AI2014-6

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

AERO ASAHI CORPORATION
J A 6 9 1 1

December 18, 2014

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

ENGINE DAMAGE
JAPANESE RED CROSS ASAHIKAWA HOSPITAL LANDING FIELD,
ASAHIKAWA CITY, HOKKAIDO, JAPAN
AERO ASAHI CORPORATION
MCDONNELL DOUGLAS MD900 (ROTORCRAFT), JA6911
AT ABOUT 16:56 JST, July 8, 2012

December 5, 2014
Adopted by the Japan Transport Safety Board

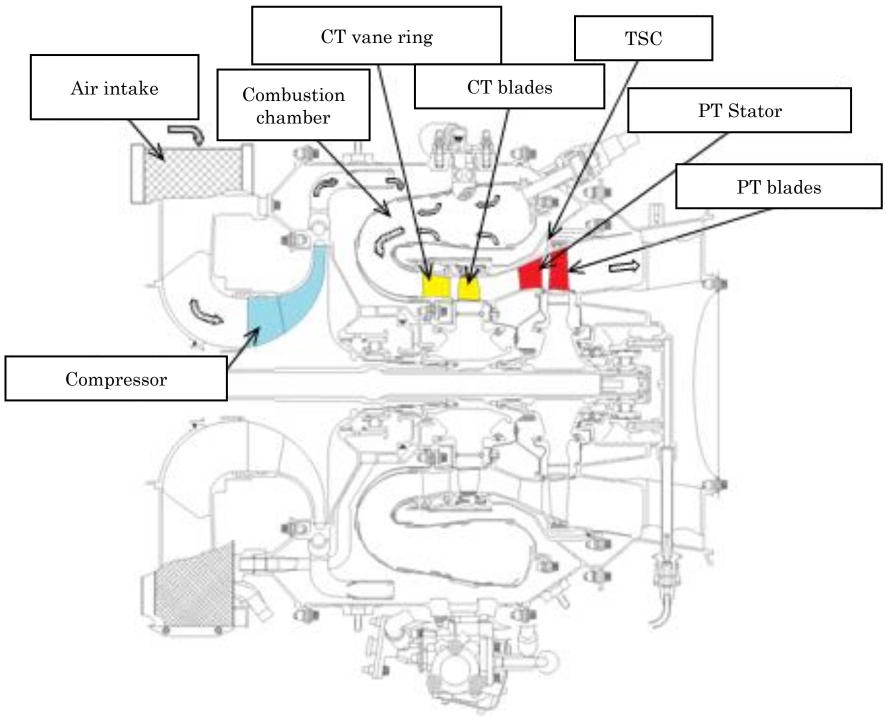
Chairman	Norihiro Goto
Member	Shinsuke Endoh
Member	Toshiyuki Ishikawa
Member	Sadao Tamura
Member	Yuki Shuto
Member	Keiji Tanaka

1 PROCESS AND PROGRESS OF THE INVESTIGATION

On July 9, 2012, the Japan Transport Safety Board designated an investigator-in-charge and one investigator to investigate this serious incident. Accredited representatives of the United States and Canada, the former as the State of Design and Manufacture of the aircraft, and the latter as the State of Design and Manufacture of the engines, participated in this serious incident investigation. Comments from the 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	According to the statements of the pilot in command (PIC) and the mechanic who was on board, the history of the flight is summarized as follows.  Serious incident aircraft On Sunday, July 8, 2012, at 16:56 (JST, UTC+9hrs), a McDonnell Douglas MD900, registered JA6911, operated by Aero Asahi Corporation, started to take off from the landing field on the roof of the Japanese Red Cross Asahikawa Hospital (hereinafter referred to as “the Helipad”) to transport an emergency patient from the landing field at Kamifurano Town, with the PIC and three persons. The Aircraft, after going airborne, climbed for around 15 ft vertically while turning towards the direction of takeoff. As it started to move forwards from hovering, a low, hollow “boom” sound was heard from the left rear side, which was followed by the sound of the “ENG OUT” warning alarm. At this time, the person who sat on the rear facing seat momentarily saw a fire spark and black smoke coming out

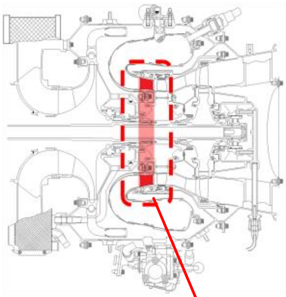
	from the rear left of the Aircraft. When the PIC looked at the instrument panel, the “ENG OUT” warning annunciator*1 was flashing, and the tachometer (Np) and the torque meter for No. 1 Engine was displaying “0.” The tachometer (Np) for No. 2 Engine was within the green zone (normal area). However, the torque meter had indicated the red zone (no-excess range). Not to loose the altitude of Aircraft, the PIC increased the forward speed and avoided the obstacles without lowering the collective lever, and gradually increased altitude. After clearing an obstacle, the PIC reduced the load on No. 2 Engine and proceeded to conduct emergency maneuvers when the “ENG OUT” warning annunciator flashed. The PIC judged that although restarting No. 1 Engine was impossible, it was only possible to continue flying with No. 2 Engine, and it was safer to land at Asahikawa Airport, which was nearer, than going back to the Helipad. Therefore, the Aircraft flew toward Asahikawa Airport and landed at Asahikawa Airport at 17:09.
2.2 Injuries to Persons	None
2.3 Damage	(1) Extent of Damage to the Aircraft: Minor damage A major damage occurred inside No. 1 Engine, but there was no damage to the Aircraft. (2) Extent of Damage to No. 1 Engine The compressor turbine (CT) vane ring*2, CT blade, power turbine (PT) stator, PT blade, and turbine support case (TSC) were damaged. The CT blades and the PT blades were fractured around the full circumference and others were damaged by heat.  Cross-section Diagram from Engine Rotation Shaft Direction

2.4 Personnel Information	PIC Male, Age 50 Commercial pilot certificate (Rotorcraft) July 6, 1989 Type rating for multi-turbine engine (land) February 15, 1996 Class 1 aviation medical certificate Validity: September 8, 2012 Total flight time 6,133 hours 59 minutes Total flight time on the type of aircraft 117 hours 07 minutes
2.5 Aircraft Information	(1) Aircraft type: McDonnell Douglas MD900 Serial number: 900-00088 Date of manufacture: March 27, 2001 Certificate of airworthiness: No. TO-23-249 Validity: September 8, 2012 Category of airworthiness: Rotorcraft, Normal (N) or Special Aircraft (X) (2) Engine

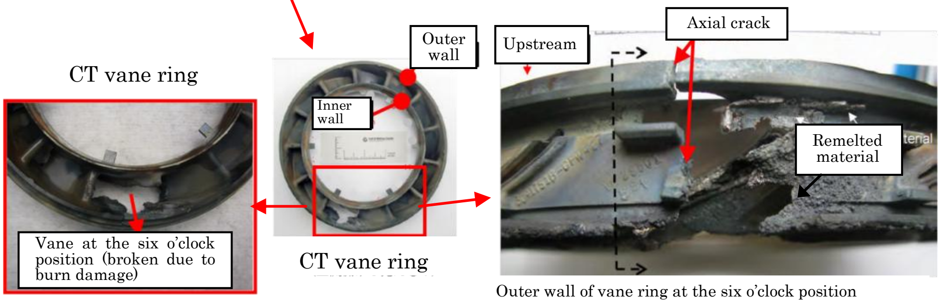
	No. 1 Engine	No. 2 Engine
Type	Pratt and Whitney Canada PW-207E	
Serial number	PCE-BG0002	PCE-BG0021
Date of manufacture	May 7, 2003	September 9, 2000
Total time of usage	1,892 hours 06 minutes	2,022 hours 53 minutes
Total usage cycle	8,217	8,175

2.6 Meteorological Information	The aerodrome routine meteorological report at 17:00 for Asahikawa Airport, about 13 km south-southeast from the site of the serious incident, was as follows: Wind direction: 320°; Wind velocity: 4 kt; Prevailing visibility: 10 km or more Clouds: Amount 1/8; Type Cumulus; Cloud base 3,000 ft Amount 5/8; Type Altocumulus; Cloud base7,000 ft Amount 7/8; Type Altocumulus; Cloud base11,000 ft Temperature 22°C; Dew point 17°C, Altimeter setting (QNH) 29.62 inHg
2.7 Teardown and other Inspections of Engine	With the cooperation of the Transportation Safety Board of Canada, the teardown inspection, functional inspection and metal inspection of No. 1 Engine were conducted at the facility of the engine manufacturer. The inspection results were as follows.

- CT vane ring



The CT vane ring for smoothing the flow of combustion gas had been severely damaged at the six o'clock position (viewed from the front (combustion chamber side) and the top aligned to 12 o'clock; same for all others) due to heat. One vane at the six o'clock position had been burnt away. Also, at the six o'clock position of the CT vane ring, there was evidence of remains of cracks across the outer wall of the CT vane ring. The downstream side had suffered burn damage. There was presence of remelted material on the outer surface of the outer walls.



(Viewed from the combustion chamber side)

Outer wall of vane ring at the six o'clock position
(Viewed from the lower side of the outer wall)

Corrosion was also observed on the inner surface of the outer walls of the CT vane ring. Scanning electron microscope (SEM) analysis showed that the corrosion did not reach the parent material of the vane. Sulphidation was observed on the corroded surface.

Numerous axial small fatigue cracks were observed on the inner surface of the outer walls of the CT vane ring near the six o'clock position, which are thermal fatigue cracks. In addition, minor cracks were observed at the one o'clock and 11 o'clock positions of the CT vane ring. SEM analysis showed that the cracks near the six o'clock position of the CT vane ring extended from the inner surface to the outer surface, and cracks extended throughout the outer surface in the thinnest section of the outer wall. The cracks originated from the corrosion, but there were no evidence of sulfuric corrosion along the cracks. There were traces indicating overheating near the six o'clock position of the CT vane ring, but no traces of overheating were found at either the one o'clock or 11 o'clock position.

- CT blades

All the CT blades had fractured almost equally at approximately 0.4 in (about 12 mm) above platform. Examination of the fracture surface of the CT blades showed that excessive load was applied to the blades. The coatings on the CT blades were

	partially flaked as a result of exposure to high temperature. Moreover, it was confirmed in the SEM analysis of the fracture surface of the CT blades that the blades had been exposed to high temperature. - TSC Perforation, discoloration and deformation due to heat had occurred on the TSC, which is the external structure of the turbine. Of the two perforations that had formed on the TSC, one of them coincided with the location of the damaged section (six o'clock position) for the CT vane ring. - Fuel nozzle, Fuel flow divider No anomalies that would affect combustion were confirmed.
2.8 Other Information	(1) There were no instrument indications that indicated any anomalies up to the occurrence of the serious incident. (2) The Integrated Instrumentation Display System (IIDS) equipped on the Aircraft recorded that the exhaust gas temperature (EGT) for No. 1 Engine had reached 1,011°C at around 16:56. (3) The Data Collection Unit (DCU) equipped on No. 1 Engine recorded that the torque rapidly declined while the EGT increased and exceeded the operating limitation (850°C). (4) The Company had conducted routine maintenance work in accordance with the engine manual.

*1 The "ENG OUT" warning annunciator flashes when the Ng revolution speed (rotation speed of CT) decreases with a rate of change exceeding 15%/sec., or when the Ng revolution speed falls below 35%. When the "ENG OUT" warning annunciator flashes, the meter display for Ng revolution speed, Np revolution speed (revolution speed of PT) and torque all become "0."

*2 CT vane ring is a monolithic structure comprised of an outer wall, inner wall and 13 vanes. The outer and inner walls are fixed to the engine structure. This is to smooth the initial flow of high-temperature combustion gas that flows out from the combustion chamber. Since the vane is constantly being exposed to high temperature, pressurized air is induced from the exterior of the outer wall to the inside of the vanes in order to cool them.

3 ANALYSIS

3.1 Involvement of Weather	None
3.2 Involvement of Pilots	None
3.3 Involvement of Rotorcraft	Applicable
3.4 Analysis of Findings	(1) It is highly probable that the small axial cracks that had developed in the outer wall of the CT vane ring were thermal fatigue cracks that had developed due to being constantly exposed to high temperature on each flight. At the six o'clock position of the CT vane ring, there was evidence that axial cracks in the outer wall of the CT vane ring. It is probable that minor heat-fatigue axial cracks that were seen in other positions had also developed in the section of the

	CT vane ring (six o'clock position) that had been burnt away. Moreover, it is probable that the cracks that had developed at the six o'clock position had also penetrated the outer wall from the inside surface to the outside surface as with the cracks that had developed near the six o'clock position. (2) It is probable that as the cracks penetrated the outer wall of the CT vane ring, the pressurized air from the exterior of the outer wall of the CT vane ring had entered the passageway of the combustion gas from the opening. It is probable that with pressurized air flowing into the high-temperature combustion gas, the oxidization of the section that had been penetrated by the cracks had accelerated. Also, it is probable that as the smooth flow of combustion gas was disturbed, the temperature distribution of the passageway of combustion gas was changed, and a localized increase in temperature had occurred. Due to this, it is somewhat likely that the corrosion due to heat for the CT vane ring at the six o'clock position had progressed further, and this also affected the cooling of the vanes, which further accelerated the corrosion of the vanes. As a result, it is probable that the CT vane ring at the six o'clock position had been severely damaged by the time of the occurrence of the serious incident. For the reason why the CT vane ring was severely damaged at the six o'clock position in comparison with the other positions, it is possible that the cracks that extended into the fillet radii of the vane and/or cracks that converged at a point had formed, and that this expedited the progression of the cracks. However, it was not possible to identify the cause of this as the CT vane ring had been burnt away. (3) When the serious incident occurred, according to the records of the IIDS and DCU, the EGT had exceeded the operating limitation, and torque was rapidly decreasing during the climb. Also, according to the statements by the PIC, as the Aircraft started to move forwards from hovering, the "ENG OUT" warning annunciator flashed, and the power of No. 1 Engine decreased. From this, it is probable that the damage to the CT vane ring led to the EGT exceeding its operating limitation, which caused the hot sections (sections where it is constantly exposed to combustion gas) to become significantly heated. Therefore, it is probable that this led to the CT blades becoming fractured and the decrease in NG revolution speed. Moreover, with the CT blades becoming fractured, it is probable that the PT blades downstream became fractured, and the torque decreased. It is somewhat likely that the progression of damage on the CT vane ring had somehow affected the engine performance and led to the increase in EGT. However, it was not possible to determine the cause of this since the condition of the CT vane ring at the time of

	the occurrence of the serious incident could not be presumed, and a precise analysis could not be conducted due to the vane ring being severely damaged. (4) Regarding why there were no instrument indications that indicated any anomalies during flight up to the occurrence of the serious incident, it is probable that the damage in the CT vane ring had affected the temperature distribution of the passageway of combustion gas, and although there was an increase in temperature, it was localized and did not seriously affect the instrument indications for EGT, which measured the overall exhaust gas temperature of the whole engine. However, it is probable that the damage in the CT vane ring continued to progress increasingly on each flight.

4 PROBABLE CAUSES

It is probable that this serious incident occurred due to the severely damaged CT vane ring (at the six o'clock position) causing the hot sections to become severe overtemperature condition, leading to the CT blades becoming fractured and the PT blades downstream also becoming fractured .

For the reason as to why the CT vane ring was severely damaged at the six o'clock position in comparison with the other positions, it is somewhat likely that the cracks that extended into the fillet radii of the vane, and/or cracks that converged at a point had formed, and that said cracks expedited the progress of the cracks. However, it was not possible to identify the cause of this as the CT vane ring had been burnt away.