2003-4

AIRCRAFT INCIDENT INVESTIGATION REPORT

JAPAN ASIA AIRLINES FLIGHT 201
BOEING 747-200B, JA8129
OKINAWA PREFECTURE, JAPAN
FEBRURY 13, 2003

November 28, 2003

Aircraft and Railway Accidents Investigation Commission
Ministry of Land, Infrastructure and Transport

The investigation for this report was conducted by Aircraft and Railway Accidents Investigation Commission, ARAIC, about the aircraft incident of Japan Asia Airlines Boeing 747-200B in accordance with Aircraft and Railway Accidents Investigation Commission Establishment Law and Annex 13 to the Convention of International Civil Aviation for the purpose of determining cause of the aircraft accident and contributing to the prevention of accidents and not for the purpose of blaming responsibility of the accident.

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Junzo Sato,
Chairman,
Aircraft and Railway Accidents Investigation Commission

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

JAPAN ASIA AIRLINES FLIGHT 201
BOEING 747-200B, JA8129
OKINAWA PREFECTURE, JAPAN
AT ABOUT 12:55 JST, FEBRURY 13, 2003

November 5, 2003

Decision by the Aircraft and Railway Accidents Investigation Commission (Air Sub-committee Meeting)

Chairman	Junzo Sato
Member	Ryouhei Katsuno
Member	Susumu Kato
Member	Sumio Matsuura
Member	Yukiko Kakimoto
Member	Kozaburo Yamane

1 PROCESS AND PROGRESS OF THE SERIOUS INCIDENT INVESTIGATION

1.1 Summary of the Serious Incident

On Thursday February 13, 2003, a Boeing 747-200B of Japan Asia Airlines (JAA), registration JA8129, departed New Tokyo International Airport at 10:39 JST as scheduled passenger flight 201 to Taipei International Airport. While the aircraft was climbing from flight level (FL) 260 to FL280 over the sea approximately 180 km northwest of Naha City, a loud bang accompanied by severe vibration occurred at around 12:55. Thereafter, a crewmember discovered a hole in the cowling of the No. 2 (left inboard) engine. The aircraft diverted to Naha Airport, where it landed at 13:40.

There were 316 persons on board flight 201 — 298 passengers, the Captain and 17 other crewmembers. There were no injuries to persons on board.

This incident was treated as a serious incident under Civil Aviation Regulation Operating Standard Article 166 Section 4 Item 6 “Uncontained engine failure”.

1.2 Outline of the Serious Incident Investigation

1.2.1 The Organization of the Investigation

On February 13, 2003, the Aircraft and Railway Accidents Investigation Commission (ARAIC) assigned an investigator-in-charge and an investigator.

1.2.2 Accredited representative and adviser by Foreign Authorities

Accredited representatives from the United States, the state of design and manufacture of the aircraft and engines, participated in the investigation of this serious incident.

1.2.3 The Implementation of the Investigation

The Investigation proceeded as follows.

February 13-15, 2003	Investigation of the aircraft and interviews eyewitness .
February 17, 2003	Detailed engine investigation.
March 25-26, 2003	Analysis of fan blade fracture surface

(The US National Transportation Safety Board (NTSB) cooperated in the analysis of the fracture surface of the fan blade.)

September 19-October 23,2003	Comment inquiry from the state of design and manufacture.

1.2.4 Factual information offer to Civil Aviation Bureau of Japan

On February 21, 2003, ARAIC reported to the Civil Aviation Bureau of Japan (CAB) the results of this investigation, including that marks characteristic of fatigue damage had been confirmed on the fracture surface of the fan blade.

1.2.5 Hearings from Persons relevant to the Cause of the Serious Incident

Hearings were held.

2 FACTUAL INFORMATION

2.1 History of Flight

On 13 February 2003, a Boeing 747-200B of Japan Asia Airlines, registration JA8129, was operated as JAA scheduled flight 201 from New Tokyo International Airport to Taipei International Airport.

The flight plan of the aircraft submitted to New Tokyo International Airport Office of the Civil Aviation Bureau was as follows:

> FLIGHT RULES: IFR, DEPARURE AERODROME: New Tokyo International Airport, CRUSING SPEED: 493kt, CRUSING ALTITUDE: FL260, ROUTE: TETRA (point) – HNE (Haneda VOR/DME) – KCC (Nagoya VORTAC) – airway V28 – SANDA (point) – AJE (Awaji VOR/DME) – KRE (Kochi VOR/DME) – DONKY (point) – HKC (Kagoshima VORTAC) – airway A1 – APU (Anpu VOD/DME), DESTINATION AERODROME: Taipei International Airport, PLANNED BLOCK OUT TIME: 10:00, TOTAL ESTIMATED EN-ROUTE TIME: 3 hours and 36 minutes, FUEL LOAD IN TERMS OF FLIGHT TIME: 5 hours 19 minutes

The aircraft took off from New Tokyo International Airport at 10:39 with 316 persons—298 passengers and 18 crew— on board. During flight at FL260 over the sea approximately 180 nm northwest of Naha city, as thrust was increased at 12:55 to climb to FL280 in order to avoid light turbulence there was the sound of an explosion followed immediately by severe vibration, and the exhaust gas temperature (EGT) of the No. 2 engine suddenly increased. The Captain shut down No. 2 engine, and after being informed by the senior cabin attendant (SCA) that there was a hole in the No. 2 engine, he directed the flight engineer to check the condition of the engine from the cabin. The flight engineer reported a hole in the nose cowling of the No. 2 engine, and at around 13:02 the Captain requested Naha Area Control Center (Naha ACC) permission to divert to Naha Airport. The aircraft landed at Naha Airport at 13:40.

The outline of the circumstances of the occurrence of this serious incident based on the statements of the Captain, the First Officer, the flight engineer, one of the cabin attendants is as follows.

(1) Statement of the Captain and the First Officer

On the day of the incident, before departure from New Tokyo International Airport, the three cockpit crewmembers—the Captain, the First Officer and the Flight Engineer—carried out the pre-flight checks and found no abnormality in the aircraft, including all engines.

The aircraft took off from New Tokyo International Airport at 10:39 and was cruising at FL260 in accordance with flight plan. Because light turbulence was encountered over the vicinity of Kochi city, and another JAA scheduled flight reported light turbulence at FL250, the aircraft descended to FL240.

The aircraft climbed back to FL260 as it passed the RUSAR point on airway A1. Because there were gaps in the thin clouds the crew suspected that there might be turbulence. After passing RUSAR and with 130 nm remaining to the BULAN point, as thrust was increased to climb from FL260 to FL280 there was the sound of an explosion and vibration that was clearly not due to rough air. At that time, the EGT of the No. 2 engine rose to 940°C and the amber light on the EGT indicator came on, while the No. 2 engine pressure ratio (EPR: pressure ratio between engine inlet and outlet) gave a steady indication of approximately 1.52. As the result, the crew judged that the No. 2 engine had failed.

The No. 2 engine was immediately brought back to idle, and its fan speed (N1) and EGT decreased. The engine was shut down in accordance with the emergency “In-flight Engine Failure and Shutdown Procedure”. The crew then reported failure of the No. 2 engine to Naha ACC. Naha ACC asked whether the aircraft could maintain FL280, to which the crew replied that this was possible.

Afterward, the SCA reported a hole in the No. 2 engine and that a panel had come loose, and the flight engineer entered the cabin to check the state of the No. 2 engine. He reported that because there was a hole in the nose cowling and that the engine itself was shaking it was possible that a fan blade had failed. The Captain therefore decided to divert to Naha International Airport as the best course of action.

Because at that stage all systems were normal apart from the engine failure, the crew did not declare an emergency to air traffic control but requested a diversion to Naha Airport. The flight continued and the aircraft landed at Naha Airport at around 13:40.

The sound of the explosion and vibration of the aircraft occurred at around 12:55 over the sea on airway A1 130 nm before the BULAN point.

(2) Statement of the flight engineer

Before departing New Tokyo International Airport the flight engineer confirmed from the flight logbook that the aircraft had no engine-related carry over “squawks”.

After takeoff, the aircraft reached its cruising altitude of FL260 and the flight engineer confirmed that the engine instruments and indications were normal.

The aircraft was cleared to climb from FL260 to FL280 to avoid turbulence in cloud. The moment engine thrust was increased to maximum continuous thrust (MCT) and the climb started, there was a “bang” and the No. 2 engine EGT suddenly rose and the amber light on the EGT indicator came on, so the thrust lever was pulled back.

At first the thrust lever was not pulled back as far as idle but the No. 2 engine EGT indication did not drop, so the thrust lever was retarded to idle. The flight engineer felt that the vibration was not due to rough air because the whole aircraft was shaking. Because EPR was steadily indicating 1.5, around its maximum limit, and EGT was rising abnormally, the No. 2 engine was shut down.

Afterward, the SCA reported abnormality in the No. 2 engine, and the flight engineer checked the engine from a window at the rear of the business class section on the main deck. He found a hole in the nose cowl and, concluding that a fan blade had failed, he advised the captain to divert to the nearest airport. The flight continued normally on the remaining three engines. The vibration of the aircraft continued until speed was significantly reduced.

(3) Statement of one of the cabin attendants

While the cabin attendant was clearing up after in-flight services, a slight shaking began at around 12:50, which she thought was due to turbulence. She then heard the sound of a bang, and the shaking increased.

As she felt that the shaking was not normal and it accompanied a bang, the cabin attendant looked out of the window in the L2 door (the second door from aft on the left side of the aircraft) and saw a hole in the nose cowl of the No. 2 engine and could parts inside. She herself then urgently contacted the flight deck to report damage to the outer wall of the engine. She then reported the matter to the senior cabin attendant, who again reported it to the flight deck.

The cabin attendant stated that less than one minute elapsed from the onset of the light shaking until the bang occurred. She felt that after the bang the whole aircraft was shaking, and the shaking was great even in the aft cabin.

At around 12:58 the SCA made an announcement that the No. 2 engine had failed and asked the passengers to remain calm. At around 13:10, the Captain announced to the passengers that the aircraft would divert to Naha International Airport because of failure of the No. 2 engine, and the aircraft subsequently landed at Naha airport.

This serious incident occurred at around 12:55 at an altitude of 27,000 ft over the sea 180 nm northwest of Naha city.

(See Fig.1(Presumed flight pass))

2.2 Injuries to Persons

There were no injuries to any of the 316 persons—298 passengers and 18 crewmembers—on board the aircraft.

2.3 Damage to Aircraft

Examination of the aircraft after the serious incident occurred revealed no damage to the aircraft except to the No. 2 engine. The state of the damage to the No. 2 engine was as follows.

(1) A portion of the No. 35 fan blade from approximately 19 cm outboard of the platform had broken off, and the separated portion had broken into at least three fragments. The fragment nearest the root with a length of 20 cm was found between the fan blades and exit guide vanes. A 10 cm long fragment including the blade tip was found stuck into the acoustic panel on the inner wall of the nose cowl forward of the fan at a three o'clock position looking from the rear of engine. Of the total 70 cm length of the fan blade, fragments with a total length of approximately 21 cm were not recovered.

(2) A hole that breached the nose cowl was found in the 4 o'clock position. Its greatest size in the direction of the engine axis was approximately 34 cm and circumferentially approximately 44 cm.

(3) The acoustic panel on the inner wall of the nose cowl was damaged.

(4) Some bolts that attached the engine tail cone were fractured.

(5) Apart from the broken No. 35 fan blade, most of the 45 other fan blades were damaged.
(See Fig. 2 and Photographs 1, 2, 3)

2.4 Damage to articles apart from the aircraft

There was no damage to any items except the aircraft.

2.5 Personnel Information

(1) Captain: Male aged 54

Airline Transport Pilot License	Issued March 9, 1990
Type Ratings	
Airplane multiengine (land)	Issued October 19, 1974
Boeing 747	Issued April 2, 1982

Class 1 Airman Medical Certificate	
Term of Validity	Until March 31, 2003
Total flight time	13,407 hours 25 minutes
Flight time during the previous 30 days	52 hours 01 minute
Total flight time on Boeing 747	13,069 hours 06 minutes
Flight time during the previous 30 days	52 hours 01 minute

(2) First Officer: Male aged 46

Commercial Pilot License (airplane)	Issued November 29, 1993
Type Ratings	
Airplane multiengine (land)	Issued February 25, 1994
Boeing 747	Issued February 15, 1995
Instrument rating (airplane)	Issued June 22, 1994
Class 1 Airman Medical Certificate	
Term of Validity	Until May 20, 2003
Total flight time	4,246 hours 08 minutes
Flight time during the previous 30 days	35 hours 36 minutes
Total flight time on Boeing 747	2,817 hours 21 minutes
Flight time during the previous 30 days	35 hours 36 minutes

(3) Flight Engineer: Male aged 51

Flight Engineer License (airplane)	Issued May 22, 1981
Type Ratings	
Airplane multiengine (land)	Issued May 22, 1981
Boeing 747	Issued May 22, 1981
Class 1 Airman Medical Certificate	
Term of Validity	Until September 25, 2003
Total flight time	11,671 hours 57 minutes
Flight time during the previous 30 days	54 hours 44 minutes
Total flight time on Boeing 747	11,671 hours 57 minutes
Flight time during the previous 30 days	54 hours 44 minutes

2.6 Aircraft Information

2.6.1 The Aircraft

Type	Boeing 747-200B
Serial number	21678

Date of manufacture	February 16, 1979
Certificate of Airworthiness	Tou-12-174
Term of validity	Until valid data of JAA Maintenance Program Manual from June 15, 2000
Total flight time	67,621 hours 32 minutes
Flight time since scheduled maintenance “6M/29C” Check on December 27, 2002	308 hours 32 minutes

2.6.2 The Engine

Type	Pratt and Whitney JT9D-7A
Serial number	685914
Date of manufacture	October 30, 1973
Total flight time	72,591 hours 36 minutes
Flight time since overhaul on October 8, 2002	202 hours 35 minutes
Date of installation on the aircraft	January 13, 2003
Flight time since installation on the aircraft	202 hours 35 minutes

2.6.3 Fuel and Lubricating Oil

The fuel on board was JET-A-1. The lubricating oil was Mobil Jet oil II.

2.7 Metrological Information

According to the statement of the Captain, the weather was fine with Visual Metrological Conditions at around FL 260 in the vicinity of the point where the serious incident occurred (130 nm south of RUSAR point). However, there was very thin cloud at around FL240, where the aircraft had encountered slight turbulence.

2.8 Information on the Digital Flight Data Recorder and Cockpit Voice Recorder

The aircraft was equipped with a Honeywell model 980-4100-DXUS Digital Flight Data Recorder (DFDR) and Collins model 522-4057-010 Cockpit Voice Recorder (CVR) on which voices and sounds in the cockpit were recorded and stored for 30 minutes.

The DFDR had recorded all engine data relevant to the serious incident. The CVR had recorded voices and sounds in the cockpit for the 30 minutes up to the time when the aircraft stopped at its parking spot at Naha airport, but recordings before that time had been overwritten and so no recordings from the time of the serious incident remained.

2.9 Test and Research to Find Facts

2.9.1 The History of No. 35 Fan Blade

The No. 35 fan blade of the aircraft's No. 2 engine had accumulated 67,606 hours and 25,340 flight cycles in service. Records of maintenance performed on the fan blade on June 28, 1974 showed that the fan blade had been in service for over 28 years.

2.9.2 Detailed Investigation of the Fracture Surfaces of No. 35 fan blade

Pieces of the No. 35 fan blade were collected and the fracture surfaces were examined by optical microscope, Scanning Electron Microscope (SEM) and Energy Dispersive Spectroscopy (EDS) analysis. The result of these examinations were as follows.

(1) Visual and optical microscope examination of fracture surfaces

As mentioned 2.3(1), although the fan blade had broken into at least four pieces, only three pieces, including the piece that had remained attached to the hub, were recovered. These three pieces were examined. (See Figure 2 and Photograph 3.)

Examination of the fracture surfaces of these fragments found beach marks, indicative of fatigue fracture, on the fracture surface of the fragment that had remained on the hub. On the other hand, the condition of the fracture surfaces of the other fragments indicated that they had been torn off by shear forces due to impact etc. or the surfaces were considerably worn.

(See Photo 4).

The beach marks originated at the trailing edge of the blade approximately 19 cm outboard of the platform and extended approximately 6 cm toward the leading edge. Beyond this, the remainder of the fracture surface indicated instantaneous tearing.

The fan blade was fabricated from a titanium alloy that included aluminum (6%) and vanadium (4%).

(2) The fracture surface on which beach marks had been found was examined by SEM examination and EDS analysis.

① SEM examination of the starting point of the crack at the trailing edge convex corner revealed traces of a cavity in which there was an additional microscopic crack.

(See Photo 5)

② EDS analysis showed that no evidence of inclusions except titanium, aluminum and vanadium around the cavity.

③ A metallurgical analysis was made of the convex surface of the fan blade including the fracture surface to determine the depth and internal structure of the fracture. This showed the following three layers.

a) A needle-shaped region of abnormal microstructure evidently different to the base material microstructure, which extended approximately 0.4 mm from the crack origin towards the leading edge, and approximately 1.2 mm towards the platform.

b) A heat-affected microstructure surrounding the region approximately 2.0 mm wide by 1.0 mm deep.

c) The normal microstructure of the base material.

(See Photo 6)

The abnormal microstructure in a) was created from melting and resolidification and contained several microscopic pores that were not present in the base material microstructure.

④ A cavity mentioned in a) above had an abnormal microstructure, and an additional microscopic crack extended from the region of abnormal structure.

⑤ Measurement of the hardness of the three layers—the abnormal microstructure, the heat-affected microstructure, and the base material microstructure —gave Rockwell Hardness (HRC: Note 1) values of HRC 54, HRC 44, HRC 38 respectively. Therefore, the surface layer region was the hardest and the most brittle.

(Note 1) Rockwell Hardness ： a hardness value obtained by pressing a prescribed shape onto the surface of the specimen with a constant load and measuring the size of the resulting surface indentation.

2.9.3 Damage on the fan blades other than No. 35 fan blade

Other than No. 35 fan blade, all the other blades were damaged. Investigation of the damage showed no beach marks but indications of tearing by impact shock forces.

2.9.4 Damage on the EPR sensor of No.2 engine

The DFDR recording showed that at 1254:51, when the fan blade is estimated to have broken, the EPR of the No. 2 engine rose from 1.492 to 1.515, where it then remained constant.

Investigation of the EPR transmitter part of the EPR sensor showed that the retainer of the voltage converter that converts movement of a bellows that senses engine intake air pressure to an electrical signal had become loose, and so the intake pressure could not be correctly converted to an electrical signal.

2.10 Other Relevant Information

2.10.1 Welding Work related to the No. 35 Fan Blade

Before occurrence of this serious incident, there were two cases of work on the shroud (Note 2) that are considered possible causes of arc burn: welded repairs on the contact surface of the shroud on August 25, 1980, and coating rework on the contact surface of the shroud on April 22, 1996.

(Note 2） shroud : They are board-like projection installed cordwise in to a fan blade of the position of 12cm and 36cm from the outer end of the blade.

Fan blades are installed into a hub with some margin.

During fan rotation, this margin allowds each shroud to contact with neighboring shrouds to prevent blade deformation and free movement of blades, thus assures steady rotation.

2.10.2 Fan blade maintenance

The following are the main mandatory maintenance actions on Pratt & Whitney JT9D-7A engine fan blades specified in the JAA maintenance manual.

(1) The following maintenance shall be executed every soft 2,000 cycles (Note 3) at a maintenance shop with fan blades removed from the engine.

① Eddy current inspection of the root

② Shot peening of root (Note 4)

③ Repair of any leading edge erosion found

④ Visual inspection for arc burn over the entire blade (Note 5)

⑤ Visual inspection for wear of the root area

(Note 3) Every soft 2000 cycles: Work to be executed when a fan blade has accumulated more than 2,000 cycles since it was previously removed for execution of the same work.

(Note 4) Shot Peening: A treatment method for metal surfaces in which the surface is bombarded with small steel balls or glass beads. This hardens the surface and creates compressed areas of residual stress that give increased resistance to fatigue and to stress corrosion cracking.

(Note 5) Arc Burn: Burning or melting of metals etc. due to heat generated by an electrical discharge.

(2) The following maintenance shall be executed every 150 flight hours (maximum 180 flight hours) with the fan blade on the aircraft.

① Visual inspection for cracks and other damage to the shroud

② Visual inspection for cracks, nicks, dents, arc burn and other damage to leading and trailing edges

2.10.3 Recent maintenance prior to this serious incident

Recent maintenance carried out on the No. 35 fan blade prior to this serious incident was as follows.

(1) August 4–November 22, 1999

The following maintenance was carried out in accordance with the maintenance manual with the fan blade removed from the engine.

① Visual inspection for wear and eddy current inspection of the root

② Shot peening of the root

③ Visual inspection for cracks and other damage over the whole blade

(2) March 8 – August 19, 2002

The following maintenance was carried out in accordance with the maintenance manual with the fan blade removed from the engine.

① Visual inspection of the shroud for cracks and other damage

② Visual inspection of the whole blade for cracks, nicks, dents and arc burns

③ Leading edge erosion repair, etc.

(3) January 27, 2003

The following maintenance was carried out in accordance with the maintenance manual with the fan blade installing in the engine on the aircraft.

① Visual inspection of the shroud for cracks and other damage

② Visual inspection of leading and training edges for cracks, nicks, dents, arc burns and other damage

2.10.4 Other cases of fan blade failure caused by arc burn

Although the Pratt & Whitney JT9D-7A engine has been in worldwide use for more than 30 years and 760 engines are currently in service, there have been only five cases worldwide of fan blade failure as a result of melting and resolidification of part of the blade, including this serious incident. Further, although this type of engine has been used more than 30 years in Japan, this is the first time this type of serious incident has occurred in Japan.

3 ANALYSIS

3.1 Analysis

3.1.1 The Captain, First Officer and Flight Engineer had valid airman proficiency certificates and valid airman medical certificates in accordance with applicable regulations.

3.1.2 The aircraft had a valid certificate of airworthiness and had been maintained in accordance with applicable regulations.

3.1.3 It is estimated that the weather conditions at the time did not contribute to the serious incident.

3.1.4 From the discovery of beach marks, which are characteristic of fatigue fracture, on the fracture surface of the piece of the No. 35 fan blade remaining on the hub, it is estimated that a crack which originated at the trailing edge approximately 19 cm outboard of the platform was propagated. Judging from the length of the beach marks, it is estimated that when the crack caused by fatigue, the fracture was propagated approximately 6 cm due to high cycle fatigue, the remainder was instantaneously fractured.

From the fact that the other fan blades other than the No. 35 were damaged, and that the fracture surfaces on No. 35 fan blade fragments other than the one mentioned above showed indications of tearing by impact shear forces, etc., it is estimated that the approximately 51 cm portion of fan blade which broke away approximately 19 cm outboard of the platform was broken into more than three pieces by shear forces etc. caused by impact with other fan blades. The fracture surface mating to the fracture surface containing the beach marks was worn due to contact with the inside wall of the fan case, etc.

Estimates of fatigue crack growth rates could not be obtained because it was impossible to define quantitatively the many flight parameters, including engine operating conditions, necessary for the estimation.

It is estimated that damages to the fan blades other than No. 35, the inner wall of nose cowling, and fracture of bolts installed in the tail cone were secondary damage due to the failure of the No. 35 fan blade.

3.1.5 It is estimated that the reason the crack originated was as follows.

(1) A small area of the trailing edge of No. 35 fan blade was melted by arc burn, and as it re-solidified rapidly in the air a brittle region with changed microstructure was created.

(2) The brittle region was subsequently damaged, and a crack initiated in the damaged area.

3.1.6 Although it is considered possible that the arc burn to the No. 35 blade trailing edge may have occurred when an inappropriate repair was made to the contact face of the shroud as mentioned in §2.10.1, the cause of the arc burn could not be identified.

3.1.7 Although eddy current inspection to the blade root and visual inspection to other area of fan blade were carried out in shop with the fan blade removed from the engine as mentioned in §2.10.3, it is considered that the arc burn mark and crack were not found by means of these inspections.

While it visual inspection is considered to be the most effective means of finding arc burns, in this case the crack caused by arc burn was not found by visual inspection. It is therefore considered that the arc burn area was extremely small and localized.

It is considered that it might have been possible to detect crack if eddy current inspection, which is an effective method of detecting cracks in metal surfaces, or detailed visual inspection using a magnifier, had been carried out on the entire leading and trailing edges of the fan blade.

3.1.8 It is considered that the EPR of No. 2 engine indicated steadily at 1.515 because the retainer of the converter which converts mechanical movement of the bellows sensing the engine intake air pressure to a voltage value was loosened by impact of a fan blade fragment, rendering it unable to correctly convert engine intake air pressure into a voltage signal.

4 PROBABLE CAUSE

In this serious incident, it is estimated that while the aircraft was climbing, a fan blade in the No. 2 engine failed due to a fatigue crack and damaged the engine, with fragments of the fan blade being projected through the engine nose cowling.

It is estimated that a part of the fan blade was fatigue fractured because an arc burn caused microstructure changes and increased the brittleness of a small region of the trailing edge of the fan blade. Damage to that region then caused a crack, which led to a portion of the fan blade breaking off.

5 MATTERS FOR REFERENCE

5.1 Measures taken by the Civil Aviation Bureau (CAB)

Responding the notification on the result of the factual investigation into this serious incident by ARAIC on February 21, 2003.

CAB took the following measures on the same day.

5.1.1 The CAB issued an airworthiness directive (TCD) ordering Japanese operators of aircraft with Pratt & Whitney JT9D-7A engines to carry out detailed visual inspection of fan blades by no later than February 28, 2003 and to report the inspection results to the CAB.

5.1.2 The CAB notified the U.S. Federal Aviation Administration, the civil aviation authority of state of design and manufacture of the engine, of this serious incident and requested it to consider appropriate measures.

5.2 Measures taken by Operators

The operators of aircraft equipped with Pratt & Whitney JT9D-7A engines—Japan Asia Airlines, and Japan Airlines and JAL Ways—took the following measures.

5.2.1 The three operators carried out the inspection mandated by the TCD as mentioned in §5.1.1, and reported to the CAB that no problems were found on engines installed on aircraft and stored spare engine by February 27, 2003.

5.2.2 The three operators added eddy current inspection and detailed visual inspection of the entire leading and trailing edges to their fan blade shop maintenance program.

Figure 1 Presumed flight pass

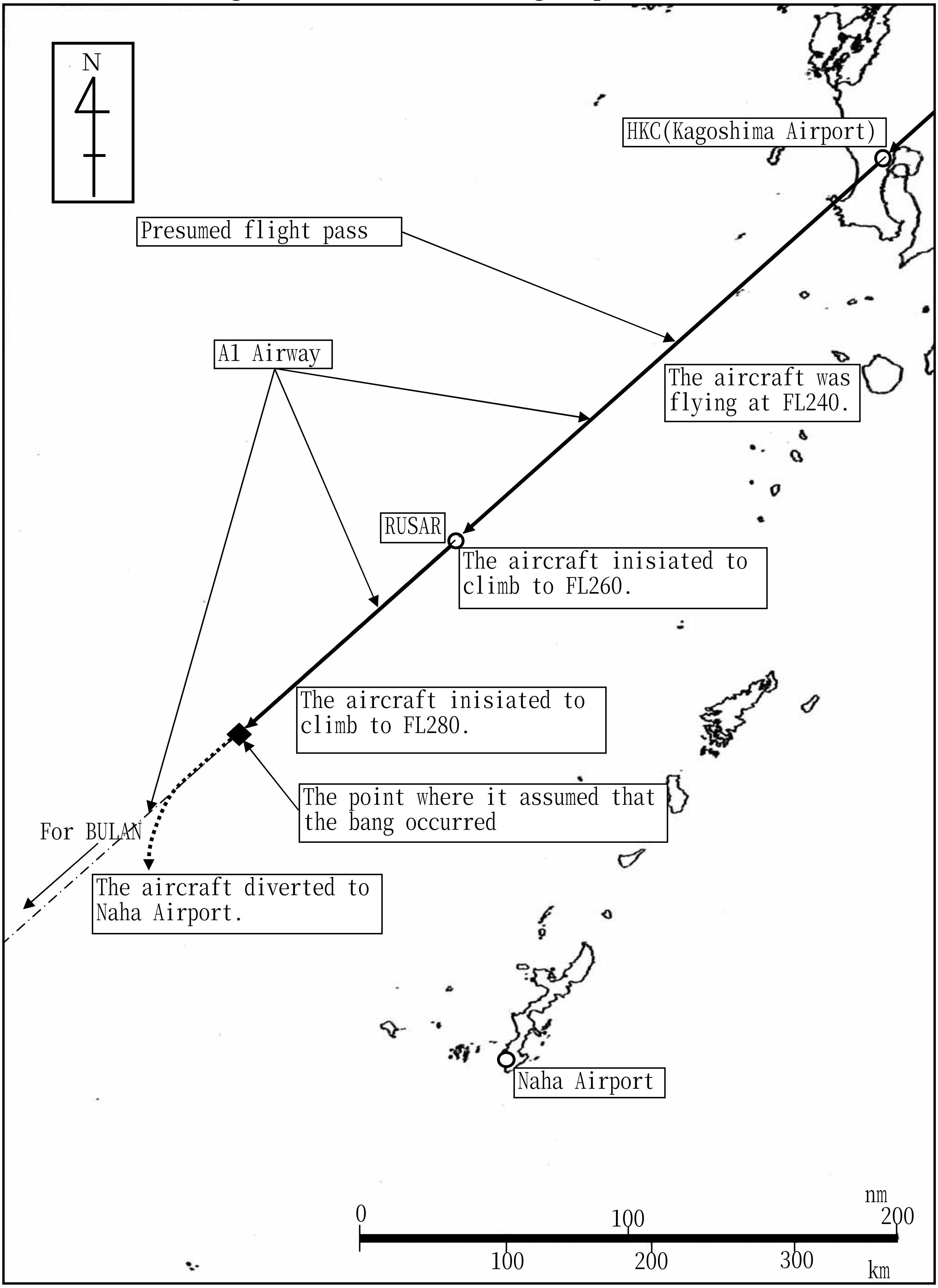


Figure 2 The figure of No.35 fun blade

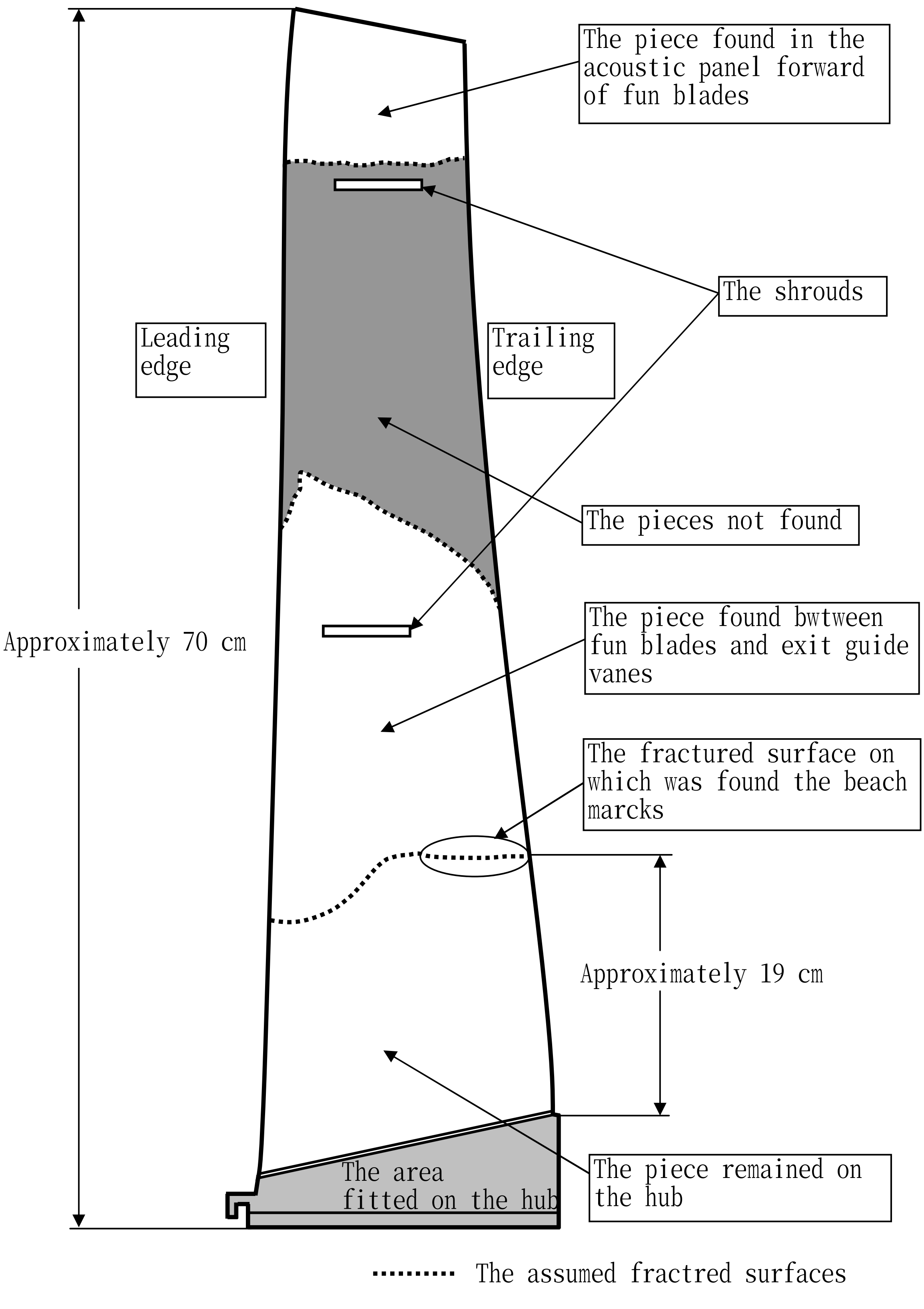
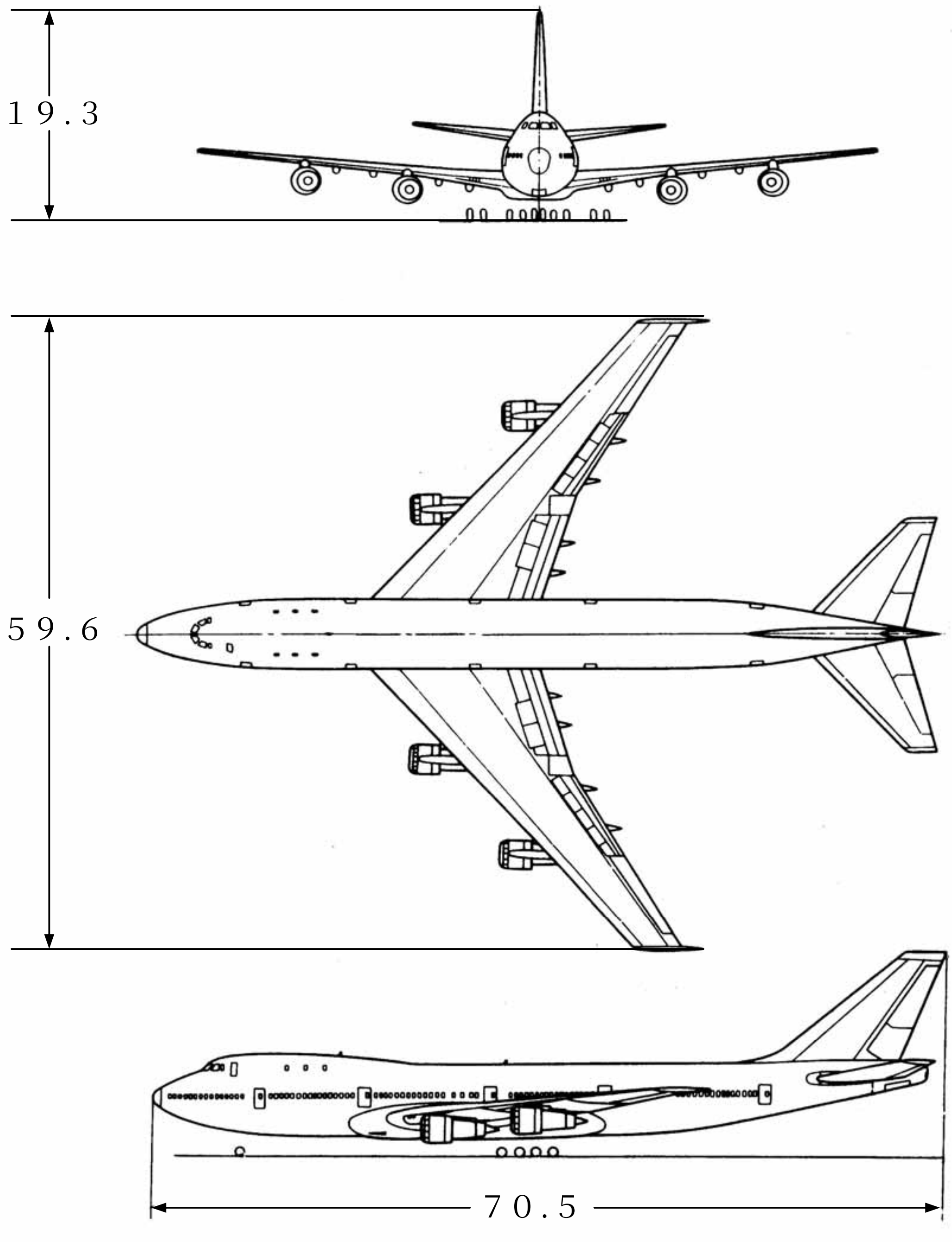
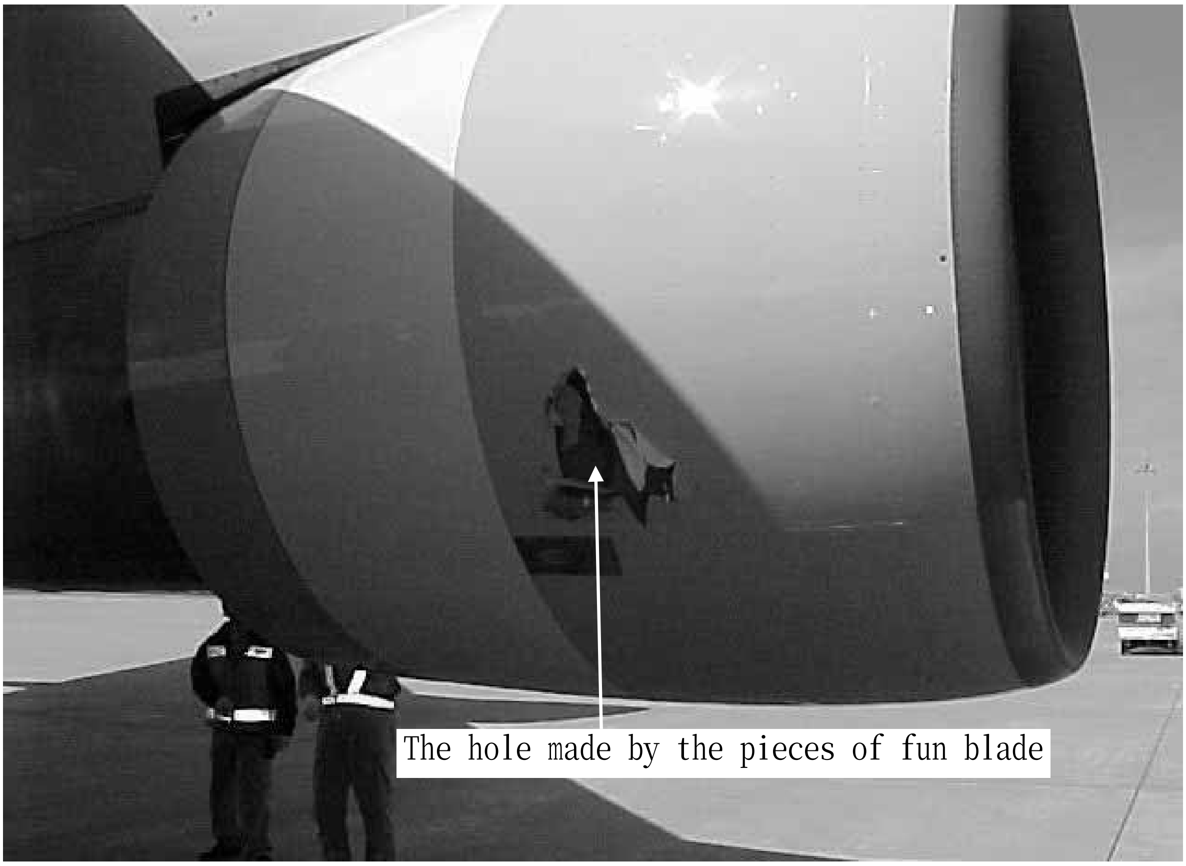


Figure 3 Three views of Boeing 747-200B

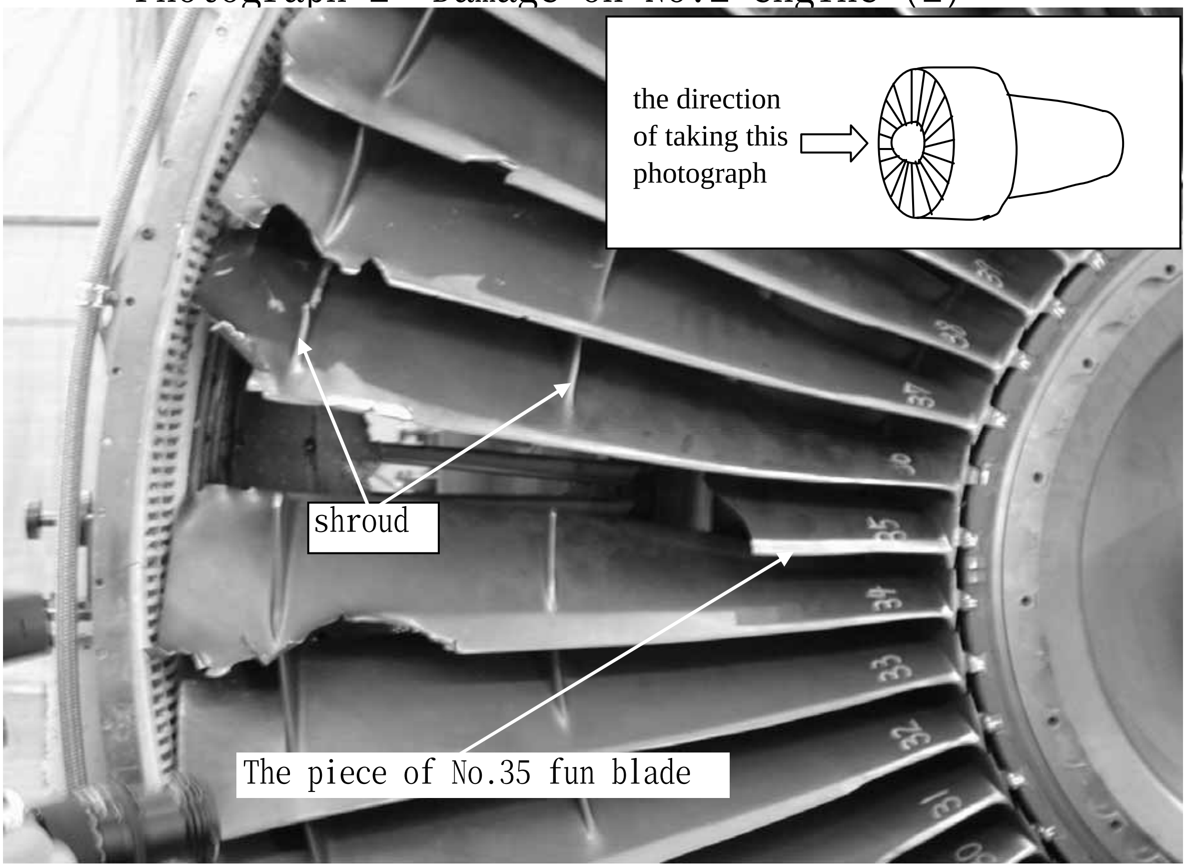
Unit : m



Photograph 1 Damage on No.2 engine (1)

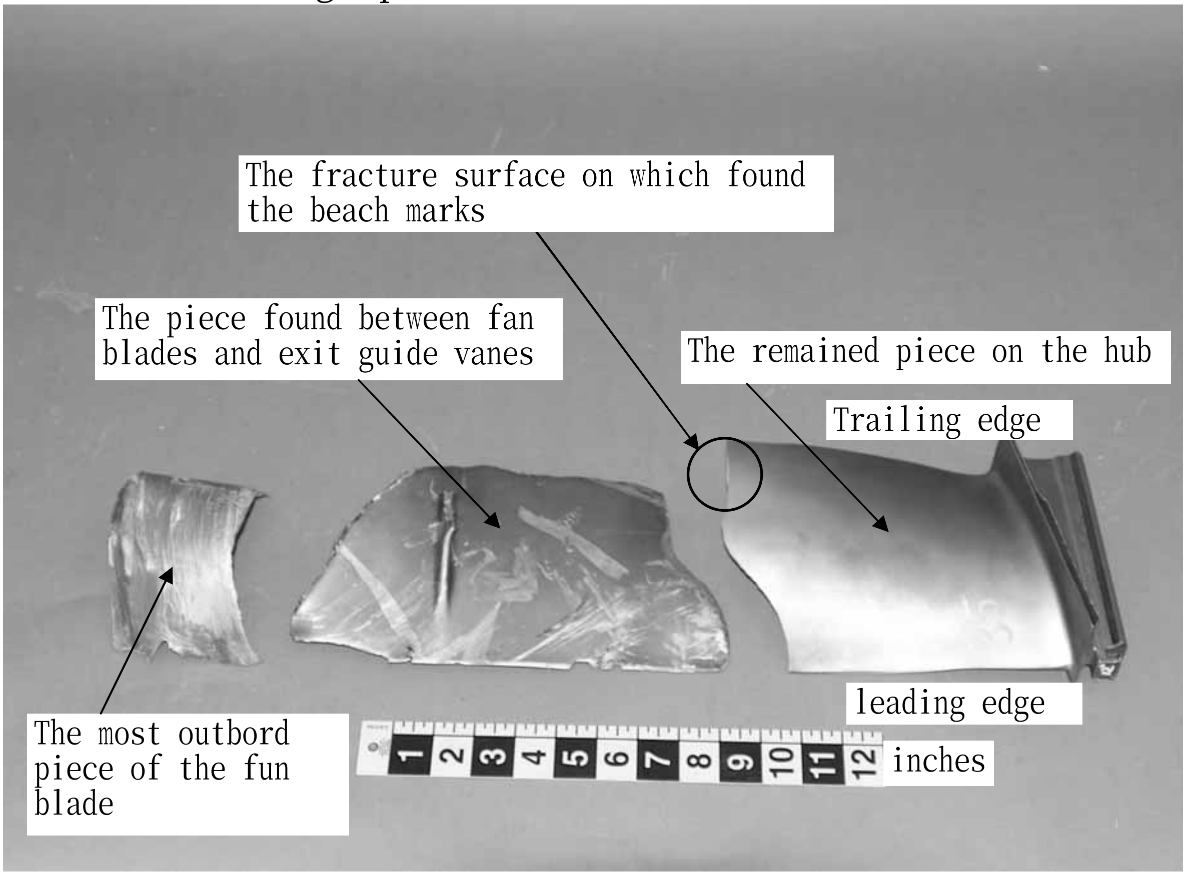


Photograph 2 Damage on No.2 engine (2)

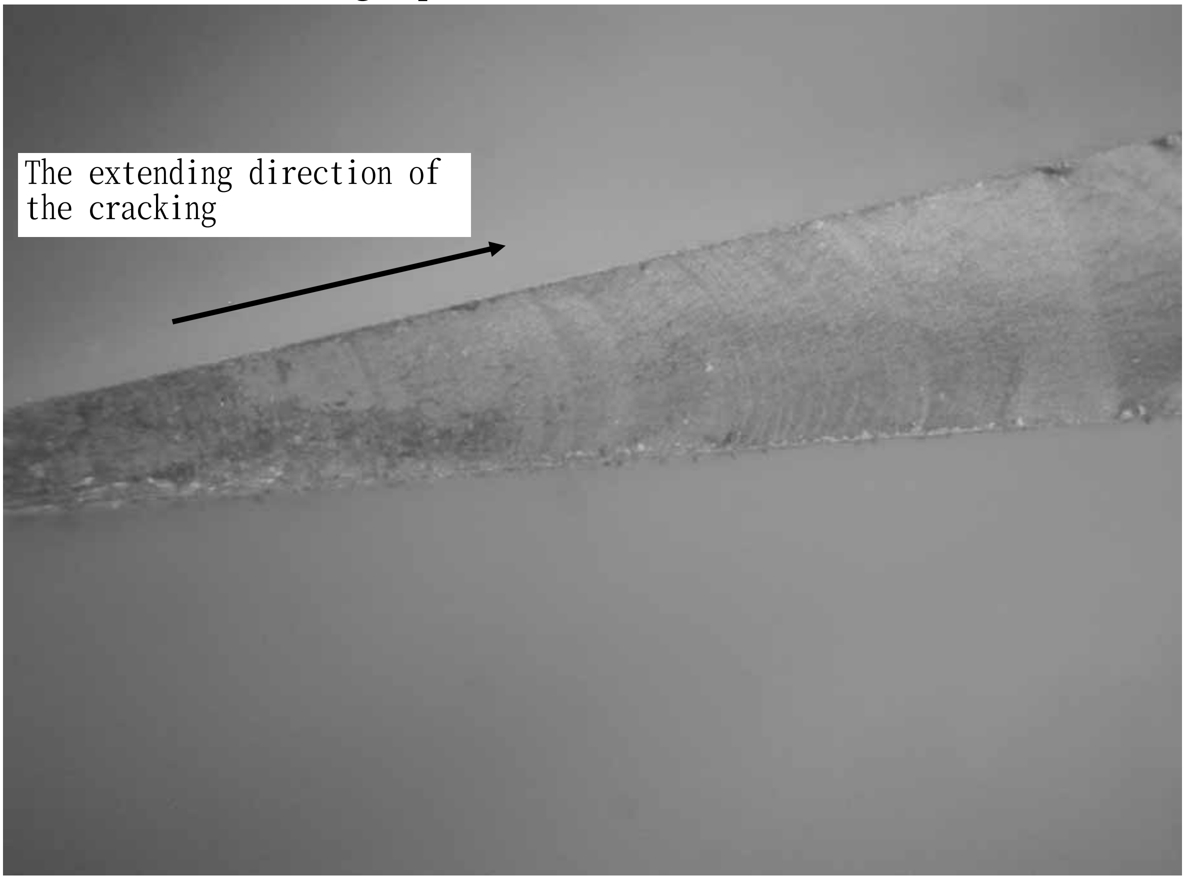


Note) Looking from the forward of the engine with removing the nose cowling, etc

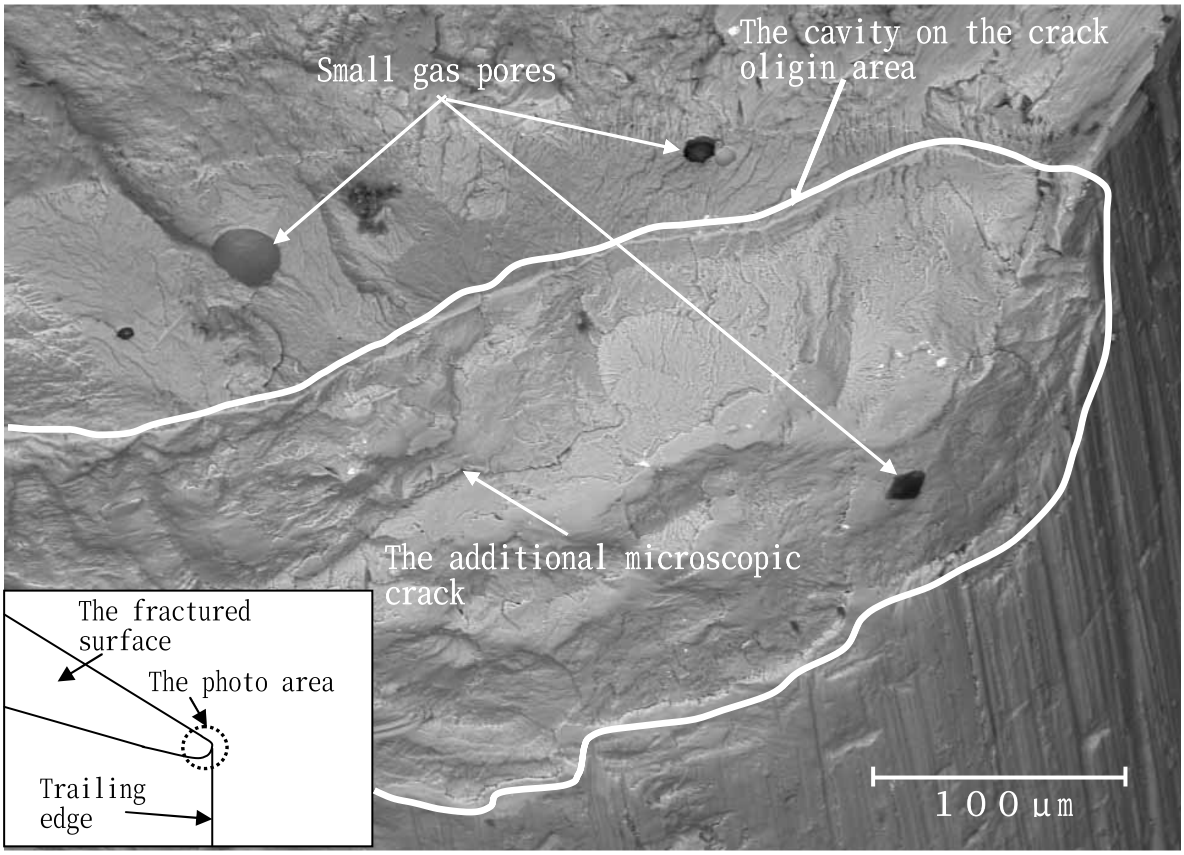
Photograph 3 Pieces of No.35 fun blade



Photograph 4 The beach marks



Photograph 5 The enlarged photo the cracking origin area



Photograph 6 Three different region at the cracking oligin area