

AI2012-4

**AIRCRAFT SERIOUS INCIDENT
INVESTIGATION REPORT**

**EVERGREEN INTERNATIONAL AIRLINES, INC.
N 4 8 2 E V**

May 25, 2012



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

**EVERGREEN INTERNATIONAL AIRLINES, INC.
BOEING 747-200 (CONVERTED FREIGHTER MODEL), N482EV
ABOUT 4 NM SOUTHWEST OF
CHUBU CENTRAIR INTERNATIONAL AIRPORT, JAPAN
AROUND 06:03 JST, NOVEMBER 28, 2010**

April 20, 2012

Adopted by the Japan Transport Safety Board

Chairman	Norihiro Goto
Member	Shinsuke Endoh
Member	Toshiyuki Ishikawa
Member	Sadao Tamura
Member	Yuki Shuto
Member	Toshiaki Shinagawa

SYNOPSIS

〈Summary of the Serious Incident〉

At 06:00 Japan Standard Time (JST: UTC+ 9hr, unless otherwise stated all times are indicated in JST on a 24-hour clock) on November 28 (Sunday), 2010, a Boeing 747-200, registered N482EV, operated by Evergreen International Airlines, Inc., took off from runway 36 of Chubu Centrair International Airport as the airline's scheduled flight 238 (a cargo flight) for Anchorage International Airport, the United States of America. During its takeoff climb, the No. 2 engine thrust indication dropped with strong aircraft vibrations. The aircraft, after the engine shut-down and fuel jettison, turned back and landed at Chubu Centrair International Airport at 07:14.

There were three persons on board the aircraft, the Pilot in Command (PIC), the First Officer (FO) and a Flight Engineer (FE); but no one was injured.

〈Probable Causes〉

It is possible that the serious incident occurred because the fractured 1st stage LPT rotor blades in the No.2 engine damaged the downstream components during takeoff climb.

The following abbreviations are used in this report:

BSI	: Borescope Inspection
CC	: Combustion Chamber
CVR	: Cockpit Voice Recorder
DFDR	: Digital Flight Data Recorder
EGT	: Exhaust Gas Temperature
EPR	: Engine Pressure Ratio
HPC	: High Pressure Compressor
HPT	: High Pressure Turbine
LPC	: Low Pressure Compressor
LPT	: Low Pressure Turbine
N1	: Low Pressure Compressor Speed (Fan Speed)
N2	: High Pressure Compressor Speed
NGV	: Nozzle Guide Vane
NTSB	: National Transportation Safety Board
TEC	: Turbine Exhaust Case

Unit Conversion Table

1 ft	: 0.3048 m
1 kt	: 1.852 km/h (0.5144 m/s)
1 nm	: 1,852 m

1. PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of Serious Incident

The occurrence covered by this report falls under the category of “Damage of engine (limited to a major damage occurred inside the engine)” as stipulated in Clause 6, Article 166-4 of the Ordinance for Enforcement of the Civil Aeronautics Act, and is classified as an aircraft serious incident.

At 06:00 Japan Standard Time (JST: UTC+ 9hr, unless otherwise stated all times are indicated in JST on a 24-hour clock) on November 28 (Sunday), 2010, a Boeing 747-200, registered N482EV, operated by Evergreen International Airlines, Inc., took off from runway 36 of Chubu Centrair International Airport as the airline’s scheduled flight 238 (a cargo flight) for Anchorage International Airport, the United States of America. During its takeoff climb, the No. 2 engine thrust indication dropped with strong aircraft vibrations. The aircraft, after the engine shut-down and fuel jettison, turned back and landed at Chubu Centrair International Airport at 07:14.

There were three persons on board the aircraft, the Pilot in Command (PIC), the First Officer (FO) and a Flight Engineer (FE); but no one was injured.

1.2 Outline of Serious Incident Investigation

1.2.1 Investigation Organization

The Japan Transport Safety Board (JTSB) designated an investigator-in-charge and another investigator to investigate this serious incident on December 1, 2010, when it received a report about the occurrence of the serious incident.

1.2.2 Representative from Relevant State

An accredited representative of the United States of America, as the State of Design and Manufacture, Registry and the Operator of the aircraft involved in this serious incident, participated in the investigation.

1.2.3 Implementation of Investigation

December 2, 2010	Aircraft and engine examinations and interviews
December 3, 2010	Interviews

1.2.4 Comments from Parties Relevant to Cause of Serious Incident

Comments were invited from parties concerned with the cause of the serious incident.

1.2.5 Comments from Relevant State

Comments on the draft report were invited from the relevant State.

2. FACTUAL INFORMATION

2.1 History of Flight

At 06:00 on November 28, 2010, a Boeing 747-200, registered N482EV (hereinafter referred to as “the Aircraft”), operated by Evergreen International Airlines, Inc. (hereinafter referred to as “the Company”), took off from runway 36 of Chubu Centrair International Airport (hereinafter

referred to as “the Airport”) as the Company’s scheduled flight 238 for Anchorage International Airport, the United States of America.

The outline of the flight plan for the Aircraft was as follows:

Flight rules:	Instrument Flight Rules (IFR)
Departure aerodrome:	Chubu Centrair International Airport
Estimated off-block time:	02:15
Cruising speed:	490kt
Cruising altitude:	FL (Flight Level) 290
Route:	ANJYO REVERSAL ONE (Standard Instrument Departure Route) – CHAUS (reporting point) – TENRU (reporting point) – W18 (airway) – (The rest is omitted)
Destination aerodrome:	Anchorage International Airport
Total estimated elapsed time:	6 h 05 min

The history of the flight up to the time of this serious incident is summarized as below, based on the ATC communications, the radar tracking records and the AIRCREW IRREGULARITY REPORT written by the aircrew of the Aircraft (hereinafter referred to as “the Irregularity Report”) as well as the Serious Incident Report submitted by the Company.

2.1.1 History of Flight based on ATC Communications and Radar Tracking Records

The Aircraft was pushed back from the Spot 117 around 01:55 and the Aircraft reported to the Airport Ground Control Station (“the Ground”) that it would undergo a maintenance work for about five minutes at the place it stands after the pushback around 02:03. Later it returned to the Spot 117 for maintenance around 02:22.

Around 05:13, after a lapse of about 2 hours and 50 minutes, the Aircraft reported to the Ground that its engine issues were corrected and requested for a pushback from the Spot 117 and engine start. Around 05:47, the Aircraft started taxiing toward runway 36 as directed by the Ground. It took off at 06:00 after obtaining a takeoff clearance from the Local Control Station (“the Tower”).

The Aircraft was instructed by the Departure Control (“the Departure”) to climb to 12,000 ft and around 06:03, it was climbing through about 3,500 ft.

At 06:03:48, when the Aircraft was climbing through about 4,000 ft, the Aircraft reported to the Departure that it needed to dump fuel for return to the Airport because of an engine problem. Around 06:04 the Aircraft reported to the Departure that it would take 45 minutes to one hour for fuel dump. Around 06:07, the Aircraft reported to the Departure that it shut the troubled No.2 engine down.

The Aircraft landed on runway 36 of the Airport at 07:14.

2.1.2 History of Flight based on the Irregularity Report and Serious Incident Report

(1) Irregularity Report

The Irregularity Report submitted by the PIC of the Aircraft describes the situation at the time of this incident as follows:

While performing Standard Instrument Departure (SID) from Chubu Centrair International Airport (RJGG) to Anchorage International Airport (PANC), at approx 3,500 ft,

#2 engine EPR(Ratio between a turbine outlet pressure and a compressor inlet pressure) and N1 (Low Pressure Compressor Speed) rolled back accompanied with strong vibration, flaps were moving from 5° to 1° . Oil pressure was 35-40 psi. Qty was full. After engine failure check action items was completed with a heavy vibration, engine fire / severe damage check was then completed. Called dispatch / tech center discussed possible divert to Hong Kong International Airport (VHHH) or Shanghai Pudong International Airport (ZSPD). With an increase in airspeed, vibration likewise increased. I then made the decision to return to Chubu Centrair International Airport. Dumped down to 610,000 lb (landing weight) to land. FO and FE completed all check lists.

(2) Serious Incident Report

The Serious Incident Report submitted by the Company to the Minister of Land, Infrastructure, Transport and Tourism on December 5, 2010 describes the situation at the time when this incident occurred as follows:

ACFT N482EV, FLT NO.EIA238 RETURN FLT DUE TO NO.2 ENG TROUBLE RESULTING INFLT SHUTDOWN OF #2 ENG. DURING INVESTIGATION FOUND #2 ENG HAD BROKEN TURBINE BLADES LOOKING FORWARD THRU EXHAUST. FLAPS/AILERON ALSO DAMAGED.

This serious incident occurred around 06:03 at an altitude of about 3,500 ft about four nautical miles southwest of the Airport (about 34°49' N and 136°45' E). (See Figure 1 Estimated Flight Route, Figure 2 Estimated Aircraft Altitude derived from Radar Tracking Records, Photo 1 Serious Incident Aircraft, Photo 3 Damage to the Aircraft, Photo 4 Damage viewed from Engine Exhaust, Attachment ATC Communications)

2.2 Injuries to Persons

No one suffered injuries in the serious incident.

2.3 Damage to the Aircraft

2.3.1 Extent of Damage

The inside of the No.2 engine had extensive damage. The fairings of the flap driving system (hereinafter referred to as “the Fairings”) and the inboard aileron had small traces of collision.

2.3.2 Condition of Damage to the No.2 Engine

Visual and borescope inspections (BSIs) confirmed the condition of the No.2 engine as follows:

- (1) There were no traces of absorbed foreign objects on the fan blades.
- (2) The combustion chamber (CC) and the nozzle guide vanes (NGVs) at the chamber outlet were normal.
- (3) The 1st and 2nd stage high pressure turbines (HPTs) were normal.

(4) In the four-stage low pressure turbine (LPT) section, the stator vanes and the rotor blades had severe damage as their stages go rearward.

The 1st stage LPT rotor blades (hereinafter referred to as “the LPT3 Blades”) and the trailing edges of the stator vanes in front of the LPT3 blades as well as the tip of the exhaust gas temperature (EGT) probe at 12 o’clock*1 exhibited severe damage.

All the leading edges of stator vanes in front of LPT4 blades were damaged. LPT5 blades were fractured and stator vanes had trailing edge damage.

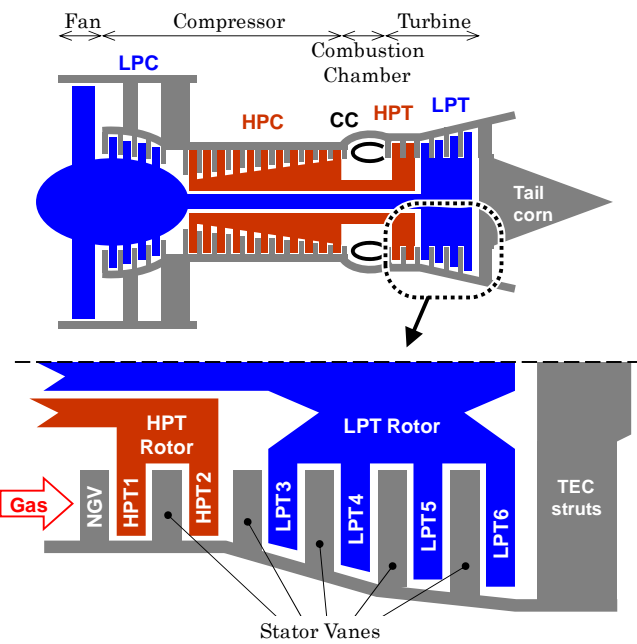
All the LPT6 blades were fractured and the stator vanes were broken.

The turbine exhaust case (hereinafter referred to as “the TEC”) struts were partially fractured and damaged.

(5) Small metallic pieces were found near the LPT6 exit.

(6) About 1 cm-long rapture was found in engine case at one o’clock. The tail cone had traces of collision.

(See Photo 2 Dismounted No.2 Engine, Photo 3 Damage to the Aircraft, Photo 4 Damage viewed from Engine Exhaust, Photo 5 Damage to Engine Case and Tail Cone)



Conceptual Diagram of the No.2 Engine

2.4 Personnel Information

(1) PIC	Male, Age 40	
Airline Transport Pilot Certificate (Airplane)		February 9, 2009
Type rating for B747-200		Date unknown
Class 1 Aviation Medical Certificate		
Validity		February 28, 2011
Total flight time		10,260 h 00 min
Flight time in the last 30 days		44 h 28 min
Total flight time on the type of aircraft		Unknown
Flight time in the last 30 days on the type of aircraft		44 h 28 min
(2) FO	Male, Age 48	
Airline Transport Pilot Certificate (Airplane)		July 10, 2008
Type rating for B747-200		Date unknown
Class 1 Aviation Medical Certificate		
Validity		December 31, 2010
Total flight time		7,400 h 00 min
Flight time in the last 30 days		13 h 06 min

*1 When an engine is viewed from aft, a point on its perimeter around its axis is given using a clockface whose 12 o’clock is aligned to the engine top position.

Total flight time on the type of aircraft	Unknown
Flight time in the last 30 days on the type of aircraft	Unknown
3) Flight Engineer	Male, Age 59
Flight Engineer Certificate	February 28, 2008
Type rating for B747	Date unknown
Class 2 Aviation Medical Certificate	
Validity	January 31, 2011
Total flight time	13,065 h 00 min
Flight time in the last 30 days	31 h 06 min
Total flight time on the type of aircraft	Unknown
Flight time in the last 30 days on the type of aircraft	Unknown

2.5 Aircraft Information

2.5.1 Aircraft

Type	Boeing 747-200
Serial number	20713
Date of manufacture	August, 1973
Certificate of airworthiness	Unknown
Validity	Unknown
Category of airworthiness	Unknown
Total flight time	109,839 h 17 min
Total cycles	25,346 cycles
Flight time since last periodical check	Unknown

(See Figure 3 Three Angle View of Boeing 747-200)

2.5.2 Engine

Model	Pratt & Whitney JT9D-7J	
	<u>No.1 Engine</u>	<u>No.2 Engine</u>
Serial Number	662232	686071
Date of manufacture	Unknown	Unknown
Total time	91,452 h 10 min	95,997 h 48 min
Total cycles	19,766 cycles	16,013 cycles
Total time since overhaul	7,942 h	20,185 h 48 min
Total cycles since overhaul	Unknown	4,372 cycles
	<u>No.3 Engine</u>	<u>No.4 Engine</u>
Serial Number	695823	663030
Date of manufacture	Unknown	Unknown
Total time	72,039 h 18 min	74,701 h 42 min
Total cycles	11,654 cycles	14,582 cycles
Total time since overhaul	13,719 h	10,480 h
Total cycles since overhaul	Unknown	Unknown

(See Figure 4 JT9D Engine)

2.5.3 History of the No.2 Engine

Following are the major events in the history of the engine involved (serial number: 686071):

(1) January 2001

The engine was installed on a Company's other aircraft for the first time after an overhaul.

(2) January 2005

Total time	85,593 h 42 min
Total cycles	13,725 cycles
Total time since overhaul	9,781 h 42 min
Total cycles since overhaul	2,084 cycles

The engine was dismantled to repair the damage of combustion chamber liner.

(3) April 2006

Total time	87,241 h 00 min
Total cycles	14,096 cycles
Total time since overhaul	11,429 h 00 min
Total cycles since overhaul	2,455 cycles

The engine was dismantled to repair the N2 (high pressure compressor speed) rotor lubricating system with the problem of decreased hydraulic pressure.

(4) April 2007

The engine was installed on the Aircraft as the No.2 engine. About half a year later it was dismantled and reinstalled on other aircraft.

(5) January 2009

C inspection for the engine was performed.

(6) September 2009

Total time	92,890 h 00 min
Total cycles	15,311 cycles
Total time since overhaul	17,078 h 00 min
Total cycles since overhaul	3,670 cycles

The TEC was dismantled and the No.4 bearing housing was replaced. Later, the engine was reinstalled as the No.2 engine of the Aircraft.

(7) December 2, 2010

The engine was dismantled from the Aircraft after this serious incident. The total time and cycles during the last installation on the Aircraft was 3,107 hours 48 minutes and 702, respectively.

2.6 Meteorological Information

Aeronautical weather observations at the Airport around the time of this serious incident were as follows:

06:00	Wind direction	240° (150° – 320° variable)	Wind velocity	5kt
	Visibility	10 km or more	Present weather	rainy
	Cloud	Amount 1/8	Type Cumulus	Cloud base 2,000 ft
		Amount 3/8	Type Cumulus	Cloud base 3,000 ft
		Amount 7/8	Type Stratocumulus	Cloud base 4,000 ft
	Temperature	14 °C	Dew point	9 °C
	Altimeter setting (QNH)	30.08 inHg		

2.7 Information on Digital Flight Data Recorder and Cockpit Voice Recorder

The Aircraft was equipped with a digital flight data recorder (DFDR) (part number: 10077A500107) made by Lockheed Aircraft Service Company of the United States of America and a cockpit voice recorder (CVR) (part number: 93-A100-30) made by Fairchild Industrial Products of the United States of America.

The DFDR (magnetic tape type) was recordable for about 25 hours. Correct analysis of the retrieved data for the incident was impossible.

The CVR was recordable for about 30 minutes, but an overwriting erased the data at the time of the occurrence.

2.8 Runway Check

The Airport has a runway (18/36) with a length of 3,500 m and a width of 60 m. The runway check done between 07:16 and 07:20 just after the Aircraft's return following the serious incident and that done between 08:17 and 08:22 after the recognition of engine damage found no engine debris or other pertinent objects.

2.9 Additional Information

2.9.1 Detailed Inspection of Engine

The No.2 engine teardown inspection was not performed because the Company did not agree to do so. Therefore, the precise damage of the engine interior remains unknown.

2.9.2 International Guideline Regarding Definition of Serious Incidents

Following remarks are included in Attachment C, List of Examples of Serious Incidents, and Attachment G, Guidance for the Determination of Aircraft Damage, in Annex 13 to the Convention on International Civil Aviation which shows international standards and recommended practices:

ATTACHMENT C. LIST OF EXAMPLES OF SERIOUS INCIDENTS

1. *The term "serious incident" is defined in Chapter 1 as follows:*

Serious incident. An incident involving circumstances indicating that there was a high probability of an accident and associated with the operation of an aircraft (Omitted) with the intention of flight (the rest is omitted)

2. *The incidents listed are typical examples of incidents that are likely to be serious incidents.*

The list is not exhaustive and only serves as guidance to the definition of serious incident.

(Omitted)

Aircraft structural failures or engine disintegrations, including uncontained turbine engine failures, not classified as an accident.

(The rest is omitted)

ATTACHMENT G. GUIDANCE FOR THE DETERMINATION OF AIRCRAFT DAMAGE

(Omitted)

3. *Occurrences where compressor or turbine blades or other engine internal components are ejected through the engine tail pipe are not considered an accident.*

(The rest is omitted)

2.9.3 View of the United States of America

The accredited representative of the United States of America showed the following view for the investigation of this serious incident:

This case is not strictly considered a 'reportable' event according to US National Transportation Safety Board (NTSB) regulations. No structural or other flight critical components of the airplane were affected that may have compromised the safety of flight, making this a reportable event. Additionally, only one engine was affected and the airplane had sufficient thrust to continue the safe return to the airport (with the remaining three engines). The Company had no plan for a repair or overhaul for the engine involved (as of February 2011) and did not agree on disintegrating the engine.

3. ANALYSIS

3.1 Qualifications of Personnel

The PIC, FO and FE supposedly held both valid airman competence certificates and valid aviation medical certificate; but the confirmation was not possible.

3.2 Airworthiness Certificate of the Aircraft

The validity of airworthiness certificate, whether its maintenance and inspections were done as prescribed were not confirmed.

3.3 Relations to Meteorological Phenomena

It is highly probable that the meteorological condition had no bearing with the occurrence of the serious incident.

3.4 Development on Aircraft

3.4.1 Before Takeoff

As described in 2.1.1, the Aircraft reported to the Ground around 02:03 that it would undergo maintenance work for about five minutes at the pushed-back location, and around 02:22 it returned to the Spot 117 for maintenance work.

In response to our inquiry about the maintenance work's linkage to the No.2 engine, the Company remained silent. However, with the fact that around 5:13 after a lapse of about 2 hours and 50 minutes, the Aircraft informed the air traffic controller of its engine issues corrected as described in 2.1.1, it is highly probable that the previous maintenance work was linked to one of the four engines.

3.4.2 After Takeoff

According to the Irregularity Report mentioned in 2.1.2 (1), it is highly probable that after the takeoff the Aircraft experienced strong vibration with the drop of No.2 engine EPR and N1 values at about 3,500 ft and it informed the air traffic controller of its engine trouble after the designated procedures. As described in 2.1.1, it was around 06:03 when the Aircraft was climbing through about 3,500 ft and it was 06:03:48 when the aircrew informed the air traffic controller of the engine trouble while climbing through about 4,000 ft.

These facts very likely indicate that the No.2 engine had the trouble around 06:03 at about

3,500 ft.

3.5 Damage to the No.2 Engine and Airframe

As described in 2.3.2, it is possible that the LPT3 blades involved were fractured and their fragments damaged the downstream components in each LPT stage.

It is possible that the trailing edges of the stator vanes just in front of and behind LPT3 blades and the tip of the EGT probe were damaged when the fragments of the fractured LPT3 blades hit them. It is probable that LPT4 to LPT6 blades and the TEC struts as well as the tail cone were damaged as a secondary effect when the fragments of the fractured LPT3 blades or those of the LPTs downstream spread to other areas.

It is highly probable that the small traces of collision found on the fairings and the inboard aileron, as described in 2.3.1, were created when the expelled fragments of LPT section hit them.

The JTSCB could not eliminate the possibility that there could have been other original causes for the engine damage other than the LPT3 blades fracture, because, as described in 2.9.1, it was denied to conduct the detailed examination of the damaged engine.

3.6 Influence on Safety of Flight

It is probable that, as described in 3.5, the parts expelled from the No.2 engine exhaust damaged the fairings and inboard aileron as described in 2.3.1. It is also probable that the damage was not serious enough to compromise the safety of the flight.

The Aircraft is a four-engine model and even with one engine troubled, it can fly safely with the remaining three engines. Therefore, it is highly probable that the Aircraft was not in a situation where the flight safety is compromised.

As described in 1.1, in the case of a “major damage occurred inside the engine,” the occurrence is treated as a serious incident in Japan under the Ordinance for Enforcement of the Civil Aeronautics Act. By contrast, the Attachment C in Annex 13 to the Convention on International Civil Aviation as described in 2.9.2, the term “serious incident” is defined as an incident involving circumstances indicating that there was a high probability of an accident. As a typical example of serious incident, an uncontained turbine engine failure not being classified as an accident is listed in the attachment. This practice may indicate that an engine interior damage is treated as a serious incident, when the damage is not contained in itself but debris penetrate the engine case causing damage to other aircraft components.

As described in 2.9.2, it is probable that this occurrence mentioned above does not meet the Annex 13 criterion — “a high probability of an accident.”

4. PROBABLE CAUSES

It is possible that the serious incident occurred because the fractured 1st stage LPT rotor blades in the No.2 engine damaged the downstream components during takeoff climb.

Figure 1 Estimated Flight Route

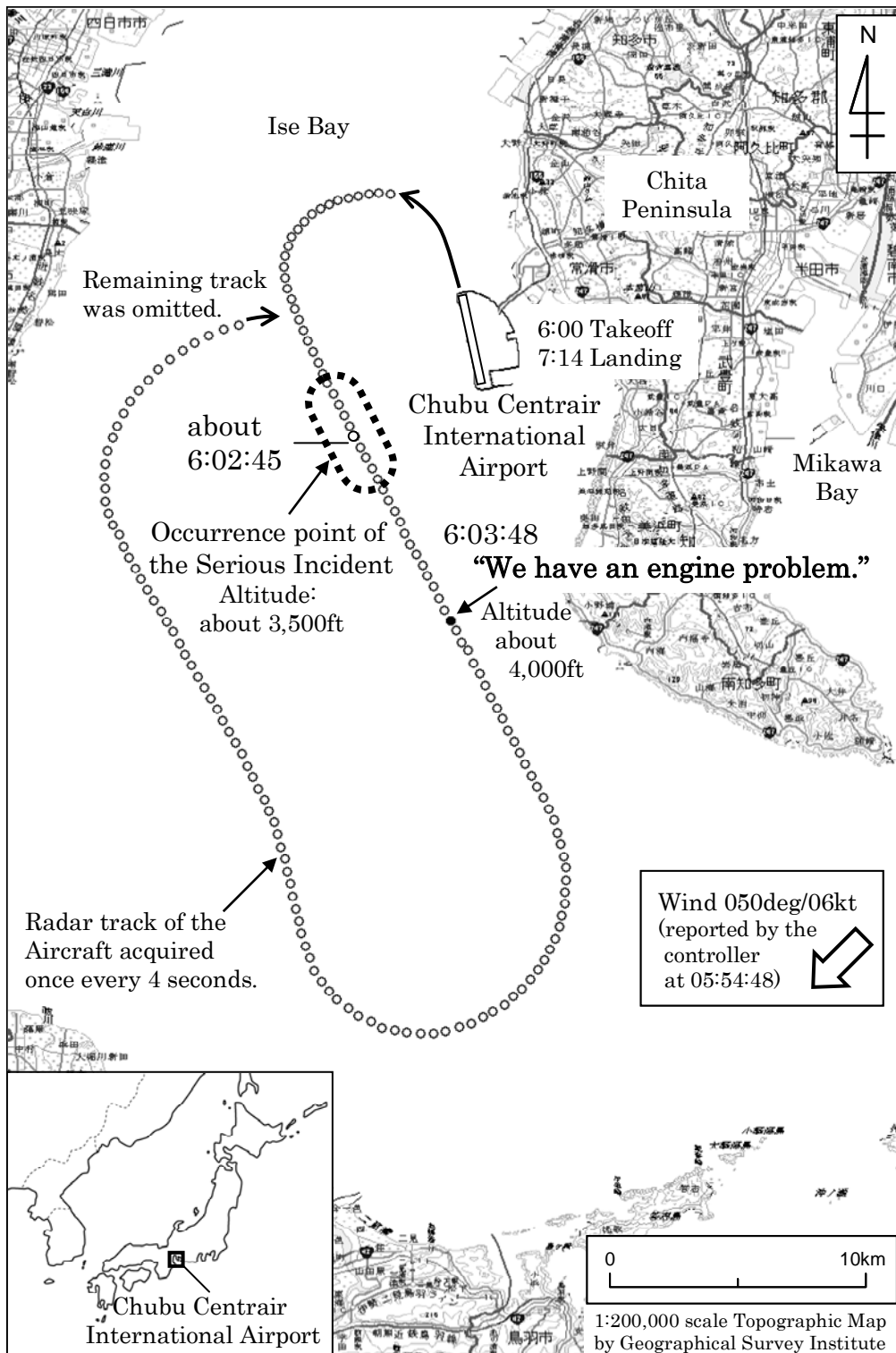
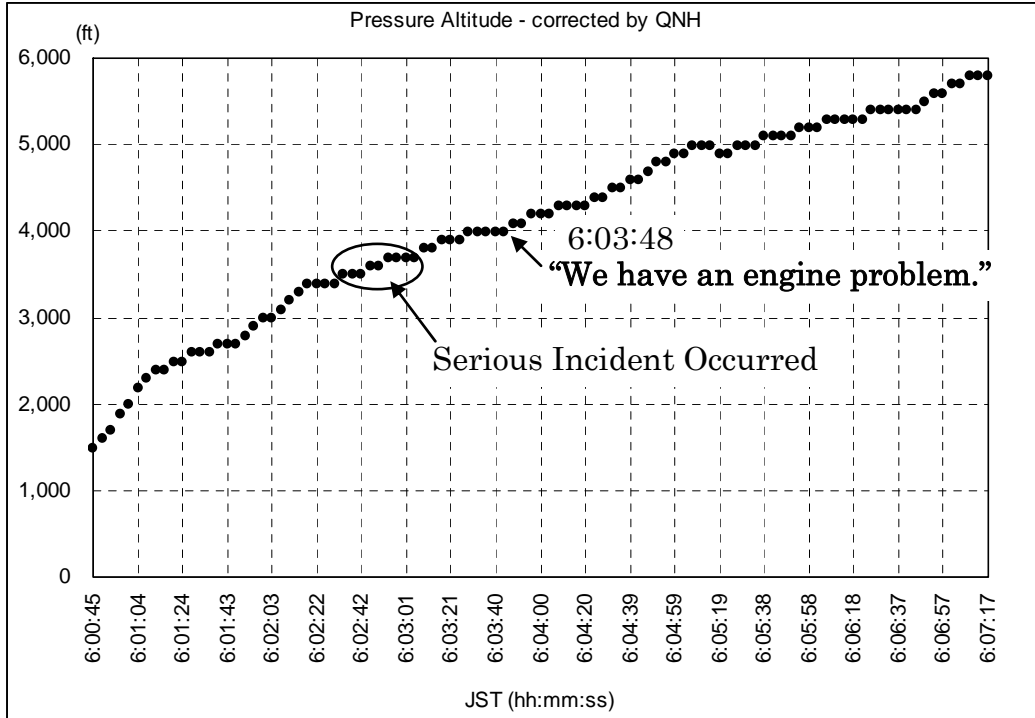


Figure 2 Estimated Aircraft Altitude
derived from Radar Tracking Records



The data of pressure altitude based on a Secondary Surveillance Radar was corrected by QNH.

Figure 3 Three Angle View of Boeing 747-200

Unit : m

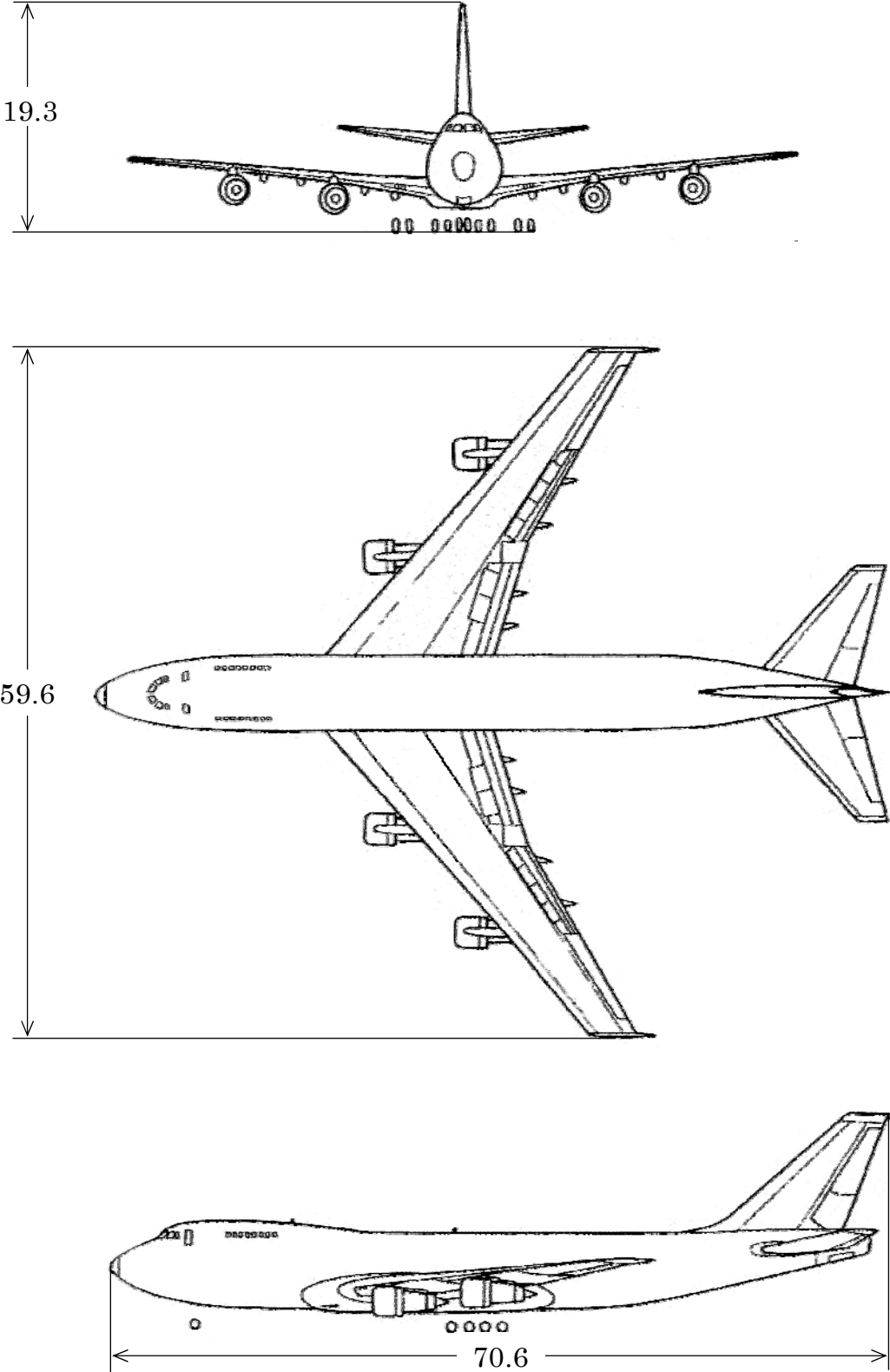


Figure 4 JT9D Engine

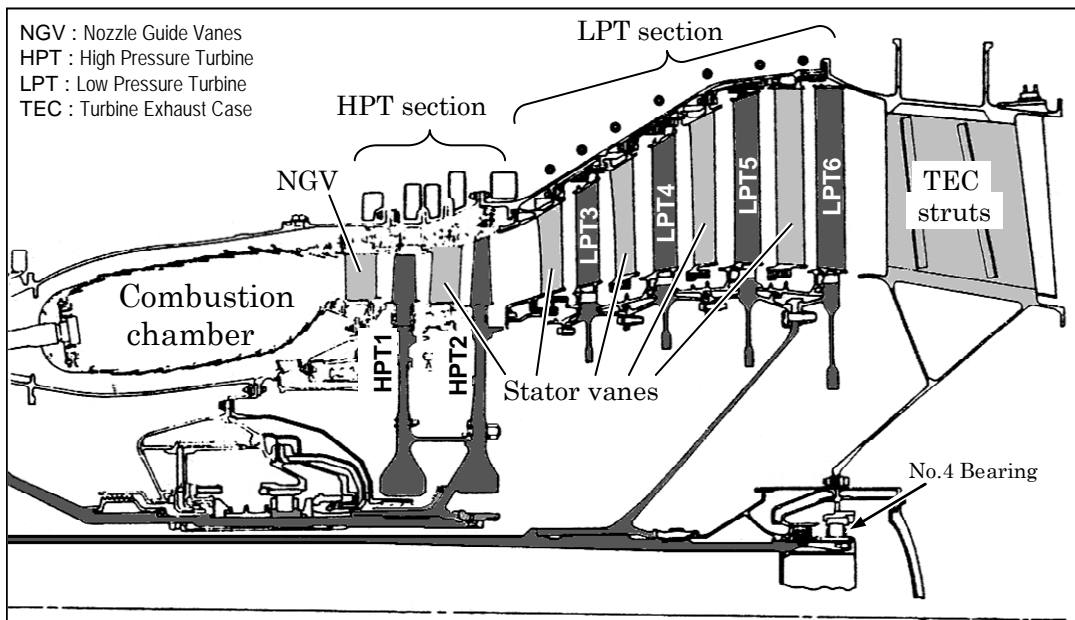
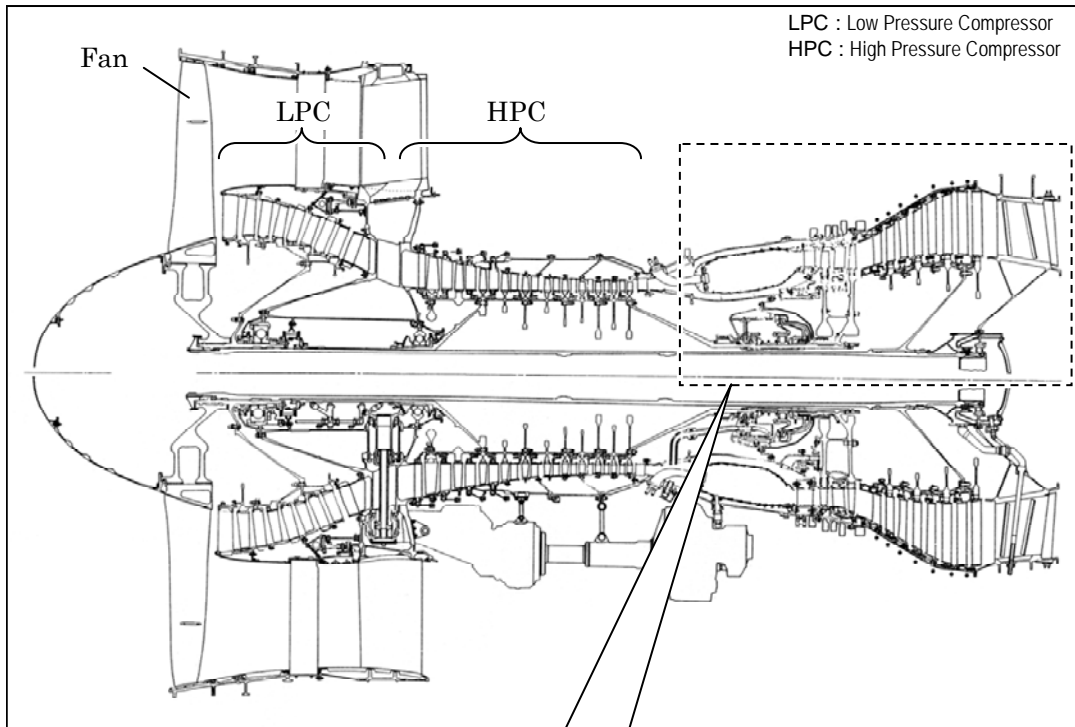


Photo 1 Serious Incident Aircraft



Photo 2 Dismounted the No.2 Engine



Photo 3 Damage to the Aircraft

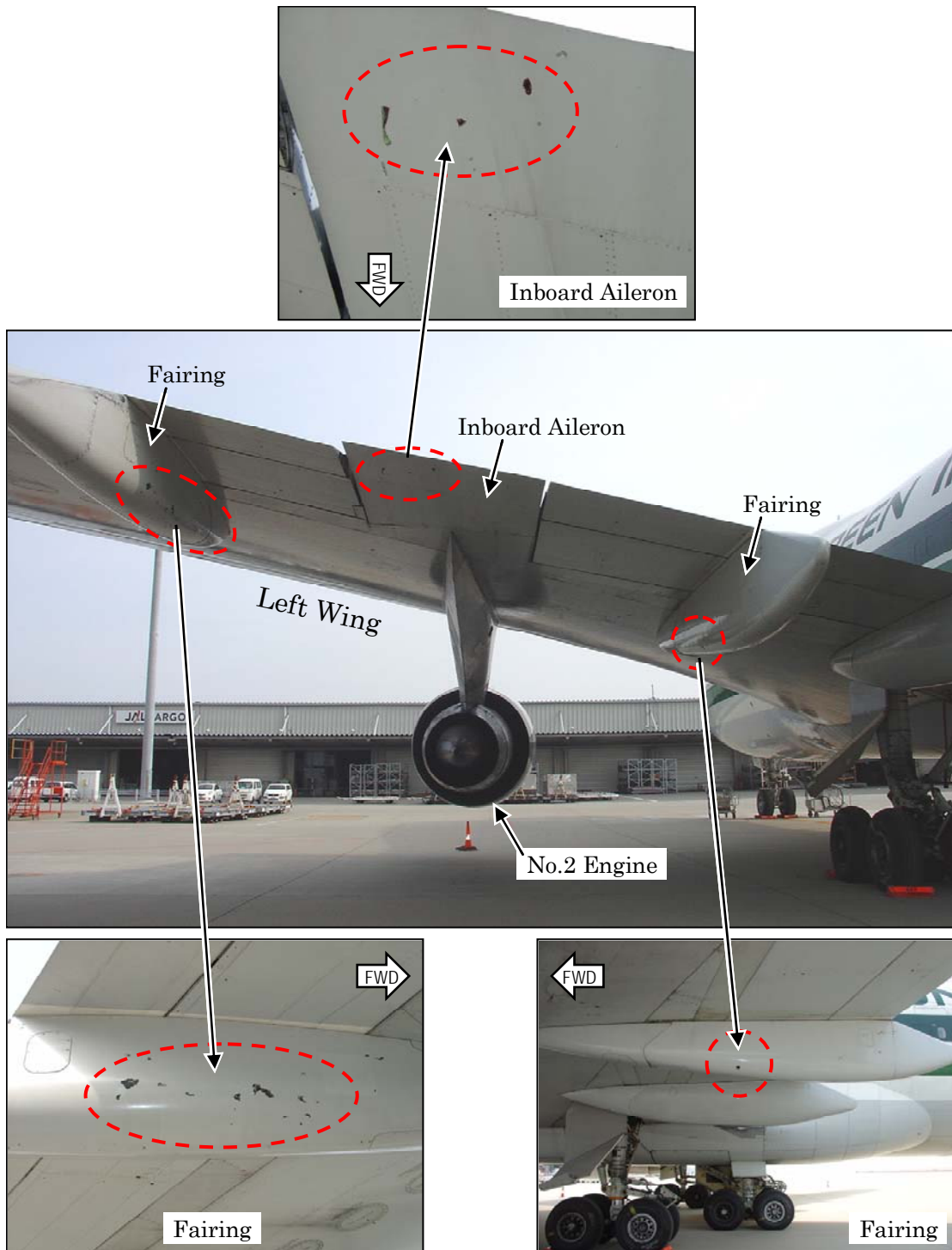


Photo 4 Damage viewed from Engine Exhaust

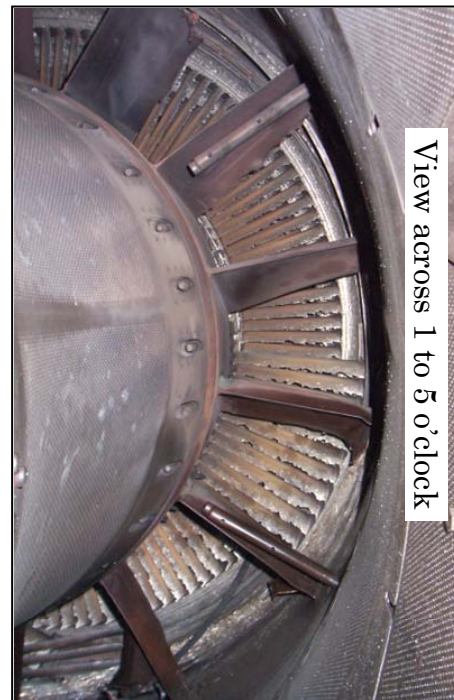


Photo 5 Damage to Engine Case and Tail Cone

