage stator vanes or rubbing of fractured surfaces, or exposure to heat during the process of progressing the crack. The sections where striations and arrest lines were confirmed had suffered less heat affect, and thus, maintained the condition at the time of the occurrence of the fractures intact (see Figure 6).  Figure 6: Condition of the fractured surface of fifth stage stator vane From the detailed investigation of LPT fifth stage stator vanes segments of the serious incident and the analysis of previous engine failures conducted by the engine manufacturer as detailed in 2.6(2), it was presumed that the fracture of LPT fifth stage stator vanes of the serious incident was caused by arch-binding that was generated on the slash-faces of platform of inner side of engine of adjacent segments of LPT fifth stage stator vanes, which then led to the crack due to the increased stress of the trailing edge side of the outer side of engine in the concavity side of the stator vane, and the crack then progressed to the fracture due to the repetitive stress by engine operations. (2) In-House Test and Service Bulletin (SB72-0637) of the Engine Manufacturer

*4 Arrest Lines refers to the lines formed on fractured surface when crack commences progress again under the situation where progress of crack repeats halts and reopens by fatigue fracture associated with change in acting status of stress.

(i) In-house tests

In-house test on the same type of the engine conducted by the engine manufacturer in March and April 2013 indicated the occurrence of the engine failure that one of LPT fifth stage stator vanes was fractured, which is similar to the serious incident. In addition, this in-house test was not conducted under the conditions of representative field cycle during normal engine operation. The idle operation before the take-off engine thrust was for 1 minute and made shorter than usual.

The stress analysis conducted by the engine manufacturer revealed that, if arch-binding occurred on the slash-faces of the inner side platform of adjacent segments of LPT fifth stage stator vanes, it increases stress of the trailing edge side of the outer side of engine in the concavity side of the stator vane (see Figure 7).

Furthermore, investigation result of the same type of the engine under operation showed that wearing caused by arch-binding was predicted on LPT fifth stage stator vanes segment.

From these, it was presumed that the fracture of LPT fifth stage stator vane of the in-house test had been initiated by the crack generated at the point where the stress had been increased caused by arch-binding, and then the crack had progressed further to the fracture by the repetitive stress by engine operations.

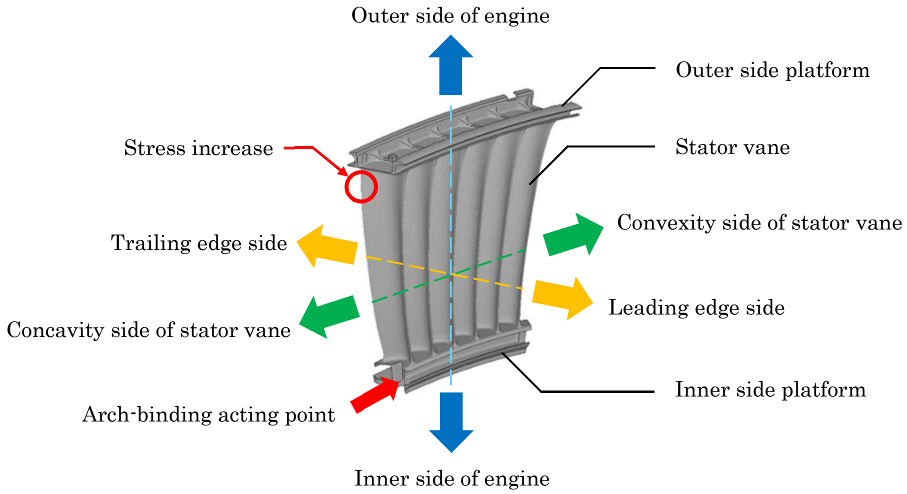


Figure 7: LPT fifth stage stator vane segment

(ii) Service bulletin (SB72-0637)

The engine failure analysis described in (i) above induced the engine manufacturer to change the design in a way to widen the space of the leading edge side of the inner side of engine of adjacent segments of LPT fifth stage stator vanes in order to avoid the occurrence of arch-binding (see Figure 8).

Engines on and after the serial number 907-745 incorporated segments with a widened space.

The engine manufacturer published the service bulletin (SB72-0637) on May 4, 2015 notifying that the design-changed LPT fifth stage stator vanes segment is compatible with previous parts for use as spare parts. This service bulletin (SB72-0637) did not describe that the part was design-changed as a countermeasure for the in-house test.

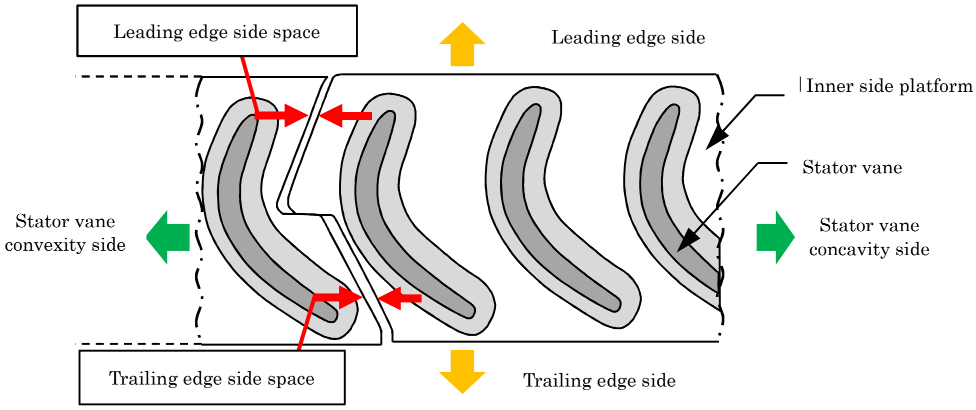


Figure 8: Space of LPT fifth stage stator vanes segments

(3) Handling of service bulletin (SB72-0637) by the Operator

According to the Operator, the service bulletin (SB72-0637) was set to apply to the same type of the engine of the Operator, however, due to absence of imminent need of replacement of the part, the Operator intended to replace LPT fifth stage stator vanes segment when it became worn away and required the replacement with a spare part which has design change in accordance with the service bulletin (SB72-0637).

According to the maintenance records of the Operator, one of the LPT fifth stage stator vanes segments of the same type of the engine was replaced with a spare part which has design change in accordance with the service bulletin (SB72-0637) during maintenance work of the same type of the engine, but not a subject engine, conducted in February through November 2015, before the serious incident had occurred.

(4) The Actions Taken by the Operator after the Serious Incident

The Operator, as an interim safety action, conducted inspection on all LPT fifth stage stator vanes of the same type of the engine under operation for existence of cracks using a bore scope. The Operator thereafter conducted Bore Scope Inspection (hereinafter referred to as "BSI") every 100 cycles, and has currently been conducting BSI every 250 cycles.

In November and December 2018, crack was found in LPT fifth stage stator vanes of two engines. The inspection, where the crack was found, was the fourth BSI since the serious incident had occurred.

(5) The Actions Taken by the Engine Manufacturer since the Serious Incident

(i) Inspection on LPT fifth stage stator vanes segments by the engine manufacturer

The engine manufacturer has been conducting inspection at their engine parts repair facility for existence of cracks or wearing caused by arch-binding on LPT fifth stage stator vanes segments, which were carried in for inspection or repair, since February 2018 in an attempt to investigate

	relevant factors of the serious incident. (ii) Service bulletin (SB72-0786) The engine manufacturer published the service bulletin (SB72-0786) on July 12, 2018 after the serious incident. The service bulletin (SB72-0786) is such that BSI is once conducted for existence of cracks on the trailing edge side of the outer side of engine of LPT fifth stage stator vanes of the same type of the engines carried in their engine maintenance facility in view of the doubt that increased stress of the trailing edge side of the outer side of engine contributed to crack by arch-binding. Furthermore, on September 30, 2019, this service bulletin was revised, and this inspection was repeatedly carried out every time it was brought into the engine maintenance factory. (iii) Service bulletin (SB72-0821) The engine manufacturer published the service bulletin (SB72-0821) on August 16, 2019. The service bulletin (SB72-0821) is such that modification is conducted in order to widen the space of the each LPT fifth stage stator vane segments before the design change of the service bulletin (SB72-0637) when the LPT is disassembled. (6) Inspection Result of LPT Fifth Stage Stator Vanes Segments According to the engine manufacturer, BSI on the same type of the engines under operation and BSI in accordance with the service bulletin (SB72-0786) found cracks and wearing caused by arch-binding from 18 segments of LPT fifth stage stator vanes equipped in 14 engines until April 2019. The 14 engines include two engines in which the Operator confirmed cracks. (7) Analytical Result of the Crack Confirmed by the Operator (see Figure 9) In November 2018, the BSI of the Operator for the same type of the engine identified cracks in the LPT fifth stage vanes segments. Result of the detailed inspection conducted by the engine manufacturer on the engine was as follows: (i) Detailed result of inspection BSI conducted by the Operator confirmed cracks existing on stator vanes of three segments of LPT fifth stage stator vanes. Inspection conducted after disassembly of the engine confirmed cracks on stator vanes of another two segments of LPT fifth stage stator vanes. 26 segments of LPT fifth stage stator vanes equipped in the subject engine consisted of 25 segments, which were before design change in accordance with the service bulletin (SB72-0637), and one segment after design change. Wearing presumed to have been caused by arch-binding was confirmed on the 25 segments of inner side of engine before design change, however, was not confirmed in the one segment after design change. The confirmed crack progressed from trailing edge side with length of 1.2 to 1.6 inches. a. It was confirmed that the materials of fractured surface did not have any anomaly. b. Analytical result of fractured surface showed that the longest crack

(1.6 inches long) was about 1,000 cycles based on a count of the striations at the fracture surface.

c. Oxidized cover was confirmed on fractured surface.

d. Failure mechanism and progress speed of the crack were similar to those of the serious incident.

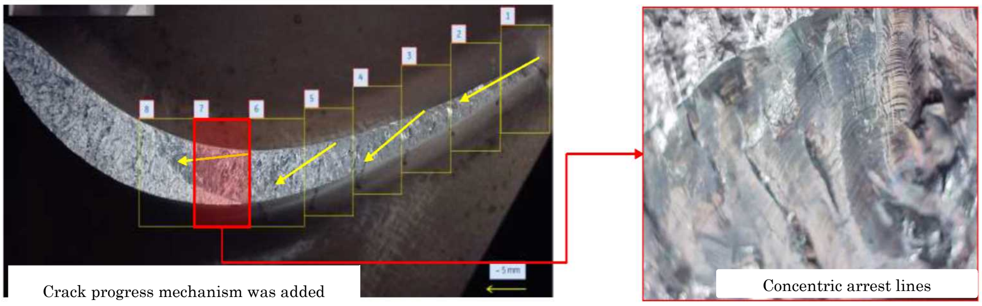


Figure 9: Condition confirmed crack

(8) LPT Fifth Stage Stator Vanes Inspection by Maintenance Manual

Maintenance manual of the subject engine does not set inspection items for LPT fifth stage stator vanes when engine is equipped in airframe under operation. The manual requires to conduct inspection on each stage of LPT stator vanes when all LPT is disassembled for engine overhaul and to replace stator vanes when cracks or dents in excess of tolerance were confirmed.

(9) Similar Cases

According to the engine manufacturer, there was no record of engine failure which required in flight shut down of the engine due to damaged LPT fifth stage stator vanes of the same type of the engine under operation before the serious incident had occurred.

(10) Analysis of the Hole Generated on TRF

The analysis entrusted to NIMS of the hole generated on TRF obtained the result of high probability that the collided fragments did not penetrate the subject hole because warp on the edge of deformation did not generate on the edge of the hole and the fractured surface of the hole did not have traces of rubbing with substances (see Figure 5) although the section in contact with the hole had concavity deformation (dent) generated.

3. ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilot	None
3.3 Involvement of Aircraft	Yes
3.4 Analysis of Findings	(1) Damage on LPT (i) Damage on multiple stages of LPT stator vanes and turbine blades It is highly probable that damages on fifth and sixth stage turbine blades which were downstream from LPT fifth stage stator vanes were triggered by fracture of one stator vane of the fifth stage stator vanes segment, then

collisions of fragments with fifth stage turbine blades led to further damage, and continuous collisions of those fragments with other sections resulted in the secondary damage.

(ii) Fracture of LPT fifth stage stator vane

It is highly probable that the fractured fifth stage stator vane was impelled to be supported only by the inner side of engine due to the crack which reached from the trailing edge side to the leading edge side caused by repetitive stress associated with operations of engine, followed by another crack generating and progressing on inner side of engine, which finally resulted in fracture, because many striations indicating fatigue fracture were confirmed on the fractured surface of the outer side of engine of LPT fifth stage stator vane segment.

It is probable that the crack of LPT fifth stage stator vane was caused by increased stress on the trailing edge side of LPT fifth stage stator vane caused by arch-binding, because wearing, which was a trace of arch-binding, was confirmed on the slash-face of LPT fifth stage stator vane segment on the inner side of engine and arrest lines were periodically confirmed through fracture analysis.

(2) The Hole of TRF

It is highly probable that the hole of TRF was caused by collisions of fragments generated by the damaged LPT.

It is probable that fragments did not penetrate the hole, because analytical results by NIMS and engine cowl did not show damage.

(3) Flame Outbreak at Engine Aft

It is highly probable that the flame that occurred at the engine aft became incomplete combustion by the change in mixing rate in air flow amount and fuel flow amount after the engine rpm had deviated from normal operating condition due to the damage occurred in LPT, and then, the after fire occurred due to the mixed gas including the fuel was exhausted to the engine aft and was rapidly burned by the supply of oxygen in the atmosphere along with the heat of exhaust duct, because evidence of abnormal combustion inside the engine was not confirmed.

(4) Burned Grass Area along the Side of Runway

It is probable that burned grass area was caused by high temperature fragments exhausted from the engine aft due to damage of LPT and fell on the grass area on the side of runway near the taking off area of the Aircraft.

(5) Safety Actions to Avoid Similar Cases

Inspection conducted by the Operator and the engine manufacturer after the serious incident confirmed that cracks and wearing caused by arch-binding occurred in multiple segments of LPT fifth stage stator vanes.

In the serious incident, there occurred the ground damage of burning grass area caused by many fragments of damaged multiple stages of LPT stator vanes and turbine blades, which fell on runway and its surroundings. From this, it is probable that taking safety actions as described below is meaningful to prevent similar engine failure cases and falling objects on the ground in

	the future: (i) Widening space between adjacent segments of LPT fifth stage stator vanes Cracks and wearing caused by arch-binding were confirmed to have occurred on multiple segments of LPT fifth stage stator vanes since the serious incident. It is probable that widening space between adjacent segments of LPT fifth stage stator vanes, which has not changed design in accordance with the service bulletin (SB72-0637), reduces stress increase to the outer side of engine of LPT fifth stage stator vanes caused by arch-binding and contributes to prevent occurrence of cracks in fifth stage stator vanes. It is probably meaningful to widen space between adjacent segments by use of LPT fifth stage stator vanes in accordance with the service bulletin (SB72-0637) or by modification of segments to which the service bulletin (SB72-0637) has not been applied in order to avoid recurrence of similar cases. (ii) Inspection of LPT fifth stage stator vanes segments It is probable that BSI is effective for early detection of similar engine failure, because the cracks were confirmed on LPT fifth stage stator vanes of multiple engines by one time BSI on each engine at the engine maintenance facility after the serious incident, and furthermore, the cracks were confirmed on LPT fifth stage stator vanes of multiple engines by the BSI which the Operator has been conducting every 250 flight cycles on the same type engines under operation. Accordingly, it is desirable that the engine manufacturer notify the users of the same type engine of the method of BSI and an appropriate interval to repeat BSI for the segments of LPT fifth stage stator vanes, which have not taken countermeasure to widen space between adjacent segments of LPT fifth stage stator vanes on engines under operation by service bulletin (SB).

4. PROBABLE CAUSES

It is highly probable that the serious incident was caused by collisions of some of fragments with turbine rear frame (TRF), which led to generating the hole due to damage to multiple stages of stator vanes and turbine blades of low pressure turbine (LPT) of No. 1 (left side) engine immediately after take-off.

It is highly probable that damage to multiple stages of stator vanes and turbine blades of low pressure turbine was contributed by the fracture of one of LPT fifth stage stator vanes.

It is highly probable that the fracture of one of LPT fifth stage stator vanes was contributed by the crack generated by stress concentration caused by arch-binding, which progressed to the fracture by repetitive stress associated with engine operation.

5. SAFETY ACTIONS

(1) The Engine Manufacturer

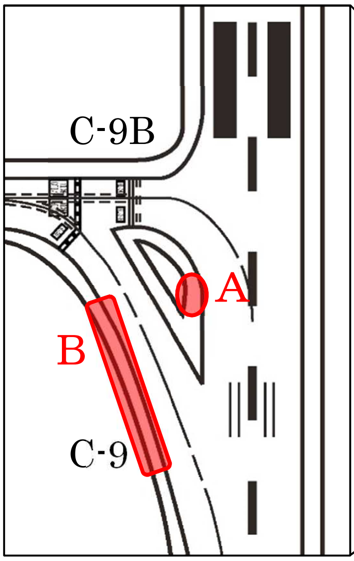
The engine manufacturer published the service bulletin (SB72-0821) on August 16, 2019. The service bulletin (SB72-0821) is such that modification is conducted in order to widen the space of the each LPT fifth stage stator vane segments before the design change of the service bulletin (SB72-0637) when the LPT is disassembled.

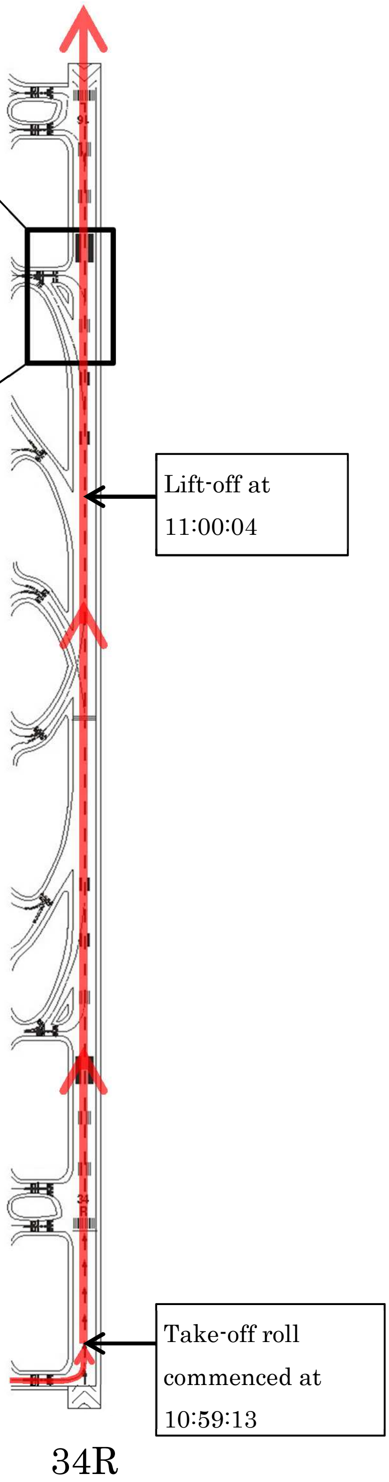
Furthermore the engine manufacturer is set to revise the service bulletin (SB72-0786) to repeatedly continue inspection for existence of crack of LPT fifth stage stator vane for the same type of the engines carried in their engine maintenance facility on September 30, 2019.

The engine manufacturer is set to keep focusing on inspection results of LPT fifth stage stator vanes segments in the future and to take measures based on the results.

(2) The Operator

The Operator is conducting a counterplan to widen the space of the each LPT fifth stage stator vane segments. Furthermore the Operator has been checking LPT fifth stage stator vanes of the same type of the engines under operation, which have not taken to widen space between adjacent segments, for existence of cracks using a bore scope.



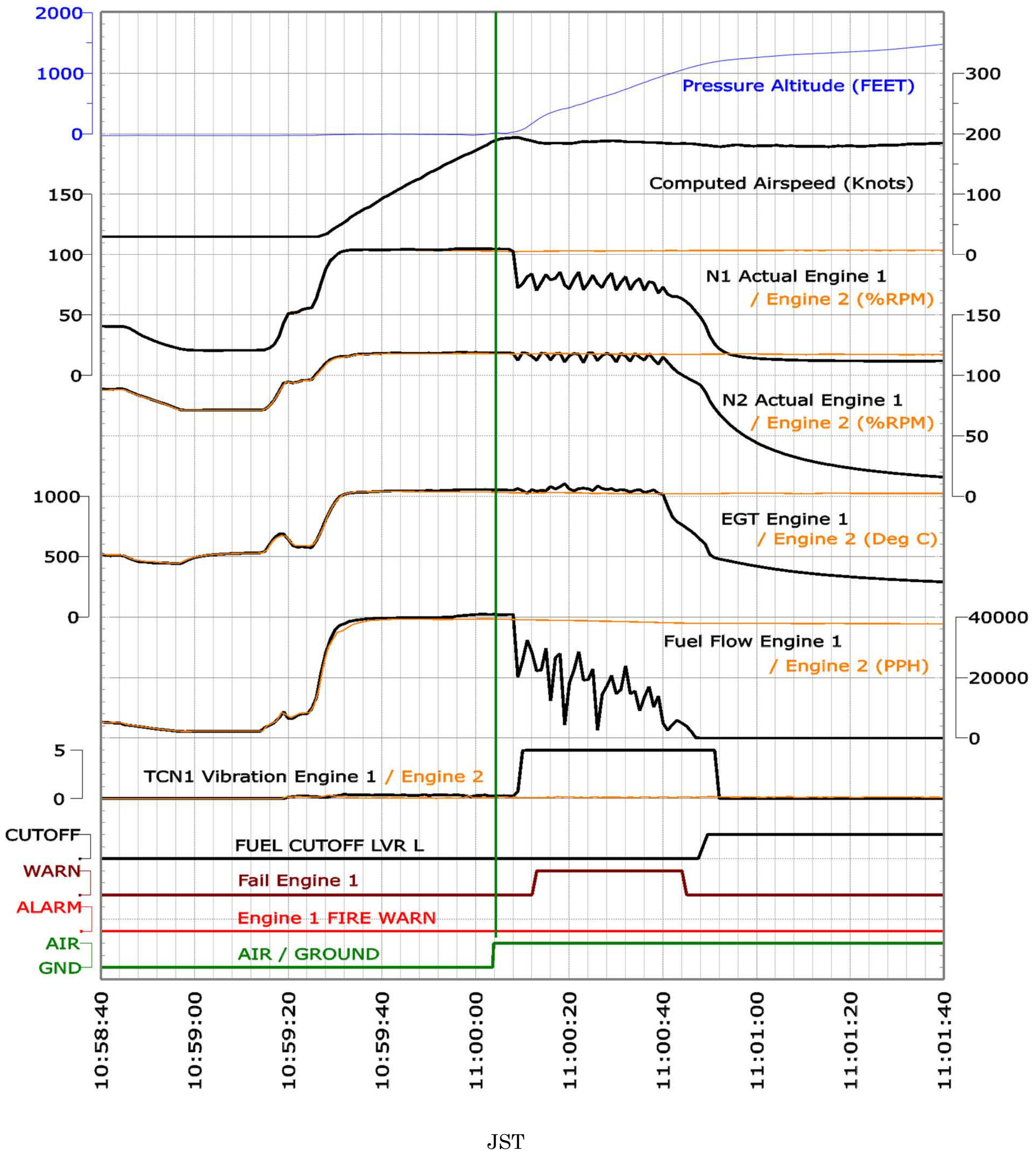


Appended Figure 1: Locations of burned grass area

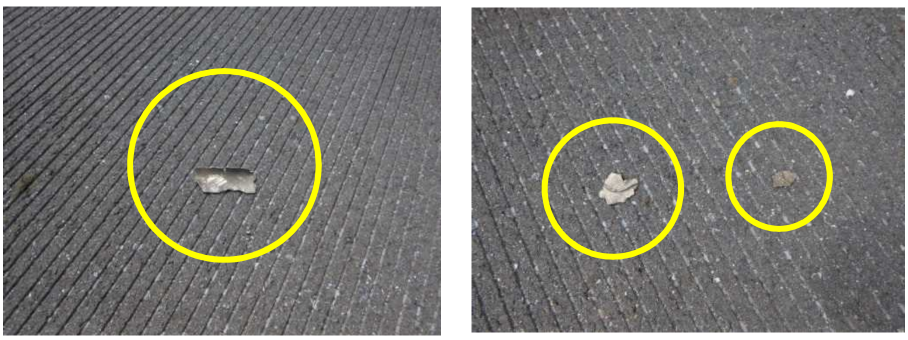
Point A about 1 m x 1 m

Point B about 15 m x 1 m

Appended Figure 2: Burned condition of grass area



Appended Figure 3: Records of Flight Data Recorder of JA743J



Appended Figure 4: Metal fragments scattered on runway