AI2007-2

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

KALITTA AIR (USA)
BOEING 747-200B, N714CK
APPROXIMATELY 3 km SOUTH OF NEW CHITOSE AIRPORT,
AT AN ALTITUDE OF APPROXIMATELY 1,300 ft
AROUND 10:52 JST, JULY 4, 2005

May 25, 2007

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 serious incident of KALITTA AIR(USA) BOEING 747-200B, N714CK 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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Norihiro Goto,
Chairman,
Aircraft and Railway Accidents Investigation Commission

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April 27, 2007
Adopted by the Aircraft and Railway Accidents Investigation Commission
(Air-Sub committee Meeting)

Chairman Norihiro Goto
Member Yukio Kusuki
Member Shinsuke Endo
Member Noboru Toyooka
Member Yuki Shuto
Member Akiko Matsuo

1. PROCESS AND PROGRESS OF AIRCRAFT SERIOUS INCIDENT INVESTIGATION

1.1 Summary of the Serious Incident

The event covered by this report falls under the category of "Flame in Engine Fire suppression Area" as stipulated in Clause 9, Article 166-4 of the Civil Aeronautics Regulations of Japan (at the time of the incident) and, as such, is classified as an aircraft serious incident.

The Boeing 747-200B, N714CK, operated as Kalitta Air non- scheduled Flight 825 (Cargo), took off from New Chitose Airport at 10:51 JST on July 4, 2005 (Monday), bound for Anchorage International Airport.

After takeoff, at about 10:52 JST, the fire warning light for the No. 3 engine illuminated and an audible alarm sounded. The pilot in command(PIC) shut down the engine, activating the fire extinguishing system, then jettisoned fuel to reduce aircraft weight to the maximum landing weight or below, changed its destination and landed at New Chitose Airport at 12:09 JST.

After the landing, damage was found on the right cowling of the No. 3 engine.

Of the total of six persons on board, consisting of the PIC, three other operating crewmembers, and two mechanics, no one was injured.

1.2 Outline of the Serious Incident Investigation

1.2.1 Investigation Organization

On July 4, 2005, the Aircraft and Railway Accidents Investigation Commission appointed an investigator-in-charge and one investigator for the serious incident.

1.2.2 Foreign Representative

An accredited representative of the United States of America, the state of register, operator, design and manufacture of the incident aircraft, participated in the investigation.

1.2.3 Implementation of Investigation

July 4 and 5, 2005	Investigation of aircraft and interviews
July 6 – August 31, 2005	Analysis of flight data recorder and cockpit voice recorder
July 11, 2005	Investigation of the affected engine
July 18, 2005 – September 6, 2006	Teardown examination of the affected engine and investigation of fuel tubes and other relevant parts (The investigation was carried out with cooperation from the American accident investigation authority (NTSB).

1.2.4 Status Report

On July 28, 2006, status report was presented to the Minister of Land, Infrastructure and Transport, and made public, which was based on the result of fact finding investigation up to that date.

1.2.5 Comments from Parties Relevant to the Cause

Comments will be taken from the parties relevant to the cause of the serious incident.

1.2.6 Comment from Participating State

Comment will be invited from the participating state.

2. FACTUAL INFORMATION

2.1 History of the Flight

On July 4, 2005, the Boeing 747-200B, N714CK (hereinafter called "the aircraft"), operated by Kalitta Air (hereinafter called "the company") was scheduled to fly from New Chitose Airport to Anchorage International Airport as the company's Flight 825 (cargo).

According to the statements of the PIC and the mechanics aboard the aircraft, the preflight check they carried out did not reveal any anomalies on the aircraft.

The flight plan submitted to the JCAB New Chitose Airport Office is as outlined below.

Flight rules:	Instrument flight rules (IFR)
Departure aerodrome:	New Chitose Airport
Estimated off-block time:	10:15
Cruising speed:	502 kt
Cruising altitude:	FL310
Route:	MKE (Mukawa VOR/DME) ➞ CHE (Chitose VOR/DME) ➞ V6 (airway) ➞ OBE (Obihiro VOR/DME) ➞ The subsequent portion of the route is omitted.
Destination aerodrome:	Anchorage International Airport
Estimated flight time:	5 h and 40 min

On the aircraft the PIC took the left seat as Pilot Flying (primarily responsible for aircraft maneuvering), the First Officer took the right seat as Pilot Not Flying (primarily responsible for non-maneuvering tasks), the Flight Engineer during familiarization training took the flight engineer's seat and the other flight engineer who was to instruct the aforementioned flight engineer took the observer's seat behind the left seat. There were also two mechanics, who were in charge of maintenance of the aircraft at airports of call sat on the passenger seats located aft of the cockpit.

The flight history of the aircraft, as summarized below, was determined based on the statements from the PIC, other operating crewmembers and mechanics aboard the aircraft as well as from the record of ATC communications and the record of radar tracking.

(1) Statements from the Operating Crewmembers

The PIC started all engines normally in the sequence of No. 4, No. 3, No. 2 and No. 1.

After the aircraft took off from Runway 19R, the fire warning light for the No. 3 engine illuminated and an audible alarm sounded when the PIC reduced the engine power from takeoff to climb. The altitude, at that time, was 1,300 ft.

The needle of nacelle temperature indicator for No.3 engine on the flight engineer's instrument panel pointed gauge "9," indicating a fire.

The First Officer declared an emergency to the Chitose terminal control (hereinafter called "the ATC") as ordered by the PIC. The Flight Engineer shut down the No. 3 engine in accordance with the engine fire checklist, the start fire extinguishing agent was discharged.

The PIC, keeping the aircraft attitude, climbed the aircraft and maintained for while an altitude of 3,000 ft , and then climbed to 4,000 ft.

The PIC, informed the ATC of fuel jettison over the sea, jettisoned approximately 140,000 lb. of fuel to reduce aircraft weight to the maximum landing weight (630,000 lb.) or below, and landed the aircraft.

(2) Statements from the mechanics aboard

Upon hearing an audible alarm, the mechanics looked into the cockpit and found the No. 3 engine fire warning light illuminated. They went down to the first floor and looked at the No. 3 engine through the center and aft windows, but did not detect any fire.

(3) Records of ATC communications and radar tracking

10:51:49	Passed an altitude of 1,300 ft.
10:53:15	Declared an emergency and reported heading and that it was maintaining an altitude of 3,000 ft.
10:55:22	Received clearance to climb to an altitude of 4,000 ft.
10:57:14	Reached an altitude of 4,000 ft.
10:59:47	Reported the start of fuel jettison.
12:00:43	Received instruction to descend to an altitude of 3,000 ft.
12:03:17	Received clearance for ILS approach to Runway 19R .
12:09	Landed at New Chitose Airport.

This serious incident occurred at about 10:52 in the air approximately 3 km. south of New Chitose Airport (latitude 42° 49′ 22″north and longitude 141° 42′ 20″east) and at an altitude of approximately 1,300 ft. (See Figure 1 and Photo 1.)

2.2 Injuries to Persons

None

2.3 Damage to the Aircraft

There was no damage to the aircraft except for the No. 3 engine, the details of which are as follows.

(1) Engine cowling

Deformed and broken areas were found on the engine cowling right side.

Part of the inside frame of the cowling and the hinge fittings attaching the cowling were found broken.

(2) Engine exteriors

Right upper part of the area extending from the high-pressure compressor to the the

high-pressure turbine of the engine exhibited sooting. Damage was found on the electric cables, tubes, and other parts around the area. The turbine sleeve at the aft part of the engine had an open hole in its right upper portion, measuring approximately 75 cm in length and approximately 10 cm in width.
(See Photo 2.)

2.4 Damage to Items Other than the Aircraft

None

2.5 Pilot Information

(1) PIC Male, Age 51 years

Airline transport pilot certificate (airplane) (Issued by the USA)	January 27, 2005
Type rating for Boeing 747	
1st class aviation medical certificate	
Validity	Until September 2005
Total flight time	12,000 h
Flight time in the last 30 days	65 h and 30 min
Flight time on the aircraft type	Approximately 3,000 h
Flight time in the last 30 days	65 h and 30 min

(2) First Officer Male, Age 44 years

Airline transport pilot certificate (airplane) (Issued by the USA)	April 11, 2004
Rating for multi-engine airplane (land)	
1st class aviation medical certificate	
Validity	Until December 2005
Total flight time	6,285 h
Flight time in the last 30 days	48 h and 36 min
Flight time on the aircraft type	557 h
Flight time in the last 30 days	48 h and 36 min

(3) Flight Engineer Male, Age 50 years

Flight engineer competence certificate (Issued by the USA)	March 22, 2005
Rating	Turbojet
1st class aviation medical certificate	
Validity	Until August 2005
Total flight time	8,899 h and 12 min
Flight time in the last 30 days	47 h and 42 min
Flight time on the aircraft type	47 h and 42 min
Flight time in the last 30 days	47 h and 42 min

(4) Flight Engineer Male, Age 48 years

Flight engineer competence certificate (Issued by the USA)	December 22, 1994
Rating	Turbojet
1st class aviation medical certificate	
Validity	Until April 2006
Total flight time	Approximately 4,000 h
Flight time in the last 30 days	63 h and 24 min
Flight time on the aircraft type	841 h
Flight time in the last 30 days	63 h and 24 min

2.6 Aircraft Information

2.6.1 Aircraft

Type	Boeing 747-200B
Serial number	22446
Date of manufacture	June 1981
Date of issuance of airworthiness certificate (Issued by the USA)	November 22, 2002
Total time in service	81,704 h
Time since the last periodical check (C-6 inspection on August 24, 2004)	3,915 h

(See Figure 2)

2.6.2 Engines

(1) Models

Engine No.	No. 1	No. 2	No. 3	No. 4
Model	Pratt & Whitney JT9D-7Q			
Serial number	702064	702354	702272	702355
Date of manufacture	April 17, 1979	January 23, 1981	August 28, 1980	January 26, 1981
Total time in service	94,344.4 h	60,217.3 h	61,656.9 h	57,666.9 h

(2) Maintenance of No. 3 engine

According to the company's maintenance records, the No. 3 engine was removed from the No.4 position of other aircraft (N715CK) on April 30, 2004. The engine underwent maintenance at the company's engine shop on September 21 of the same year and at that time all 20 fuel nozzles on the engine were replaced. On March 21, 2005, the engine was installed on the aircraft as the No. 3 engine. Time in service since the nozzle replacement was 1,139.8 h/218 cycles, during which there were no records indicating fuel leakage or other faults.

(See Figure 3.)

2.6.3 Weight and Balance

At the time of the serious incident, the aircraft weight is calculated as 798,648 lb. and its center of gravity as 20.3% mean aerodynamic chord (MAC), both of which are estimated to have

been within the allowable limits (833,000 lbs for the maximum takeoff weight; 630,000 lbs for the maximum landing weight; and 15.5 – 25.3% MAC for the allowable center of gravity based on the calculated aircraft weight at the time of the serious incident).

2.6.4 Fuel and lubricant

The fuel and lubricant used in the aircraft were aviation fuel Jet A-1 and Mobil 254, respectively.

2.7 Meteorological Information

The observation data in the aviation routine weather report at New Chitose Airport at around the time of the serious incident was as follows:

10:30 Direction of wind...160°; Velocity of wind...19 kt; Prevailing visibility...20 km;
Clouds: amount...1/8, type...stratus, ceiling...1,500 ft;
amount...7/8, type...stratocumulus, ceiling...2,800 ft;
Temperature...19°C; Dew point...13°C;
Altimeter setting (QNH)...29.75 in Hg.

11:00 Direction of wind...170°; Velocity of wind...20 kt; Prevailing visibility...20 km;
Clouds: amount...1/8, type...stratus, ceiling...1,500 ft;
amount...7/8, type...stratocumulus, ceiling...2,800 ft;
Temperature...19°C; Dew point...13°C;
Altimeter setting (QNH)...29.75 in Hg.

2.8 Information on Digital Flight Data Recorder and Cockpit Voice Recorder

The aircraft was equipped with a digital flight data recorder (P/N 980-4100-DXUS; hereinafter called "the DFDR") manufactured by Honeywell Inc. of the USA and a cockpit voice recorder (P/N 93-A100-80; hereinafter called "the CVR") manufactured by L-3 Communications Corp. of the USA.

The DFDR was capable of retaining a record of 25 continuous hours, while the CVR was capable of recording 30 min. The DFDR retained all the data recorded during the serious incident but the data recorded by the CVR during the serious incident was erased by overwriting as the aircraft continued flying for about one hour after the occurrence of the serious incident.

2.9 Fact-Finding Tests and Research

2.9.1 Fuel Leak Check

A fuel leak check was conducted on the aircraft's No. 3 engine at New Chitose Airport by means of wet motoring[1]. The check revealed leaking fuel from the area around the engine's 1

[1] Wet motoring is a fuel leak test method in which the engine is rotated by the starter in order to inject fuel

o'clock position[2] where the No. 2 or No. 3 fuel nozzles were fitted.

2.9.2 Construction of Fuel Nozzle Fitting Sections

Fuel nozzles are the parts that inject the fuel supplied through tubes routed on the outside surface of the engine case into the combustion chamber. There are 20 fuel nozzles, which are divided in three groups. Each group has a fuel supply. The No. 2 and No. 3 fuel nozzles belong to the same group. Each fuel nozzle has two fuel tubes connected, one is called the primary fuel tube and the other is called the secondary fuel tube. Construction of these fuel tubes and the method used for their connection to the fuel nozzles are as outlined below.

(1) Fuel tubes

Each fuel tube is made of stainless steel and is of a coaxial design consisting of an inner and outer tube. The inner tube carries fuel, while the outer tube leads any fuel that may leak from the inner tube safely to the outside of the engine nacelle. Usually, there is no fuel flowing through the outer tube.

(2) Fuel nozzle to fuel tube connection

The inner tube is connected to the fuel nozzle by means of a coupling nut, while the outer tube is connected to the nozzle using another coupling nut that is screwed on to the threads cut on the outside of the inner tube's coupling nut. Between the outer coupling nut and outer tube, there is an O-ring installed to seal the gap between these two parts.

The No. 2 and No. 3 nozzles are connected by the primary and secondary tubes. Since at the attachment surface, the fuel tubes and fuel nozzles are designed and manufactured so as to assure alignment of their centerlines, gaps rarely occur in the tube-to-nozzle connections.

2.9.3 Inspection of Fuel Tubes[3]

Inspections were carried out on the fuel tubes connecting to the No. 2 and No. 3 fuel nozzles from which a fuel leaks was detected as described in 2.9.1. The results of the inspections are outlined below.

(1) Appearance inspection

1) The primary tube coupling the No. 2 and No. 3 fuel nozzles exhibited dents on its external surface in the areas near both ends. At the primary fuel tube end connecting to the No. 2 fuel nozzle, tube was bent of the inner tube axis was confirmed to the reference of the outer tube axis. The end of the inner tube had no damage on either the inner or outer surfaces.

2) On the inner and outer coupling nuts to attach the fuel tube to the fuel nozzle, safety wires were properly attached and these nuts were not loosened.

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without operating the ignition system.

[2] "1 o'clock position" refers to the engine's circumferential position that compares to the one o'clock position on a clock dial when the engine is viewed from the aft end toward the forward end.

[3] Engine Event Investigation Report (P&W Investigation Number: 7899, September 1, 2006)

3) At the primary fuel tube end connecting to the No. 3 fuel nozzle, there existed a slight amount of flame-heat-affected material in the O-ring fitting area on the outer tube but there was no visible contamination around it. The material was found to be coincided with the O-ring material. The O-ring itself was not found. On the other hand, at the secondary fuel tube end adjacent to that, there was a burnt O-ring remaining in the O-ring fitting area of the outer tube.

(2) Leak inspection

Based on the check results mentioned in 2.9.1, an inspection was performed using compressed air and a soap and water solution on the primary and secondary fuel tubes that had been connected to the No. 2 and No. 3 fuel nozzles. This inspection confirmed an air leak near the No. 3 fuel nozzle and primary fuel tube interface.

(3) Alignment inspection

A fit check of the event primary and secondary fuel tubes was performed. When the primary fuel tube was connected to the No. 2 nozzle a misalignment/gap at the opposite end of the tube was confirmed as 9 mm (0.35 in) between the No. 3 fuel nozzle and its mating primary tube end.

On the other hand, for the secondary fuel tube adjoining to it, neither misalignment nor gap.

(See Figure 3 and Photos 3, 4, 5, 6 and 7.)

2.9.4 Condition of Engine Fire Extinguishing System

On the cockpit overhead panel of the aircraft, there is a fire control module with fire handles for the individual engines. Of these fire handles, the one for the No. 3 engine was found pulled and locked with the yellow fire flag displayed. The engine fire extinguisher switch adjacent to the handle was in the pressed position and the extinguisher agent tank was empty.

3. ANALYSIS

3.1 Qualification and Other Requirements of the Flight Crew

The PIC, the First Officer and the Flight Engineers possessed proper airman competence certificates and valid aviation medical certificates.

3.2 Airworthiness and other Requirements of the Aircraft

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

3.3 Contribution of Weather

It is estimated that the weather prevailing at the time of this serious incident was not a contributory factor to the incident.

3.4 Deformation of Fuel Tube

As described in 2.9.3, the dents on the fuel tube and the slant angle in the attachment area are not considered to have occurred after installation on the engine but it is considered possible to have occurred during the replacement work of the engine's fuel nozzles. However, it could not be determined when it occurred.

3.5 Installation of O-ring

As described in 2.9.3 (1) 3), the presence of O-ring on the primary fuel tube connecting to the No. 3 fuel nozzle, was confirmed only by the analysis of the material which deteriorated by the heat of fire, and the installation condition of the O-ring could not be determined.

3.6 Fuel Leakage

As described in 2.9.3 (3), there was a gap of approximately 9 mm as well as significant misalignment between the No. 3 fuel nozzle and primary fuel tube. It is estimated that if the inner and outer coupling nuts were fastened under this condition with proper torque specified in the manual, the resistant force resulting from the gap and misalignment would have caused the effective fastening torque of the coupling nuts to lower, after passing of time the gap emerged in the attachment area between the inner fuel tube and No. 3 fuel nozzle at the time of the serious incident.

It is estimated that this caused fuel to leak past the conical seat interface of the inner tube to No. 3 fuel nozzle joint and then the leaked fuel was injected into the engine nacelle due to incomplete sealing between the O-ring attachment area and the coupling nut of the outer fuel tube, resulting in the ignition of fuel when it contacted the hot section of the engine case.

As to that leaked fuel was injected into the engine nacelle, it is estimated to be caused by that the inner fuel tube was not properly attached to the fuel nozzle resulting in excessive fuel leakage from this joint that defeated the O-ring seal between the coupling nut and the outer fuel tube.

It could not be determined when the O-ring attachment area became not sealed.

4. PROBABLE CAUSE

It is estimated that this serious incident was caused by the following process: When the aircraft was climbing after takeoff, the fuel that had leaked from the attachment area between the No. 3 fuel nozzle and primary fuel tube inside the engine cowling of the No. 3 engine was injected into the engine nacelle, was ignited when it contacted the hot section of the engine case, which resulted in a flame inside the fire suppression zone of the engine.

It is considered that the fuel leakage was caused by the followings: During replacement work of the fuel nozzles, a fuel tube with deformed attachment area was possibly connected to the No. 3 fuel nozzle, which eventually caused a gap, and sealing function of the O-ring attachment was defeated.

Figure 1　Presumed Flight Route

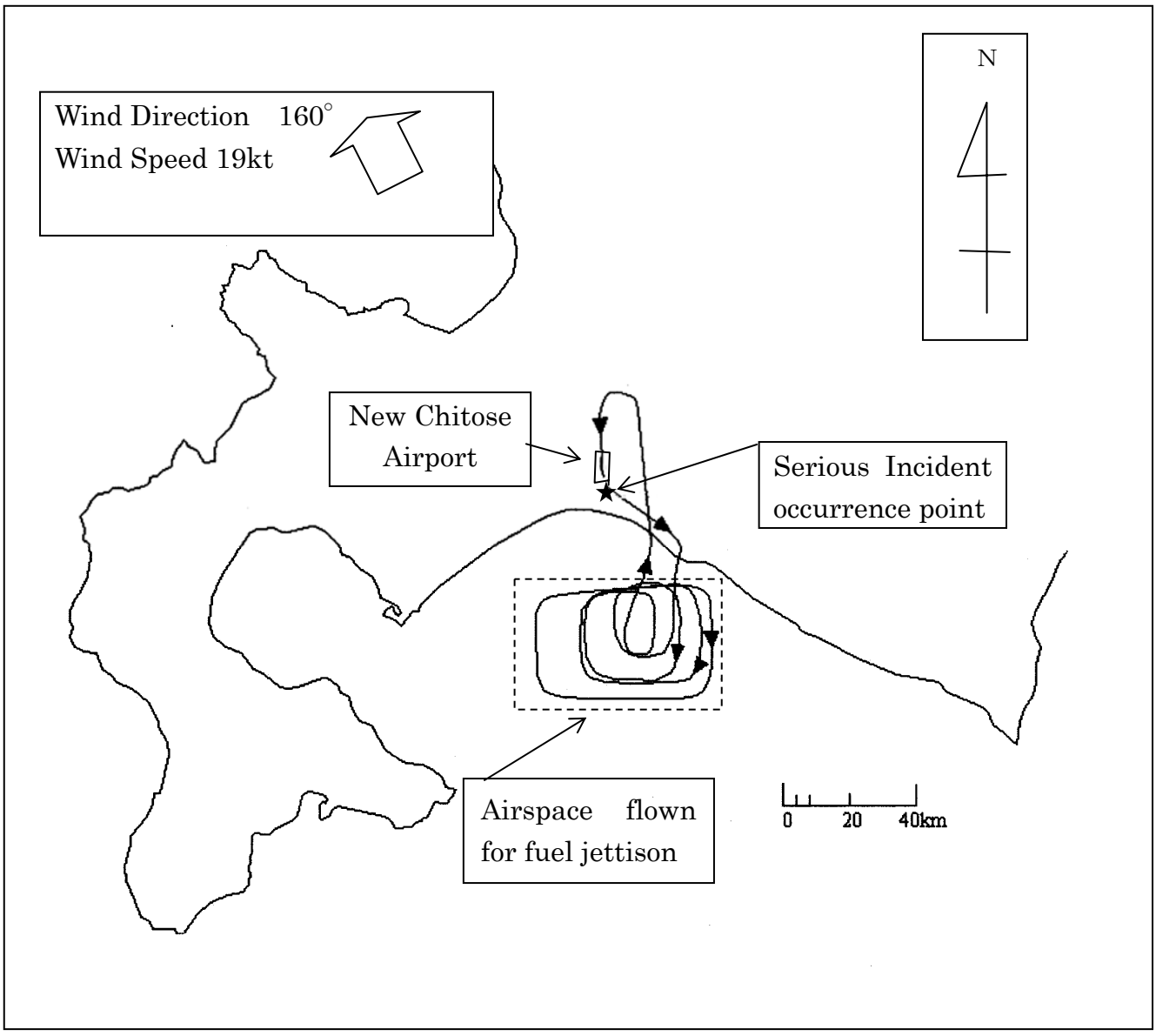
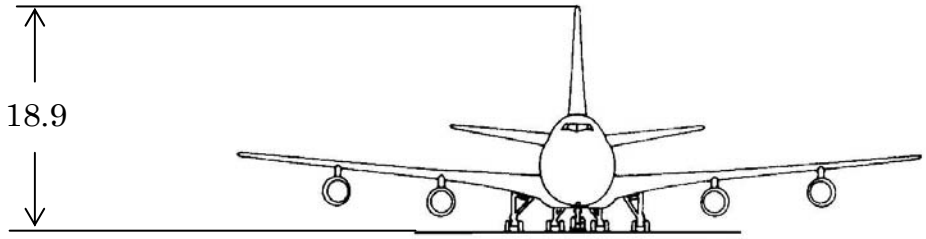
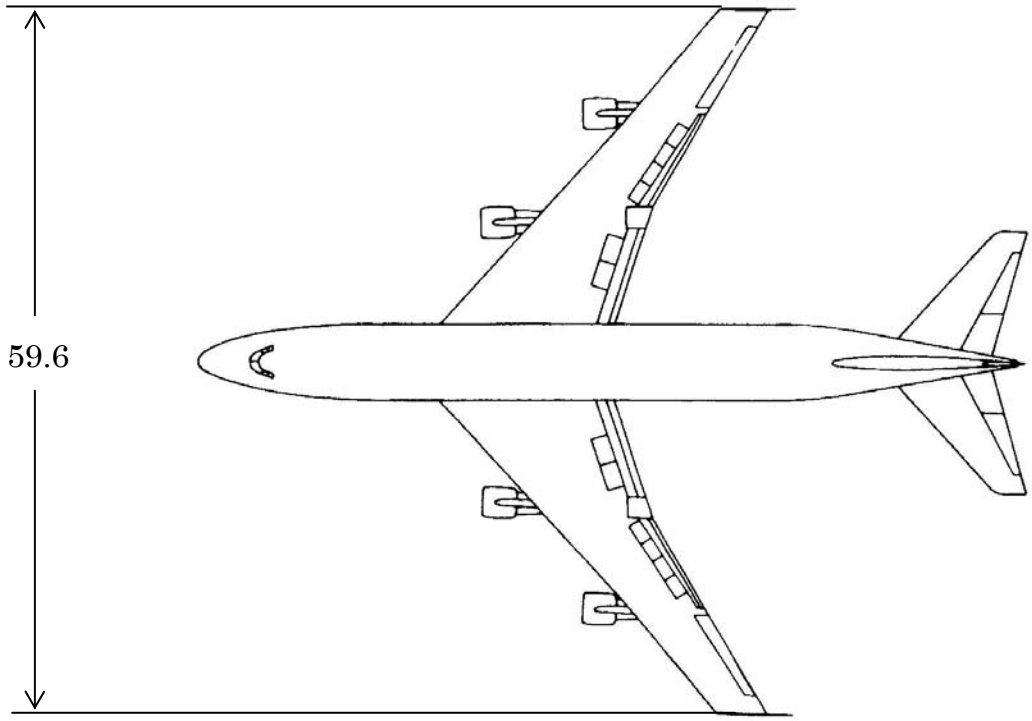


Figure 2 Boeing 747-200B Three Angle View

Unit : m





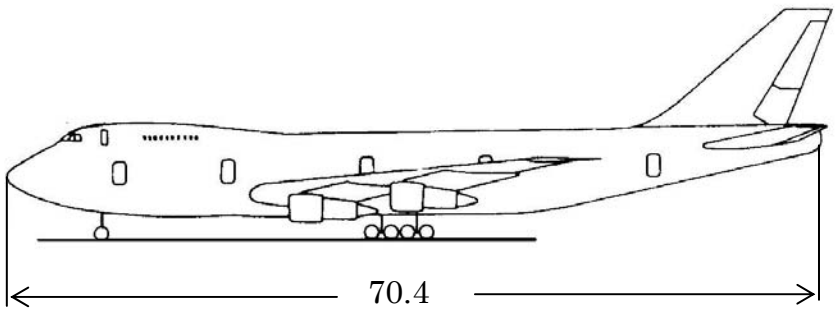
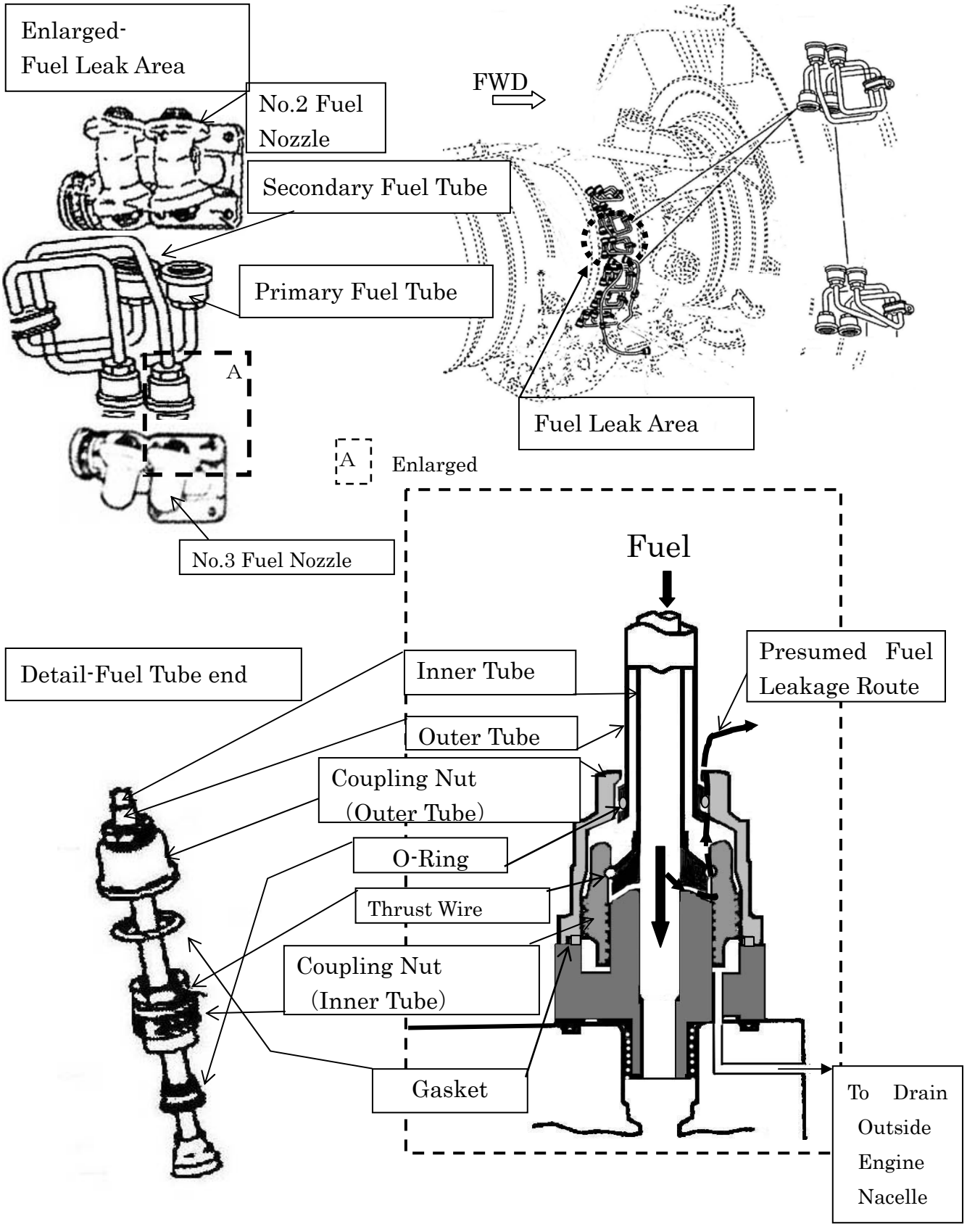
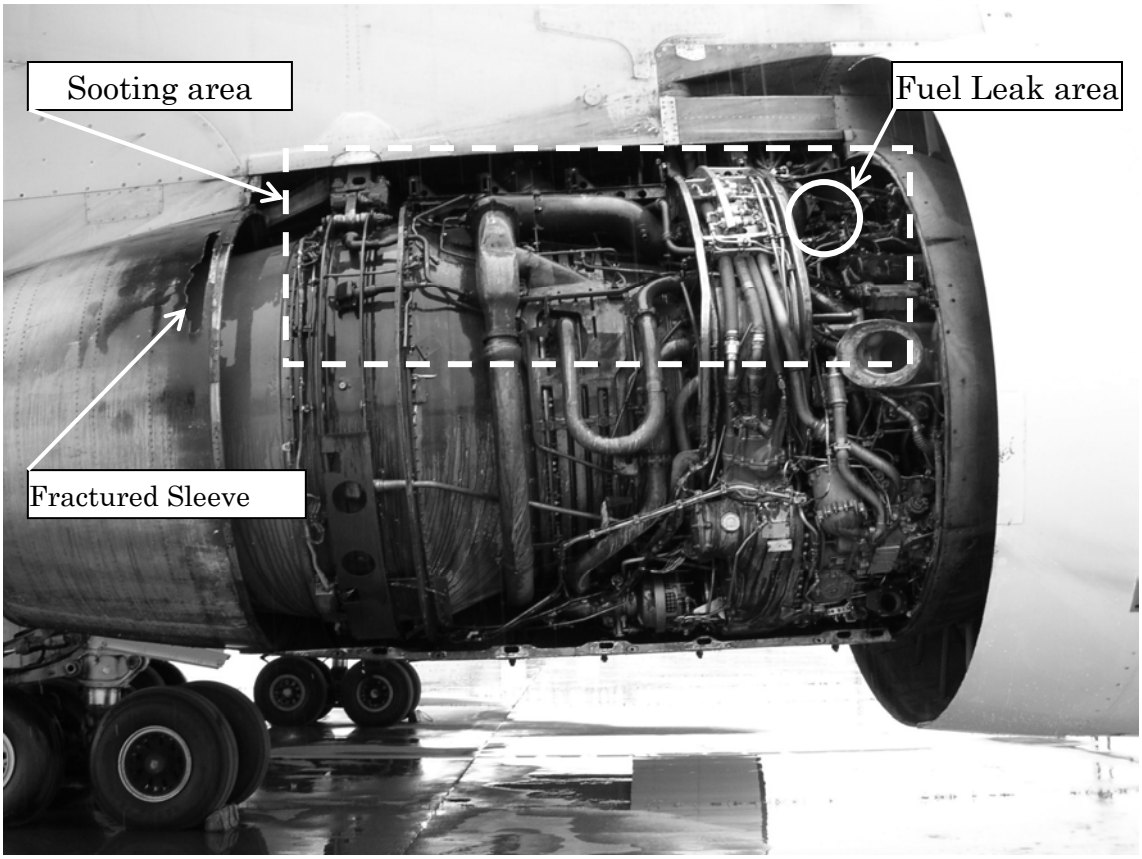


Figure 3 Fuel Tube Section View

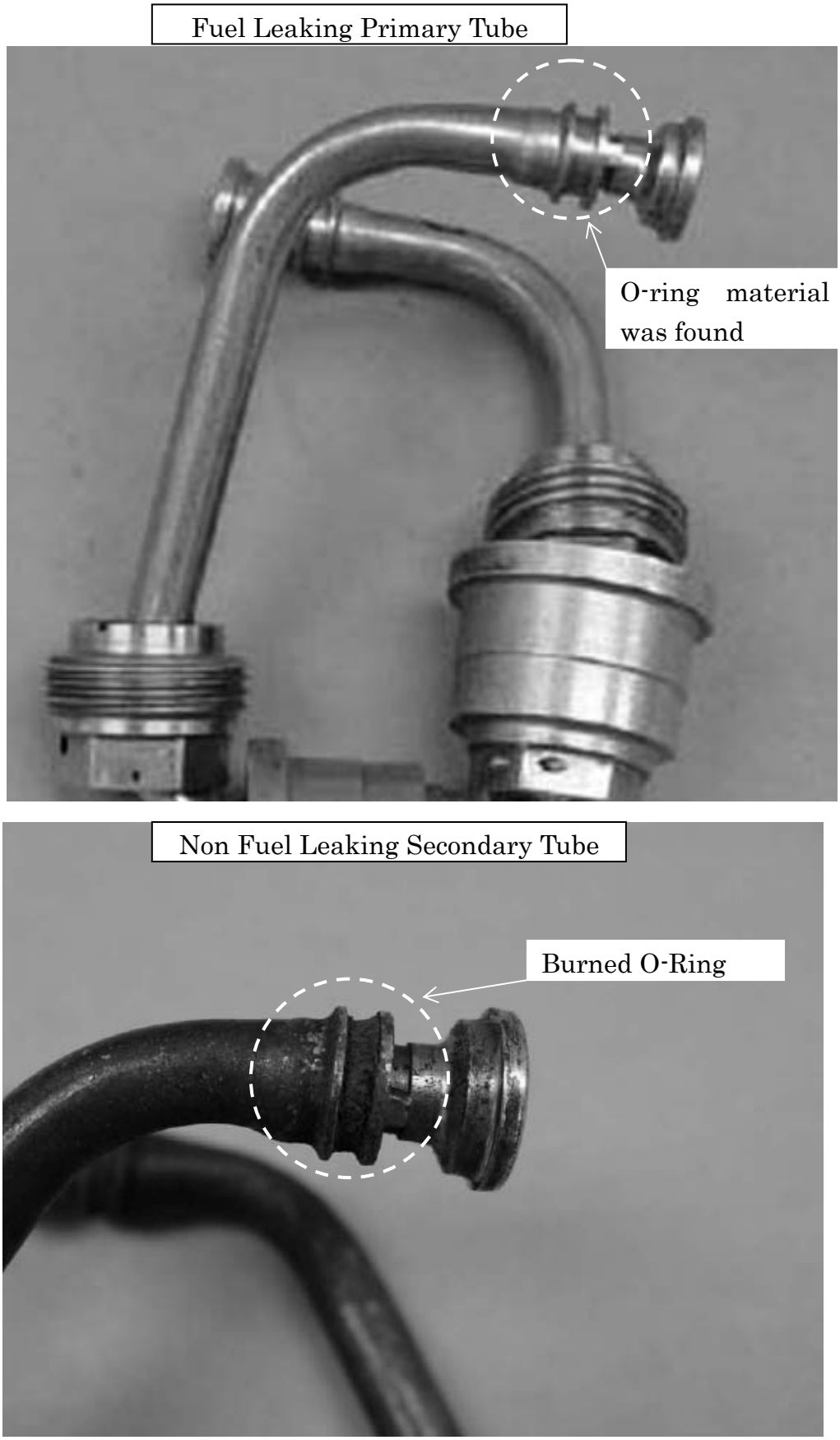


Photograph 1　Serious Incident Aircraft

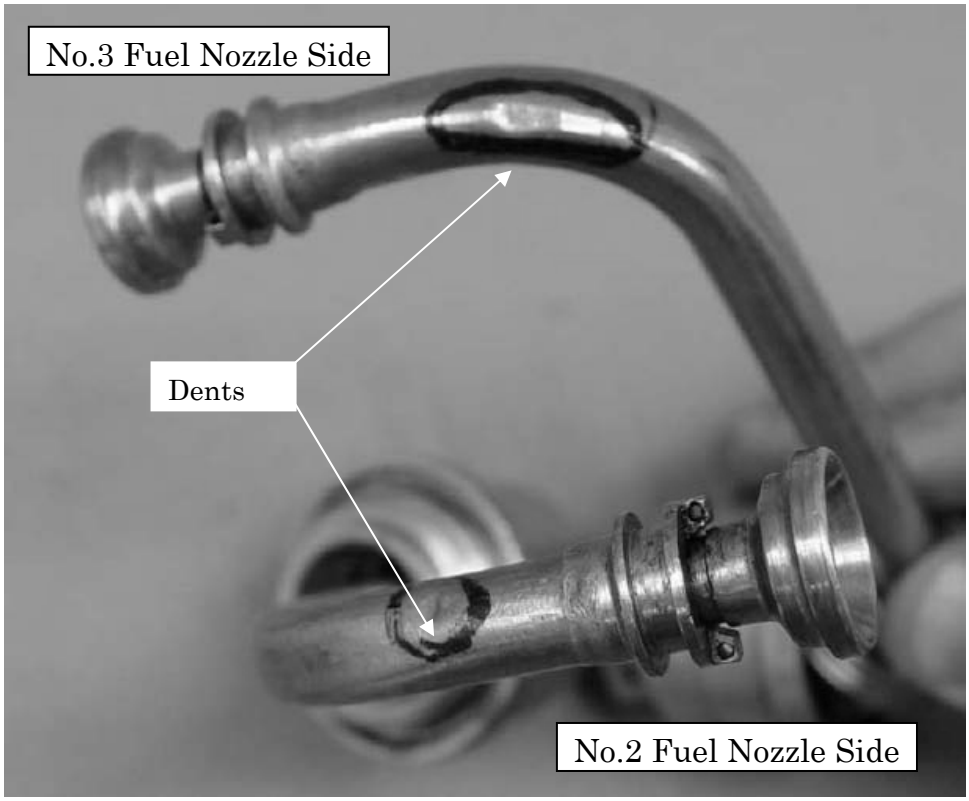
Photograph 2　No.3 Engine Right Hand Side

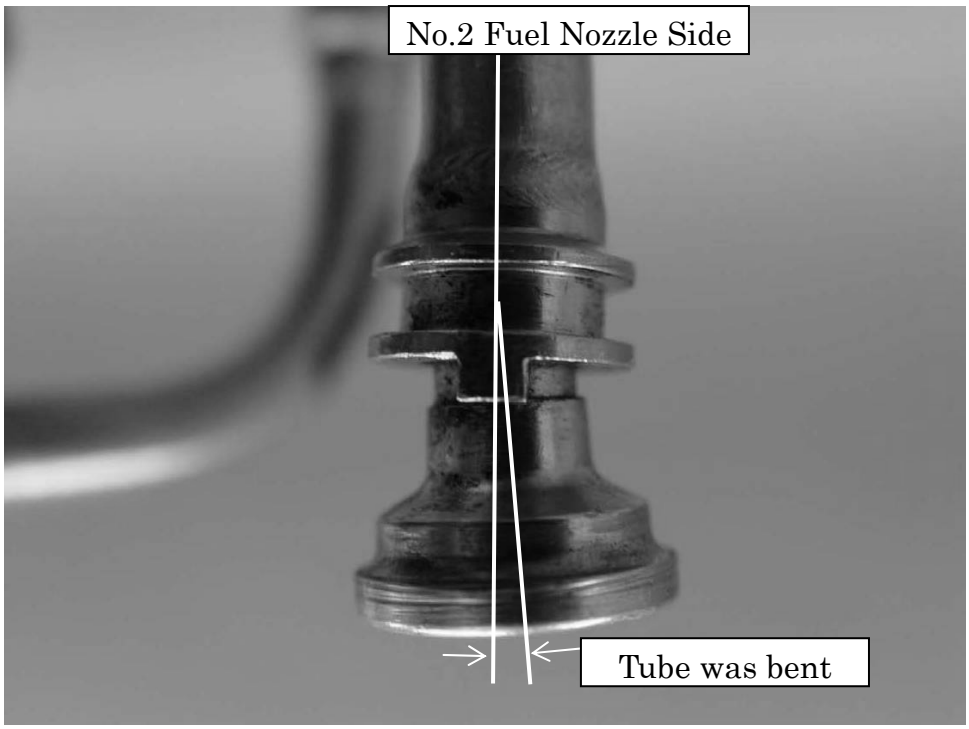


Photograph 3 Fuel Tube Ends connecting to No.3 Fuel Nozzle



Photograph 4　Deformation of Primary Fuel Tube End





Photograph 5　Primary Fuel Tube End connecting to No.2 Fuel Nozzle

Photograph 6　Leak check at Primary Fuel Tube attachment area connecting to No.3 Fuel Nozzle

Photograph 7　Primary Fuel Tube alignment