

AI2007-1

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

JAPAN AIRLINES INTERNATIONAL CO., LTD.

BOEING 747-400, JA8072

370 km SOUTHEAST OF NEW CHITOSE AIRPORT, AT AN ALTITUDE OF
APPROXIMATELY 36,000 ft

MAY 8, 2005

March 30, 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 JAPAN AIRLINES INTERNATIONAL CO., LTD. BOEING 747-400, JA8072 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.

This English version report has been published and translated by ARAIC to make its reading easier for English speaking people those who are not familiar with Japanese. Although efforts are made to translate as accurate as possible, only the Japanese version is authentic. If there is difference in meaning of the texts between the Japanese version and the English version, texts in the Japanese version are correct.

Norihiro Goto,
Chairman,
Aircraft and Railway Accidents Investigation Commission

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370 km SOUTHEAST OF NEW CHITOSE AIRPORT, AT AN ALTITUDE OF

APPROXIMATELY 36,000 ft

MAY 8, 2005, AROUND 11:41 JST

21 February, 2007

Adopted by the Aircraft and Railway Accidents Investigation Commission

(Aviation Sub-committee Meeting)

Chairman	Junzo Sato
Member	Ikuo Kusuki
Member	Susumu Kato
Member	Noboru Toyooka
Member	Yukiko Kakimoto
Member	Akiko Matsuo

1. PROCESS AND PROGRESS OF SERIOUS AIRCRAFT INCIDENT INVESTIGATION

1.1 Summary of the Serious Incident

The event covered by this report falls under the category of “Abnormal Drop of Cabin Pressure” as stipulated in Clause 10, Article 166 - 4 of the Civil Aeronautics Regulations of Japan and, as such, is classified as a serious aircraft incident.

A Boeing 747-400, JA8072, operated as Japan Airlines International Co., Ltd., scheduled Flight 47, took off from John F. Kennedy International Airport at 23:14*1 on May 7 (Saturday), 2005, bound for Narita International Airport. Around 11:41 on May 8, in response to a warning indicating drop of cabin pressure while flying at an altitude of approximately 36,000 ft, passenger oxygen masks were deployed by the crew and the aircraft made an emergency descent to an altitude of approximately 10,000 ft. Subsequently, the destination was changed to New Chitose Airport and, at 12:51 the aircraft landed there. Of the total of 374 people on board, consisting of the Pilot in Command(PIC) and other 18 crewmembers and 355 passengers, no one was injured.

1.2 Outline of the Serious Incident Investigation

1.2.1 Investigation Organization

On May 8, 2005, the Aircraft and Railway Accidents Investigation Commission appointed an investigator-in-charge and another investigator for the investigation of this serious incident. On May 10, 2005, an investigator was appointed in addition.

1.2.2 Representative and Advisor from Foreign State

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

1.2.3 Implementation of Investigation

May 9, 2005	Investigation of the aircraft
May 10, 2005	Interviews
May 10 ~ September 30, 2005	Analyses of records of the digital flight data recorder and the cockpit voice recorder
May 11, 2005	Functional test of equipment
May 13, 2005	Interviews
May 16, 2005	Interviews

*1: All of the times indicated hereafter are in Japan Standard Time (JST).

June 1, 2005 ~ March 31, 2006 Investigation of equipment (with cooperation from the National Transportation Safety Board (NTSB) of the United States of America)

1.2.4 Investigation Status Report

On July 28, 2006, investigation status report was submitted 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 the parties relevant to the cause of the serious incident

Comments were submitted from the parties relevant to the cause of the serious incident.

1.2.6 Comments from the participating state

Comments on the draft report were invited from the participating state.

2. FACTUAL INFORMATION

2.1 History of the Flight

On May 7, 2005, a Boeing 747-400, JA8072 (hereinafter called “the aircraft”), operated as Japan Airlines International Co., Ltd. (hereinafter called “the company”) scheduled Flight 47 was flying from John F. Kennedy International Airport to Narita International Airport.

According to the flight crew, no discrepancies were found during the pre-flight inspection.

The outline of the flight plan submitted to the FAA John F. Kennedy International Airport Office was as follows:

Flight rules:	Instrument flight rules (IFR)
Departure point:	John F. Kennedy International Airport
Estimated off-block time:	23:10
Cruising speed:	490 kt
Cruising altitude:	FL300
Route:	J95 (Airway) ~ J531 (Airway) ~ NCA20 (Airway) ~ NCA13 (Airway) ~ R220 (Airway)
Destination:	Narita International Airport
Estimated flight time :	13 hours and 07 minutes

When the serious incident occurred, the PIC was at the left seat as pilot flying (primarily responsible for aircraft maneuvering) while the first officer was at the right seat as pilot not flying (primarily responsible for non-maneuvering tasks).

2.1.1 History of the serious incident and subsequent flight of the aircraft is summarized as follows, which was mainly based on the records of the digital flight data recorder (DFDR) and ATC communications.

11:41:08	Cabin altitude began increasing from 5,548 ft.
11:41:19	Cabin altitude reached 10,046 ft. “CABIN ALTITUDE” message was displayed.
11:41:31	Cabin altitude reached the maximum of 10,795 ft.
11:41:56	Speed brakes were deployed.
11:42:01	The aircraft began descent from a flight altitude of 36,000 ft.
11:42:54	Passenger oxygen masks were deployed.
11:48:32	The aircraft leveled off at a flight altitude of 10,143 ft (cabin altitude of 10,222 ft). Subsequently, the flight altitude and the cabin altitude stayed nearly the same until landing.
12:18:34	The aircraft began descent for landing at New Chitose Airport.
Approximately 12:51	The aircraft landed at New Chitose Airport.

2.1.2 History of the serious incident and subsequent flight of the aircraft is summarized below,

which was based on interviews with the flight crew, the cabin attendant and the passengers.

(1) Flight crew

Drop of cabin pressure occurred when the aircraft was flying near reporting point NODAN on airway R220 at an altitude of approximately 36,000 ft, and in the cabin, the last meals were finished and the sales carts were returned. It was around 11:40, the flight crew felt slight ear popping, which made them aware of a pressure drop. The engine indication and crew alerting system (EICAS) indicated an increase in cabin altitude. Environmental control system (ECS) page was selected to confirm the condition of the outflow valves (hereinafter called “OFV”), one of them was indicated as “MAN”^{*2} and yellow indications appeared. The needles indicating positions of the LH and RH valves did not align. The “CABIN ALTITUDE”^{*3} message was displayed and aural warning sounded. On the EICAS screen, “OUTFLOW VLV R”^{*4} message was displayed in yellow. As far as the crew can remember, the cabin altitude was displayed as 10,300 ft. The crew donned oxygen masks and, as per the emergency procedure, deployed passenger oxygen masks in the cabin. Having determined that it was not possible to control the cabin altitude, the crew notified the ATC of an emergency, set the transponder to 7700 and made an emergency descent from 36,000 ft to 10,000 ft. Subsequently, the crew reduced the airspeed to 300 kt. As the cabin altitude read around 10,000 ft, the crew ordered cabin inspection and announced that the passengers could take off their oxygen masks. Condition of doors and gears were checked in the cockpit and found normal. Hydraulic pressures were checked and found normal. At 10,000 ft, the crew checked the positions of OFVs again on the ECS page and found that the LH valve was fully open with “AUTO” and the RH valve was fully closed with “MAN”.

The PIC ordered the first officer to display the position of New Chitose Airport on the navigation display (ND) to confirm its distance and direction. As New Chitose Airport was located approximately 280 nm rearward on the right, the PIC decided, to divert to there after considering also Narita and Sendai. Flying time to New Chitose Airport was estimated to be approximately 40 minutes, which was the shortest. The crew notified the ATC of the situation and declared an emergency. The crew initiated an earlier-than-normal descent, approximately 30 minutes before landing, at a rate of 500 ft per minute. When asked by the ATC for any assistance, the crew responded that it was not necessary.

The aircraft landed uneventfully. After landing, conditions of the passengers were checked and found normal.

(2) Cabin attendants

*2: “MAN” is the abbreviation for MANUAL.

*3: “CABIN ALTITUDE” message is a warning to the crew that the cabin altitude has exceeded 10,000 ft. When this happens, the master warning light comes on and a warning horn sounds.

*4: “OUTFLOW VLV R” message is displayed when the RH OFV auto-control becomes inoperative or the RH OFV has been switched to the manual mode.

- When the cabin depressurization occurred, ear popping and cold air flow were felt and the curtains in the aisles of the executive class compartment were seen flipped up. A hissing sound came from aft section.
- When working in the galley, the seat belt sign came on, and she returned to her seat. The oxygen masks were deployed and pre-recorded announcement was made. The passengers stayed calm, helping each other don their masks.
- A panel opened near the floor level near the Seat Row 66, into which a blanket and a plastic bag were sucked slowly. The emergency descent was felt like normal descent.
- As the captain announced that the aircraft had reached a safe altitude and that oxygen masks could be taken off, the conditions of passengers were checked and reported as normal to the captain.

(3) Passengers

- The cabin depressurization occurred soon after the trays of the last light meals had been collected while the passenger were relaxed after meals. Suddenly, hissing noise as if air was leaking was heard, and temperature was felt lowered. It seemed that cold air was blowing in from above or below the window just like there is an air passage. Direction of air flow could not be identified, but there was sudden air flow and noise, then temperature was felt lowered. It was felt lasted several seconds and then stopped. Soon after that, the oxygen masks were deployed, followed by an announcement. It was voice from a machine.
- It was found abnormal that something like vapor blew out from air conditioning outlet above the galley in front of the seats. Soon after that, the oxygen masks were deployed. One of the passengers reported to a cabin attendant that her small bag containing passport had been sucked and lost. There was nothing unusual other than that.

Attitude of the aircraft was difficult to recognize but seemed like nose down. Just after the oxygen mask deployment, the captain explained the situation and announced emergency descent. Subsequently, a cabin attendant made announcements a few times.

The serious incident occurred at around 11:41, approximately 370 km southeast of New Chitose Airport at an approximate altitude of 36,000 ft.

(See Figures 1 and 3, and Photo 1.)

2.2 Injuries

None

2.3 Damage to the Aircraft

None

2.4 Pilot Information

- (1) PIC Male, Age 55 years
- | | |
|--|--------------------------|
| Airline transport pilot certificate (Airplane) | May 21, 1990 |
| Type rating for Boeing 747-400 | November 11, 2004 |
| 1st class aviation medical certificate | |
| Validity of period | Until September 12, 2005 |
| Total flight time | 10,457 hours 10 minutes |
| Flight time in the last 30 days | 40 hours 06 minutes |
| Flight time on the aircraft type | 193 hours 05 minutes |
| Flight time in the last 30 days | 40 hours 06 minutes |
- (2) First officer Male, Age 33 years
- | | |
|---|------------------------|
| Commercial pilot certificate (Airplane) | November 11, 1997 |
| Type rating for Boeing 747-400 | July 29, 1999 |
| 1st class aviation medical certificate | |
| Validity of period | Until January 22, 2006 |
| Total flight time | 1,940 hours 36 minutes |
| Flight time in the last 30 days | 39 hours 33 minutes |
| Flight time on the aircraft type | 1,610 hours 59 minutes |
| Flight time in the last 30 days | 39 hours 33 minutes |

2.5 Aircraft Information

2.5.1 Aircraft

Type	Boeing 747-400
Aircraft serial number	23736
Date of manufacture	December 14, 1989
Certificate of airworthiness	No. To-99-022
Validity of period	Period during which the maintenance manual (Japan Airlines International Co., Ltd.) is applied, beginning on January 13, 1999
Airworthiness Category	Airplane, Transport
Total time in service	58,165 hours 00 minute
Time in service since last periodical check (A-check conducted on April 7, 2005)	378hours 34 minutes
(See Figure 2.)	

2.5.2 Engine

Engine No.	No.1	No.2	No.3	No.4
Type	General Electric CF6-80C2B1F			

Engine serial number	702185	704117	702400	702462
Date of manufacture	May 19, 1988	December 16, 1993	August 30, 1990	December 27, 1990
Total time in service	54,549 hours 13 minutes	41,415 hours 00 minute	42,800 hours 03 minutes	54,594 hours 01 minute

2.5.3 Weight and Balance

When the serious incident occurred, the aircraft's weight and position of center of gravity are estimated to have been 545,400 lb and 24.9% MAC respectively, both of which are estimated to have been within the allowable ranges (maximum takeoff weight of 850,000 lb, and 13 ~ 33% MAC based on the estimated aircraft weight at the time of the serious incident).

2.6 Meteorological Information

According to the PIC, weather was clear where the serious incident occurred, and there was a jet stream with 100 kt plus at around 34,000 ft.

2.7 Information on DFDR and Cockpit Voice Recorder (CVR)

The aircraft was equipped with a DFDR (P/N 980-4700-003) and a cockpit voice recorder (P/N 980-6022-001) (hereinafter called "CVR"), both manufactured by Honeywell Inc.

Both the DFDR and CVR were functioning well and retained a clearly recorded data.

For the purpose of time collation, the VHF transmitter keying signals recorded in the DFDR during communications between the flight crew and ATC were correlated with the NTT time signals that were recorded in the ATC communications record.

2.8 Outline of Cabin Pressure Control System and Others

The air-conditioning system of the aircraft has both cabin air-conditioning and pressurization functions.

The cabin pressure control system, by controlling positions of two OFVs, is designed to keep cabin altitude at 8,000 ft or below while maintaining the difference in pressure between inside and outside of the cabin (hereinafter called "pressure difference") at 8.9 pounds per square inch (psi) or less.

The cabin pressure control system consists of a cabin pressure selector panel (hereinafter called "PSL"), cabin pressure controllers (hereinafter called "CPC"), interface control units (hereinafter called "ICU"), OFVs, and positive pressure relief valves and negative pressure relief valves which are designed to protect the aircraft.

The cabin pressure condition is continuously monitored by the CPCs and, when necessary, displayed on EICAS. If cabin altitude exceeds 10,000 ft, a warning message is displayed on EICAS, master warning light comes on, and a warning horn sounds.

There are two CPCs on board, Unit A and Unit B. One unit controls all ICUs and

OFVs while the other unit stands by for backup. Control/standby changeover between the units takes place automatically on each flight if AUTO SELECT on the PSL is set in NORM. Changeover also occurs automatically if any of the following conditions occur during flight:

- The CPC is controlling OFVs to close and the pressure difference exceeds 9.07 psi.
- Cabin altitude is changing at a rate of 2,211 ft per minute or greater and the pressure difference stays at 8.9 psi or less.
- Electric power is lost for two seconds or longer.

While ICUs are controlled by CPCs, each ICU is equipped with a cabin altitude sensor on its side face that continuously monitors cabin pressure. If cabin altitude increases to 11,000 ± 500 ft, altitude limit switches on the ICUs activate to close the OFVs regardless of the CPC control, in order to prevent the cabin altitude from increasing further. While this is taking place, “MAN” is displayed on the ECS page of EICAS.

While the ICUs are controlling, no function is provided to compare the positions of the LH and RH OFVs.

Dado panels are movable panels installed at the lower part of the cabin side walls, near the floor level. If depressurization occurs in the cargo compartment and the pressure difference between the cargo compartment and the cabin becomes 0.09 psi or larger, the panels open to release the pressure difference and protect the cabin floor from collapsing.

(See Figures 4 and 5.)

2.9 Aircraft Condition

Immediately after the landing, positions of the OFVs located on the lower part of the aft fuselage were as follows: LH OFV was fully open and RH OFV was fully closed.

The positive pressure relief valves on the LH side of the forward fuselage and the negative pressure relief valves on the two cargo doors on the RH side of the fuselage were all closed.

In the cabin, the oxygen masks were deployed, and of the dado panels installed at the lower part of LH and RH side linings near the floor level, 10 aft LH and 4 aft RH panels were open.

Pillows were found on the wire meshed cover for the LH OFV under the floor in the aft fuselage. A passenger’s small bag was found between the RH outer skin of the fuselage and the inner lining.

(See Figure 4 and Photo 4.)

2.10 Tests and Research for Fact-Finding

2.10.1 Inspection of the Aircraft’s Cabin Pressure Control System

After landing at New Chitose Airport, a disagreement was confirmed as follows between the positions of PSL switches and ECS page indications. While AUTO / MAN selector switches on the PSL were both in AUTO position, ECS page showed that the LH OFV was in

AUTO (white) and the RH OFV was in MAN (yellow).

Self-testing the cabin pressure control system cleared the disagreement.

Both OFVs operated normally with the AUTO / MAN selector switches in MAN position.

Function and condition check was carried out before removing the original cabin pressure control system components (a PSL, two CPCs, two ICUs, two OFVs, eight relays and four circuit breakers) and it did not cause “CABIN ALT AUTO A” or “CABIN ALT AUTO B” message^{*5} which would have indicated a CPC failure. The system check after the replacement of cabin pressure control system components and subsequent test flight revealed no discrepancies.

According to the data, concerning ECS page and others, stored in the central maintenance computer (hereinafter called “CMC”) between 11:41:13 and 11:41:23, and the data on the flight altitude and cabin altitude stored in the DFDR, the situation can be summarized as shown in the following table. Through this period, the CPC Unit B was controlling the OFVs.

*5: “CABIN ALT AUTO A” or “CABIN ALT AUTO B” message is displayed when a fault is registered with Unit A or Unit B in the AUTO control mode.

Time	CMC data		DFDR data	
	LH OFV AUTO/MAN	RH OFV AUTO/MAN	Flight altitude (ft)	Cabin altitude (ft)
	EICAS message			
11:41:13	0.93* ⁶ MAN	0.63 MAN	36,007	7,701
	OUTFLOW VLV R			
11:41:15	0.49 MAN	0.10 MAN	36,010	9,034
	OUTFLOW VLV L* ⁷			
11:41:16	0.49 MAN	0.10 MAN	36,011	9,352
	CABIN ALT AUTO* ⁸			
11:41:18	0.58 AUTO	0.10 MAN	36,007	9,946
	CABIN ALTITUDE			
11:41:23	0.33 MAN	0.03 MAN	36,007	10,692
	OUTFLOW VLV L			

2.10.2 OFV Position

Following the serious incident, the company surveyed the actual positions of the OFVs on the aircraft in flight and summarized them as follows.

Flight altitude (ft)	Cabin altitude (ft)	LH OFV	RH OFV	Flight phase
36,000	5,524	0.1	0.1	Level flight
19,711	2,801	0.14	0.14	Descent
10,008	1,578	0.15	0.15	Descent
4,998	837	0.17	0.17	Descent

2.10.3 Functional Test on the Cabin Pressure Control System Components

A functional test was conducted on each of the cabin pressure control system components and resulted normal.

2.10.4 Inspection of the Cabin Pressure Control System Components at their Manufacturers

In order to identify the cause of the serious incident, the cabin pressure control system

*⁶: The numerical values such as 0.93 show the positions of the OFVs, with 1.0 being fully open and 0 being fully closed.

*⁷: "OUTFLOW VLV L" message is displayed when the LH OFV auto-control becomes inoperative or the LH OFV has been switched to the manual mode.

*⁸: "CABIN ALT AUTO" message is displayed when both CPCs have failed or the manual mode has been selected.

components were inspected, with regard to the influence such as electromagnetic interference, at the manufacturer's plant under the witness of an NTSB investigator. No discrepancies were found with the components during the inspection. The internal memory devices in the CPCs, without time data, retained the following pressure difference that had been recorded when the aircraft transitioned from cruise to descent: 6.412 psi in CPC Unit A; 21.325 psi in CPC Unit B.

2.10.5 Maintenance History and Other Information on the Cabin Pressure Control System Components

The company's Maintenance Manual mandates that the cabin pressure control system components be function checked as a system and OFVs be cleaned at every C check (7,500 flight hours or 18 months, whichever comes earlier).

The latest C check was conducted on the aircraft prior to the serious incident on May 23, 2004, during which no discrepancies were found.

Among the cabin pressure control system components installed on the aircraft at the time of the serious incident, the RH ICU had earlier caused the "OUTFLOW VLV L" message on EICAS twice when it was installed on another aircraft. But records show that no discrepancies were found with the ICU. Also logged in the record is the RH OFV that had seizures twice when used on another aircraft and was subsequently replaced. Other than those, no discrepancies or repair had been recorded on the components.

2.11 Other Relevant Information

Aircraft Operating Manual

Checklist of the aircraft applicable when warning message is displayed:

CABIN ALTITUDE (RAPID DEPRESSURIZATION)

Condition: Cabin altitude excessive

*9

OXYGEN MASKS AND REGULATOR: ON, 100%

CREW COMMUNICATIONS: ESTABLISH

CABIN ALTITUDE AND RATE: CHECK

If cabin altitude cannot be controlled:

PASSENGER OXYGEN SWITCH: ON

DESCENT: ACCOMPLISH

Close thrust levers.

Extend speedbrakes.

Descend at V_{MO}/M_{MO} .

Level off at lowest safe altitude or 13,000 feet, whichever is higher.

If landing gear is to be used to increase descent rate, limit speed to gear operation speed until gear is fully extended, then descend at $M .82$ or 320 KIAS.

If OUTFLOW VLV L, OUTFLOW VLV R, and CABIN ALT AUTO messages displayed:

Do not accomplish the following checklists:

CABIN ALT AUTO

OUTFLOW VLV L, R

If descent performed:

After level off, confirm following items.

Speedbrakes

Altimeter setting

Oxygen mask (NORMAL)

Transponder

*9 There are recall items and reference items in checklists. Recall items are procedures that crew must perform by memory in a critical situation, and are shown in boxes.

3. ANALYSIS

3.1 Crew Qualification

The PIC and the first officer possessed valid airman licenses and airman medical certificates.

3.2 Airworthiness Certificate of the Aircraft

The aircraft had valid airworthiness certificate and was maintained and inspected properly.

3.3 Influence of the Weather

It is estimated that the serious incident have not been influenced by the weather conditions prevailing at the time of its occurrence.

3.4 Emergency Descent

It is estimated that, when the serious incident occurred, the flight crew descended the aircraft to safe altitude in accordance with the checklist (1), *CABIN ALTITUDE (RAPID DEPRESSURIZATION)*, of the Aircraft Operating Manual described in 2.11.

3.5 Cabin Pressure Control System

3.5.1 CPC Records

Based on the DFDR records at the time of transition from cruise to descent, cabin altitude was 10,744 ft (9.81 psi) at a flight altitude of 35,745 ft (3.33 psi), with the pressure difference of 6.48 psi. Of the pressure differences retained in the memory devices of CPCs that were mentioned in 2.10.4, the value stored in CPC Unit A was reasonable and considered to have been recorded during the descent while the value stored in CPC Unit B are estimated to be erroneous.

3.5.2 CPC Fault

As mentioned in 2.1.2, when “OUTFLOW VLV R” message was displayed on EICAS and “MAN” message was displayed in OFV indication on ECS page, the crew had not operated , AUTO / MAN selector switches on PSL, consequently it is considered possible that a CPC fault might have occurred at that time.

As mentioned in 2.10.1, after the occurrence of the serious incident, CPC Unit B was controlling the OFVs. No records exist as to which CPC was controlling the OFVs immediately before the occurrence. The functional test / inspection mentioned in 2.10.3 and 2.10.4 revealed no discrepancies with CPC Unit A or Unit B. The memory device of CPC Unit B recorded pressure differences exceeding 21 psi at the time of transition from cruise to descent.

Considering that there was no message indicating CPC failure, it is estimated that at

the occurrence of the serious incident, CPC Unit B sensed the erroneous pressure difference due to certain failure(s) and that, in order to cope with the excessive pressure difference, it may have commanded the OFVs to open further, which led to the increased cabin altitude. In addition, it is considered that the circumstances at that time did not meet any of the conditions for automatic CPC changeover mentioned in 2.8, and based on the CMC records, it is considered that CPC Unit B, without changeover to CPC Unit A, may have continued to control the OFVs. The reason why the erroneous pressure difference was recorded in CPC Unit B could not be identified.

3.5.3 Positions of the OFVs

As mentioned in 2.10.2, in condition of a flight altitude of 36,000 ft and a cabin altitude of 5,524 ft, both LH and RH OFVs normally are opened to approximately 10%. As mentioned in 2.10.1, the serious incident is estimated to have occurred due to the fact recorded by the CMC that LH and RH OFVs were opened to 93% and 63% respectively.

As mentioned in 2.10.1, after the occurrence of the serious incident, it is considered that LH and RH ICUs started to control LH and RH OFVs respectively, LH OFV closed to approximately 30% and RH OFV was closed fully.

The reason why the LH OFV shifted to “AUTO” control mode temporarily while the ICUs were controlling the corresponding OFVs, is considered that due to increase of pressure of air around the LH ICU, the control function of LH ICU stopped, and the CPC controlled the OFV instead. Subsequently, it is considered that due to a drop in pressure of air, the ICU started to control the OFVs once again, which led to “MAN” control mode. The reason why the LH and RH OFVs were in different positions is considered that the LH and RH ICUs do not have a function to compare their outputs each other when controlling the corresponding OFVs from open position to close direction in order to maintain cabin altitude.

3.5.4 Cabin Altitude

The reason why the cabin altitude did not exceed 10,795 ft as described in 2.1 is estimated to be that, as explained in 2.8 and 2.10.1, the ICUs might have sensed an increase in cabin altitude, causing the altitude limit switches of ICUs to activate, controlling the OFVs from open position to close direction.

3.5.5 Cabin Pressurization at Flight Altitude of 10,000 Feet or Below

The cabin altitude was same as the flight altitude at or below the flight altitude of 10,000 ft as indicated in 2.1.1. It is considered possible that the reason why the cabin was not pressurized is such that function of ICUs to control OFVs, finished and was transferred to CPC Unit B, which controlled the OFVs towards the open position as it would have done at the time of the occurrence of the serious incident.

4. PROBABLE CAUSE

It is estimated that this serious incident was caused by excessive opening of Out Flow Valve (OFV) in cabin pressure control system, which resulted in reduction of cabin pressurization while the aircraft was cruising.

The reason for the excessive opening of the OFVs is considered that Cabin Pressure Controller(CPC) controlled the Out Flow Valves towards open position based on the erroneous indication of pressure difference, which resulted from certain failures. As tests conducted after the landing, which include self-test of the cabin pressure control system and functional tests of the individual components, revealed no discrepancies, the cause for the erroneous indication of pressure difference could not be identified.

Figure 1 Presumed Flight Route

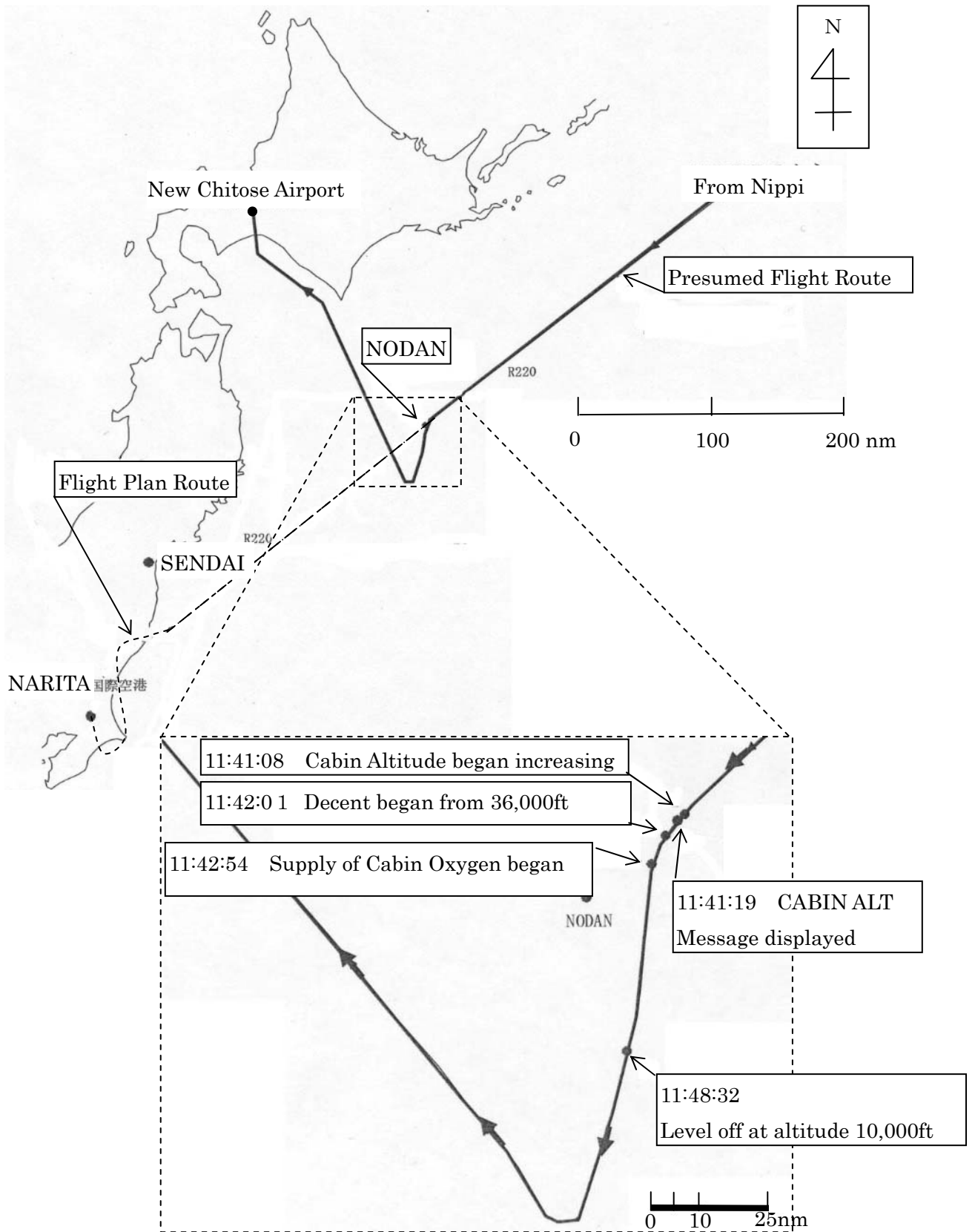


Figure 2 Boeing 747-400 Three Angle View

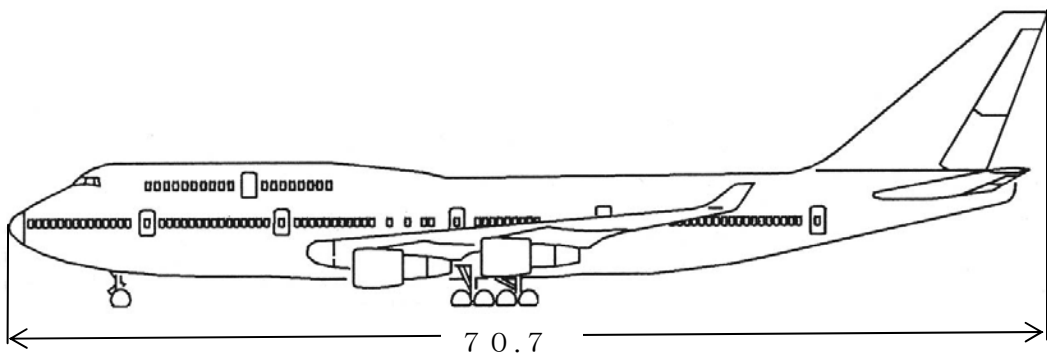
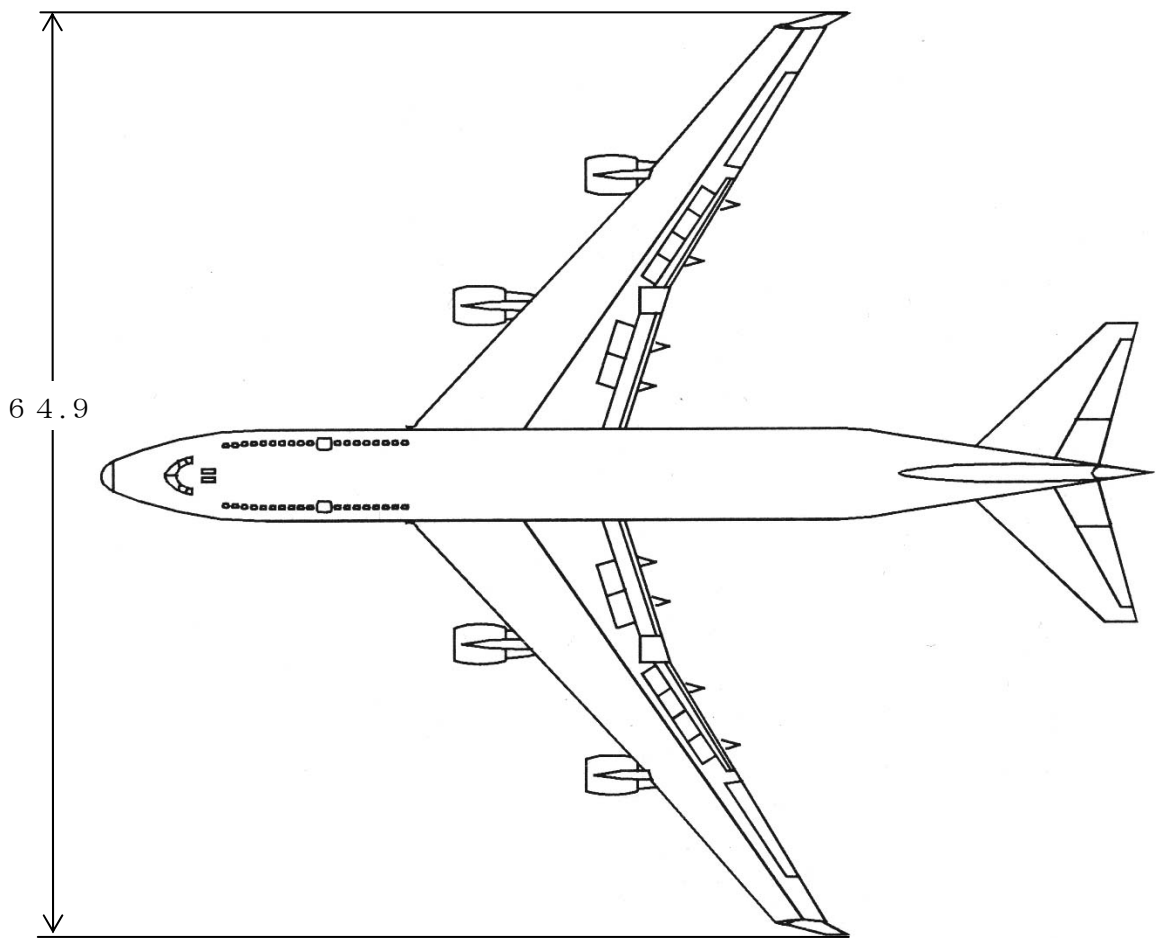
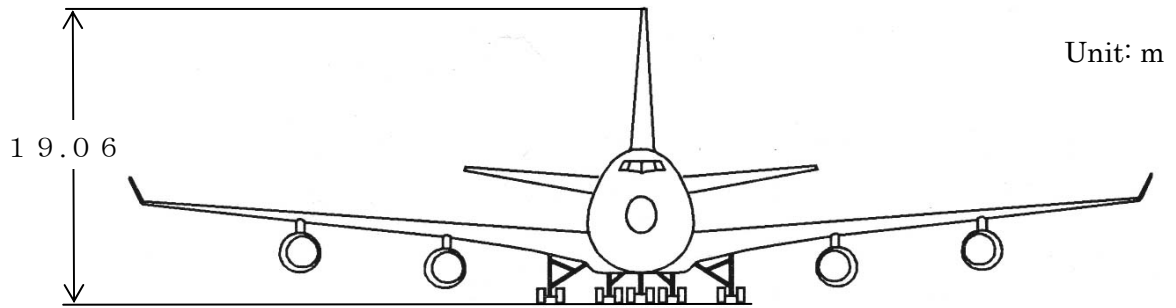


Figure 3 DFDR Data

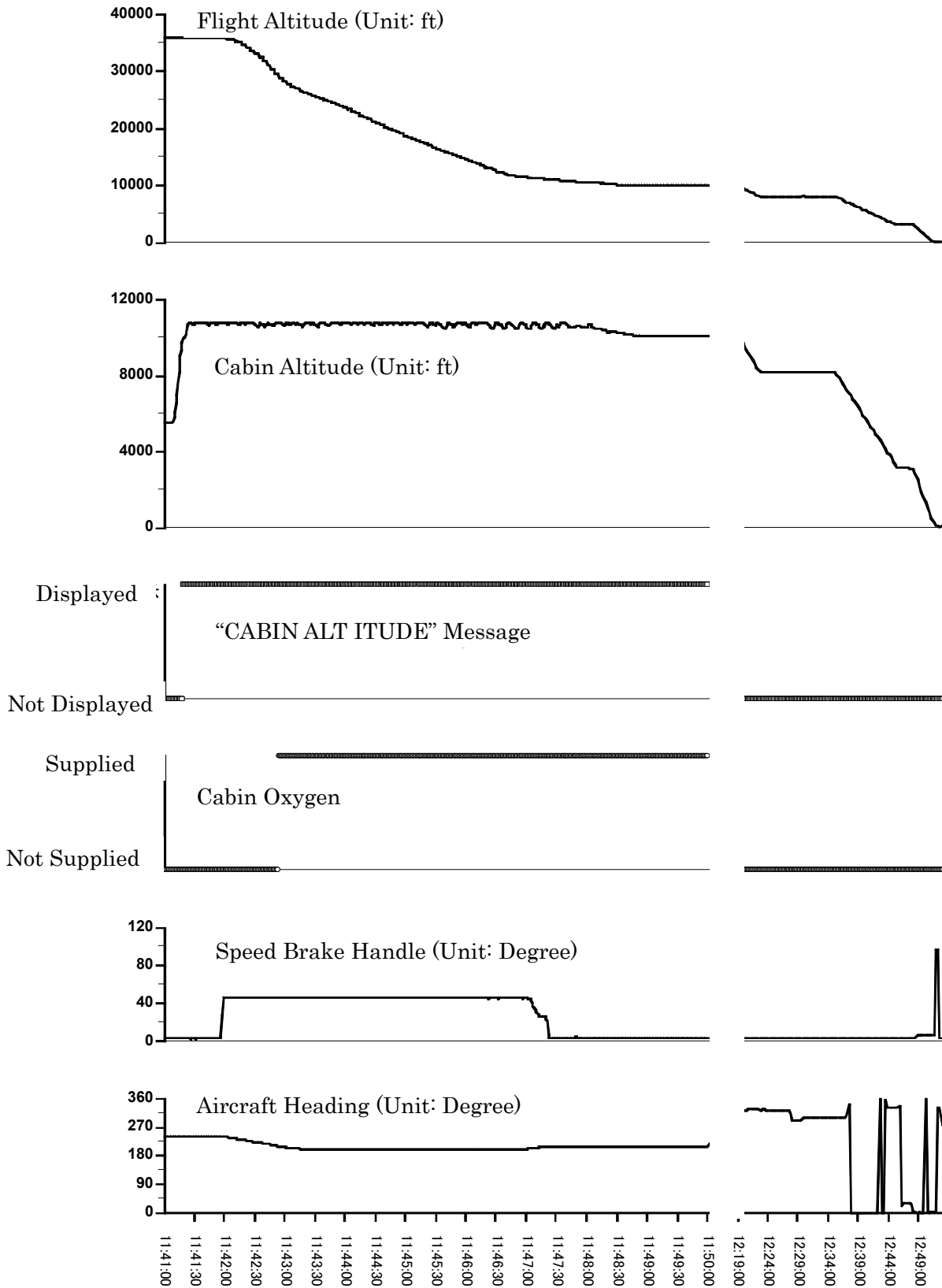
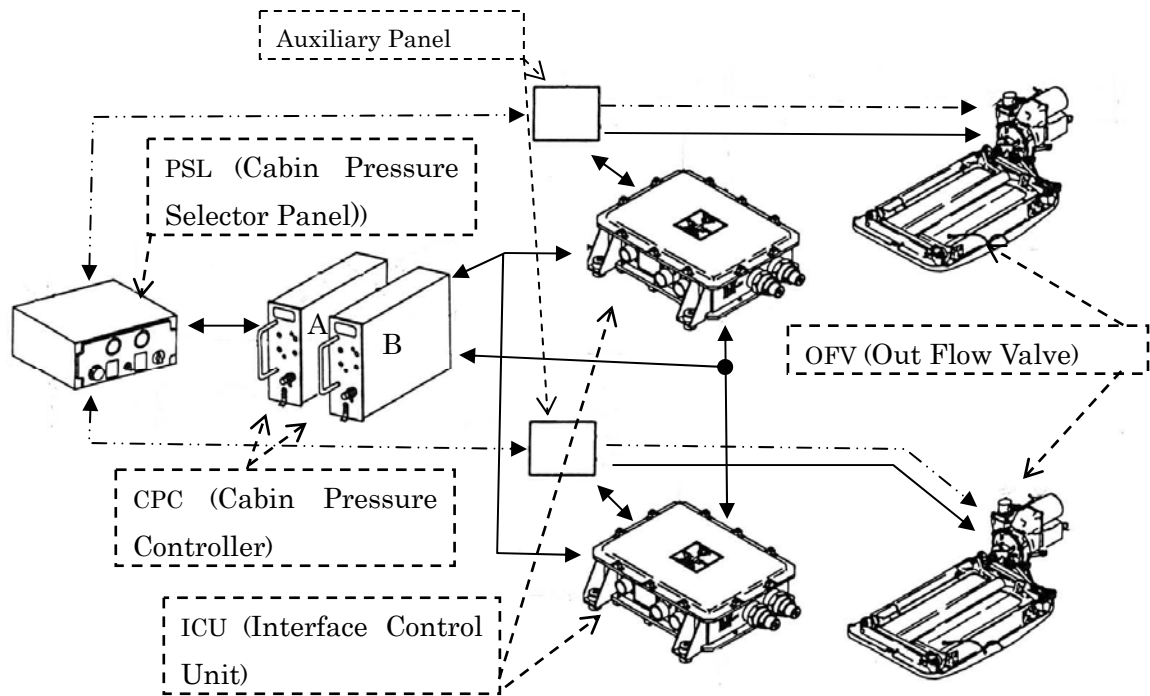
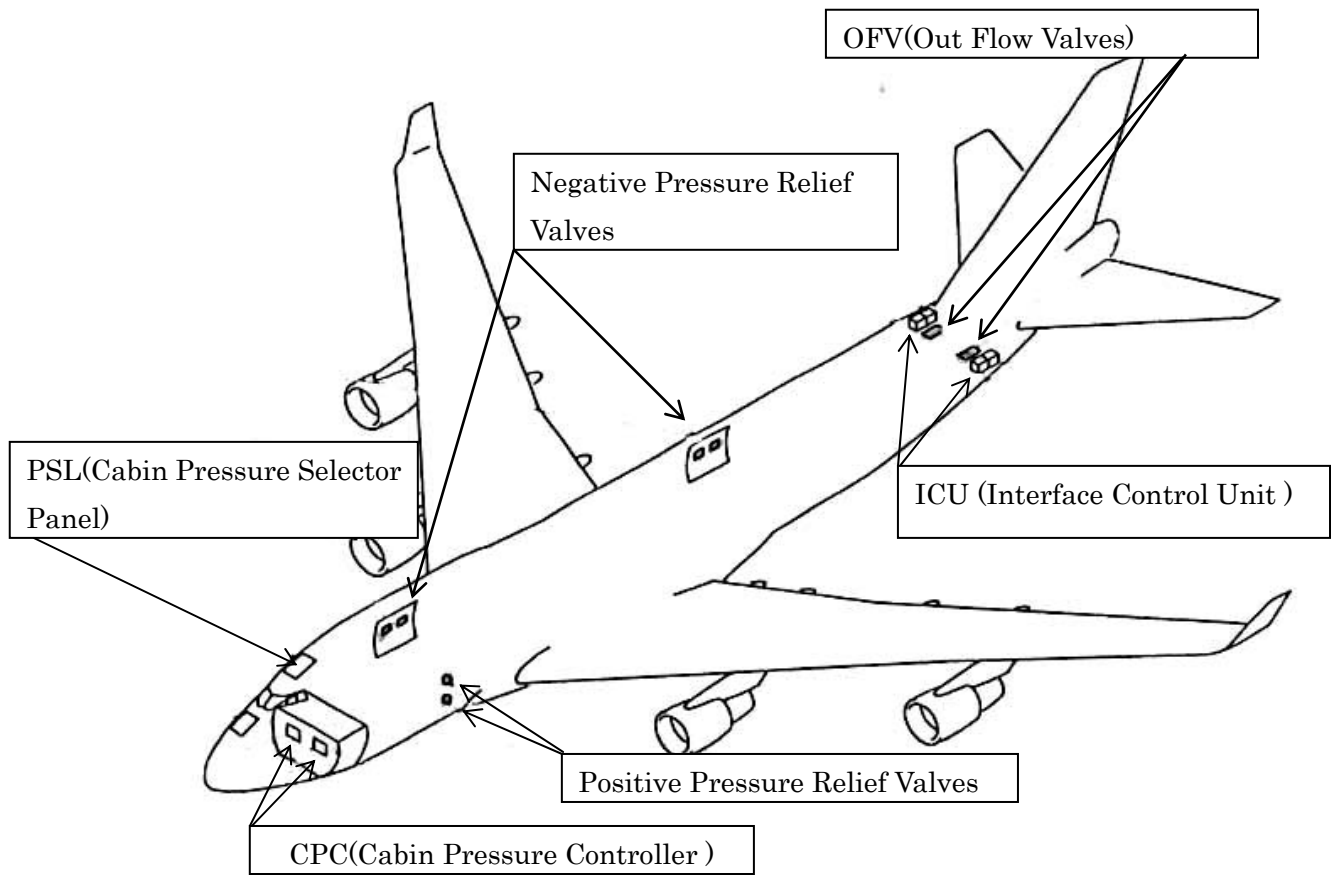


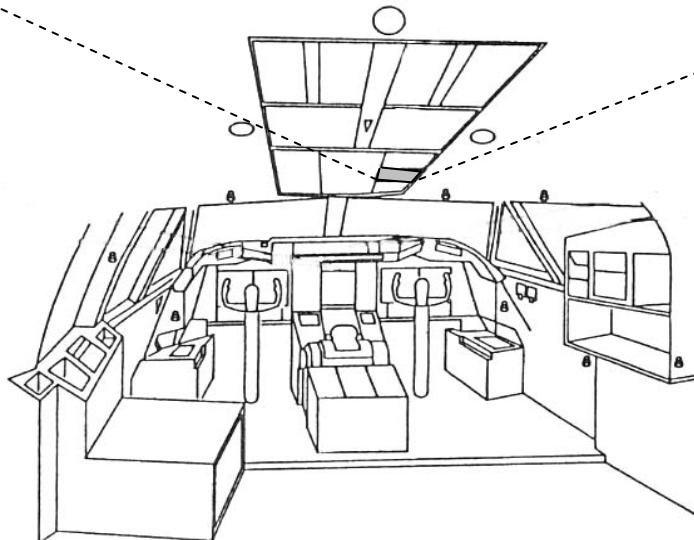
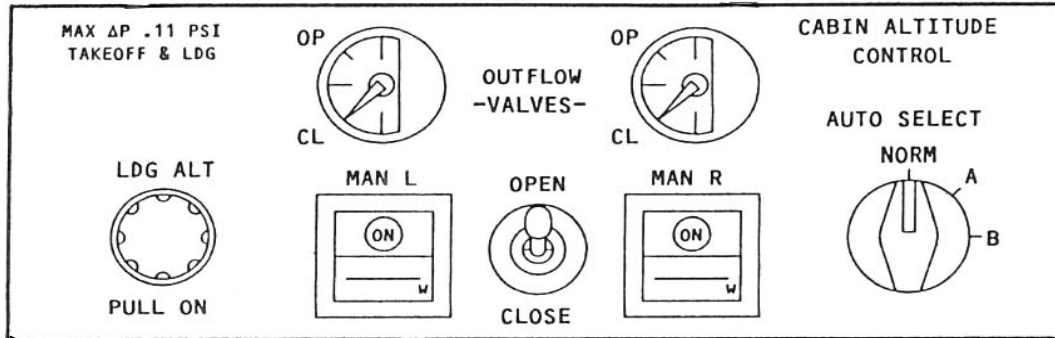
Figure 4 Cabin Pressure System Outline



Auto mode
 Manual mode

Figure 5 P S L

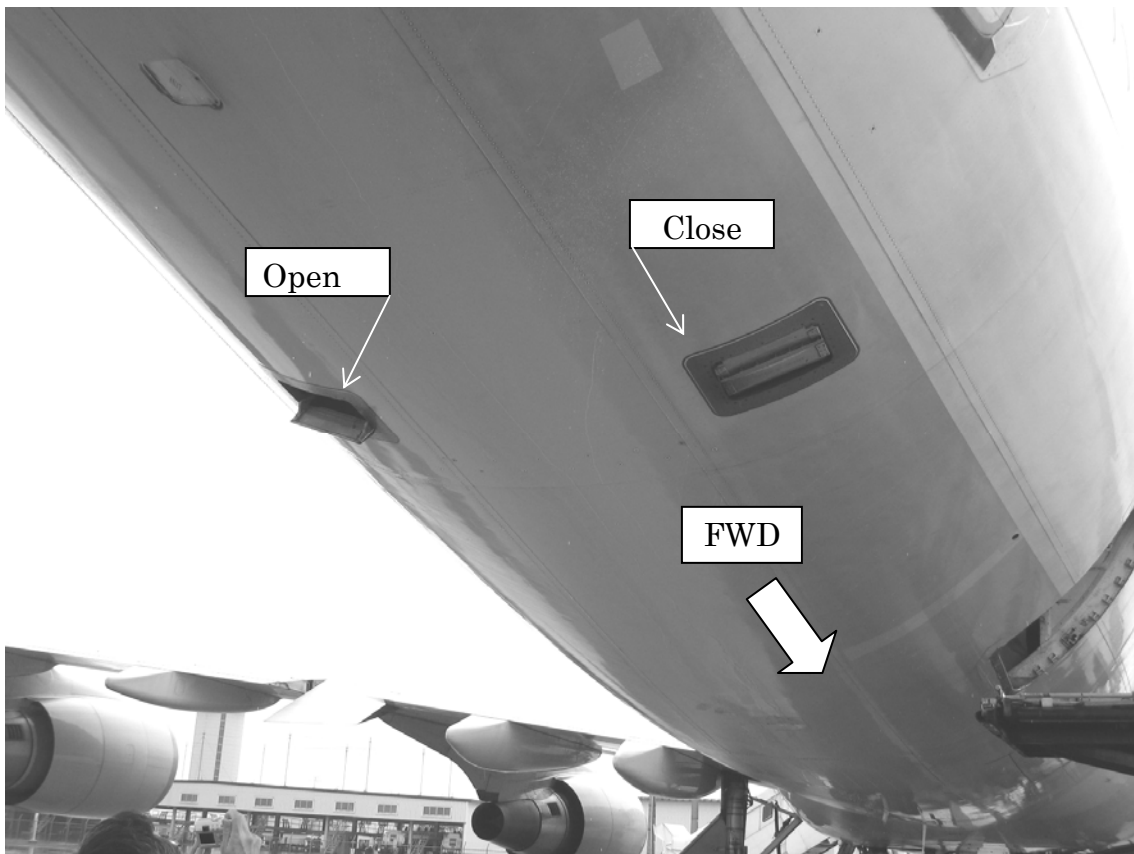
(Cabin Pressure Selector Panel)



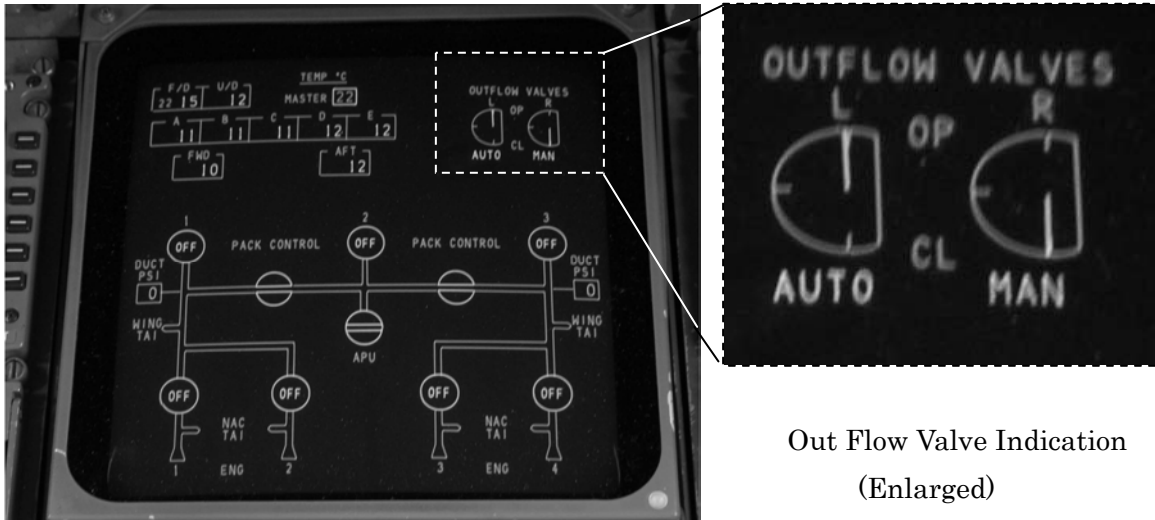
Photograph 1 Serious Incident Aircraft



Photograph 2 Out Flow Valve Condition



Photograph 3 E I C A S (E C S Page)



Out Flow Valve Indication
(Enlarged)

Photograph 4 Dado Panel

