AI2006-5

AIRCRAFT SERIOUS INCIDENT INVESTIGATION REPORT

SKYNET ASIA AIRWAYS CO., LTD.
BOEING 737-400, JA737D
AIR ABOVE SEA APPROXIMATELY 170 KILOMETERS EAST-NORTHEAST OF KUSHIMOTO VORTAC
FEBRUARY 24, 2005

September 29, 2006

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 Skynet Asia Airways119 The Boeing 737-400, JA737D 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.

Junzo Sato,
Chairman,
Aircraft and Railway Accidents Investigation Commission

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BOEING 737-400, JA737D
AIR ABOVE SEA APPROXIMATELY 170 KILOMETERS EAST-NORTHEAST OF KUSHIMOTO VORTAC
FEBRUARY 24, 2005, AT APPROXIMATELY 18:05 JST

July 26, 2006

Decision by the Aircraft and Railway Accidents Investigation Commission

(Air Subcommittee Meeting)

Chairman	Junzo Sato
Member	Yukio Kusuki
Member	Susumu Kato
Member	Noboru Toyooka
Member	Yukiko Kakimoto
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 “Abnormal Cabin Depressurization” 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.

Designated as Flight 119, the Boeing 737-400 airplane, JA737D, operated by Skynet Asia Airways Co., Ltd., took off from Tokyo International Airport at 17:34 Japanese Standard Time (JST) on February 24 (Thursday), 2005 for Miyazaki Airport on regularly scheduled service.

About 18:05, at approx. 33,700 feet above the sea, approx. 170 km east-northeast of Kushimoto VORTAC, instrument indication revealed a drop in cabin pressure and the oxygen masks in the cabin were automatically deployed. After a subsequent emergency descent, the airplane landed at Miyazaki Airport at 19:15.

A total of 108 people were on board, consisting of the pilot-in-command, four other crewmembers, and 103 passengers (one of whom was an infant). One of the passengers temporarily felt bad.

There was no damage to the aircraft.

1.2 Outline of the Serious Incident Investigation

1.2.1 Investigative Organization

On February 25, 2005, the Aircraft and Railway Accidents Investigation Commission appointed an investigator-in-charge and one investigator for the serious incident.

1.2.2 Accredited Representative Participating in the Investigation

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

1.2.3 Implementation of Investigation

February 25 – March 1, 2005	Interviews and investigation of aircraft
March 4, 2005	Interviews
March 22 and 23, 2005	Investigation of equipment
March 28 and 29, 2005	Investigation of equipment
April 5, 2005	Investigation of equipment
April 8, 2005	Investigation of aircraft
August 17, 2005	Investigation of equipment

September 29, 2005 – January 17, 2006	Investigation of equipment

1.2.4 Interviews with Personnel Relevant to the Cause

Interviews have been conducted with personnel of the organization relevant to the cause of the serious incident.

1.2.5 Comment from the State of Design and Manufacture

Comment has been invited from the state of design and manufacture of the aircraft involved in the serious incident.

2. FACTUAL INFORMATION

2.1 History of the Flight

On February 24, 2005, the Boeing 737-400 airplane, JA737D (hereafter called "the aircraft"), operated by Skynet Asia Airways Co., Ltd. (hereafter called "the company") and designated as Flight 119 on the company's scheduled service, was flying from Tokyo International Airport to Miyazaki Airport.

The aircraft flight plan submitted to the Tokyo Airport Office is outlined below.

Flight rules: Instrument flight rules (IFR)

Departure aerodrome: Tokyo International Airport

Estimated off-block time: 17:15

Cruising speed: 426 knots

Cruising altitude: FL350

Route: URAGA5 (Standard Terminal Departure Route) – MIURA (Reporting point) – OCEAN (Reporting point) – YZ (Yaizu NDB) – CELLO (Reporting point) – Y21 (RNAV route) – KEC (Kushimoto VORTAC) – A1 (Airway) – SUC (Shimizu VORTAC) – B597 (Airway) – HIROS (Reporting point) – OYODO (Reporting point)

Destination aerodrome: Miyazaki Airport

Total estimated elapsed time (EET): 1 hr and 38 min

Endurance: 5 hrs and 0 min

The aircraft took off from Tokyo International Airport at 17:34 with 108 people on board, including the pilot-in-command, four other crewmembers, and 103 passengers (one of whom was an infant). The pilot-in-command sat in the left cockpit seat as Pilot Flying (hereafter called "PF", primarily responsible for aircraft maneuvering) while the first officer sat in the right seat as Pilot Not Flying (hereafter called "PNF", primarily responsible for non-maneuvering tasks).

The flight history of the aircraft, derived from records of the digital flight data recorder (hereafter called "DFDR"), ATC communications, and statements from the crew, is outlined below.

2.1.1 Flight History Based on DFDR and ATC Communications Records

18:03:01 While flying at Flight Level (hereafter called "FL") 310, the crew contacted the Tokyo Area Control Center (hereafter called "Tokyo Control") for requesting to climb to FL350; Tokyo Control cleared.

18:03:43 The aircraft started climbing to FL350.

18:04:47 At FL337, the master caution light came on.

18:04:53 At FL339, the master caution light went off.

18:05:15 At FL347, the cabin altitude warning horn in the cockpit was activated.

18:05:31 At FL348, the crew contacted Tokyo Control, asking for requesting to descend necessitated by a problem having arisen in the cabin pressure controller (hereafter "CPC"). Tokyo Control cleared to descend and maintain FL260. The aircraft started its descent.

18:06:57 While descending through FL284, the aircraft requested Tokyo Control 10,000ft.

18:07:07 While the aircraft was descending, passing FL280, Tokyo Control contacted the crew to confirm that the descent request was 10,000 feet. In response to this, the crew declared an emergency followed by a declaration of failure to pressurize the cabin, and repeated the request for permission to descend to 10,000 feet. Tokyo Control cleared the descent with instructions to first descend to FL150 and maintain that altitude.

18:09:09 The crew requested permission to descend to FL140; the request was cleared.

18:10:55 The aircraft reached FL140.

18:14:28 At FL140, Tokyo Control asked the crew if they could resume normal flight. The crew responded by saying that they would resume normal flight at the current altitude and continue flying to Miyazaki Airport maintaining that altitude.

18:18:45 At FL140, the cabin altitude warning horn stopped sounding.

18:42:24 The crew contacted the Fukuoka Area Control Center (hereafter called "Fukuoka Control"), informing them that the aircraft was maintaining FL140. Fukuoka Control reported the QNH at that time is 29.60 inches Hg, and the pilot-in-command repeated the setting.

18:42:46 Fukuoka Control asked the crew whether the problem was related to the cabin pressurization system or to the hydraulic system. The crew told Fukuoka Control that the problem was a cabin pressurization system failure, adding that although the aircraft had been restored to a normal state at that time, they wished to maintain the current altitude as a precautionary measure. Fukuoka Control approved it and reported the QNH at that time is 29.60 inches Hg.

18:50:56 After requesting clearance from Fukuoka Control to descend to 10,000 feet and receiving clearance, the crew started a descent.

18:55:17 The aircraft reached 10,000 feet.

(See Figure 1)

2.1.2 Statements from the Crewmembers

(1) Pilot-in-command

At FL310, the flight crew contacted Tokyo Control for permission to climb to FL350 and clearance was received. At just above FL335 after starting to climb, the cabin pressurization system malfunctioned.

The cabin altitude warning horn in the cockpit was activated and, soon after that, the master caution light came on. While the first officer was performing the relevant checklist, the pilot-in-command happened to look up and see the "Pass Oxy ON" indication lighting up and noticed the oxygen masks deploying in the cabin. The cabin altitude was increasing at a rate of approx. 4,000 feet/minute at that time. He did not notice any change in pressure difference between inside and outside of the cabin before, during or after activation of the cabin altitude warning horn, nor did he notice any abnormal noise that might have suggested a malfunction. There were no other types of abnormality indications. He assumes that the problem cropped up near the MEIWA Point. He has the impression that everything happened suddenly.

According to the company's pre-established procedure (Rapid Depressurization section of the Non-Normal Check List), the pilot-in-command had the first officer contact Tokyo Control and declare an emergency. Then, the pilot-in-command made an emergency descent to FL140. He does not remember whether or not he gave the passengers prior notice of the emergency descent over the passenger address (hereafter called "PA") system. The flight crew tried in vain to resolve the cabin pressurization problem during the descent.

After confirming that the aircraft had reached FL140, the pilot-in-command checked the cabin pressurization system indication, which showed that the cabin altitude was stable at 10,000 feet or lower, so he determined that the aircraft was restored to normal.

He contacted the senior cabin attendant (hereafter "the CP"), requesting a report on the condition of the passengers. The CP answered that all passengers were all right.

The pilot-in-command then planned the subsequent part of the flight by following the pre-established procedures, taking into consideration all relevant aspects including passengers, other crewmembers, aircraft safety, fuel, weather, and his own condition.

While the pilot-in-command was not sure whether or not the cabin pressurization system was restored, he concluded that there was no need for an emergency landing at the nearest airport and that it would be safer to continue flying to Miyazaki Airport. His decision was based on the following: passengers and crewmember were neither seriously ill nor injured; the cabin altitude was stable at 10,000 feet or lower so that the aircraft was in a condition considered safe; the remaining fuel would last two hours, which was sufficient to fly to Miyazaki Airport; and meteorologically, despite a warning that had been issued to Tokyo and Miyazaki, the low-level wind shear alert was shifting towards Tokyo and conditions at Miyazaki were recovering.

The aircraft made a descent after receiving clearance from Fukuoka Control to fly directly to the OYODO Point and descend to 10,000 feet in response to the crew's request. By the end of the descent, the cabin altitude had become controllable.

After descending to 10,000 feet, the pilot-in-command had the first officer lower the cabin altitude again by manually controlling the cabin pressurization system. The setting was at approx. 2,000 feet during the continuation of the flight to Miyazaki Airport.

(2) First officer

During cruising after having took off and climbed to FL310, the aircraft was a bit choppy, so the flight crew asked Tokyo Control for clearance to climb to FL350. Upon receiving clearance, the aircraft started climbing. The seat-belt sign was kept ON during the climb.

The cabin pressurization system had been set to "AUTO MODE." At FL335, the master caution light and the system annunciator light "AIR COND" (caution light) came on and, at the same time, the "AUTO FAIL" light and the "STBY" light on the cabin pressurization mode selector panel came on. When the first officer was about to start performing the Auto Fail Check List, the cabin altitude warning horn was activated. It seemed to him that before, during and after this series of alert events, there was no other indication or sound that might have suggested any abnormality.

The first officer donned his oxygen mask and immediately switched the cabin pressurization system to "MANUAL AC MODE"[*1] and operated the cabin pressurization outflow valve towards the closed position. At that time, the cabin altitude indicator pointed between approx. 12,000ft and 14,000ft, and the cabin altitude indication had been overlapped with the cabin differential pressure indication. He did not monitor the position of the cabin pressurization outflow valve at that time.

The first officer did not check deployment of the oxygen masks in the cabin. He had no abnormal feeling in his ears or in any other parts of his body. The pilot-in-command told the first officer that he intended to make an emergency descent and instructed him to prepare for it. The first officer contacted Tokyo Control to declare an emergency, and to ask for clearance to descend. He does not think that the pilot-in-command gave the passengers prior notification over the PA system about the emergency descent.

The aircraft descended to FL140. After the aircraft started cruising at that altitude, the first officer temporarily took control as PF for the period during which the

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[*1] "MANUAL MODE" of cabin pressurization system is a mode for adjusting the main outflow valve's travel position by a manual switching operation.
There are two "MANUAL MODE"s for the cabin pressurization system: "MANUAL AC MODE" and "MANUAL DC MODE." The two modes differ in the type of electric motor used to drive the cabin pressurization outflow valve, i.e., AC motor or DC motor. The cabin pressurization outflow valve is driven faster in "MANUAL AC MODE" than in "MANUAL DC MODE."
MANUAL Light (Green) on the mode selector panel turns on if the "MANUAL MODE" is selected.

pilot-in-command checked the pros and cons of returning to Tokyo versus flying on to Miyazaki, finally deciding to fly on to Miyazaki. Then, they requested clearance from Fukuoka Control for another descent. The aircraft descended to 10,000 feet upon receiving clearance.

During the descent, with the cabin pressurization system remaining in "MANUAL AC MODE," the first officer performed the checklist, after which he checked the cabin altitude indicator and observed its reading at approx. 6,000 feet. He does not remember what the readings were for the altimeter and the cabin pressurization outflow valve position indicator at that time. During the descent, he did not feel any pain in his ears, nor did the CP and CAs report any ear discomfort.

The flight crew checked with the CP about the conditions of the cabin. The CP reported no problems. The first officer then reported the emergency descent having been made over the company radio.

During the descent, the first officer tried adjustments using the cabin altitude change rate adjuster knob after having selected the "STBY MODE"[*2] position on the pressurization mode selector panel, but he failed to control the cabin altitude. He then reselected the "MANUAL AC MODE" position. After the rapid depressurization occurred, the "AUTO MODE"[*3] position was never selected at any time.

(3) Cabin crew (primarily based on CP's statements and supplemented by CAs' statements)

About 18:00, when the CP and CAs were performing a routine cabin check, the seat-belt sign came ON. The CA who was primarily assigned to duty in the forward cabin area (hereafter called "B Area Attendant"), but happened to be near the aft cabin PA microphone at that time, advised the passengers over the PA system to fasten their seat belts and then sat in the aft left CA's seat. The CA who was primarily assigned to duty in the aft cabin area (hereafter called "C Area Attendant") sat in the aft right CA's seat. The CP sat in the forward CA's seat.

About 18:08, approx. five minutes after taking his seat, the CP experienced repeated ear popping while at the same time felt extreme cold below his knees. He did not hear any abnormal sounds. The B Area Attendant felt a strong and sudden ear popping. She

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[*2] "STBY MODE" of cabin pressurization system is a semiautomatic mode.
Apart from the mode selector set manually to STBY position, "STBY MODE" takes over automatically when the "AUTO MODE" fails to operate properly.
When "STBY MODE" activates, STANDBY Light (Green) on the mode selector panel comes on. This mode uses a DC motor to activate the main pressure outflow valve, so the operational time is slowed.

[*3] "AUTO MODE" of cabin pressurization system is used for normal flights, and is the mode which automatically adjusts to pre-selected cabin altitude and changing rate. This mode uses an AC motor to activate the main pressure outflow valve, so the operational time is faster.

simultaneously heard a loud “hissing” noise that she had never heard before, which came from behind the galley. She identified an especially loud sound as coming from around the lower right area.

About 18:04, the C Area Attendant started experiencing ear popping. Her ears usually pop gradually, but the popping she experienced at that time was accompanied by a continuous “ripping” sound. She repeatedly heard a loud, short “hissing” sound coming from behind, and thought there might be something wrong with the door. She asked the B Area Attendant, “Is the door OK?” while checking the right door by touching it. Nothing was found to be wrong with the door. She then felt an extreme chill down her legs.

Just as the C Area Attendant grabbed the nearby interphone handset to report the situation to the CP, the oxygen masks in the cabin were deployed and an automatic emergency descent announcement started. The CP advised the passengers over the PA system to put on their oxygen masks and seat belts.

The C Area Attendant stopped talking to the CP and tried to put on the oxygen mask that had been deployed right in front of her. She struggled to put it on, however, because the cord from her mask was entangled with the cord of another mask. The B Area Attendant, who had already donned a mask and was aware of the C Area Attendant’s struggle, handed over one of the two masks that had deployed in front of her. The C Area Attendant put on that mask. In the meantime, the aircraft had started an emergency descent but neither the CP nor any of the CAs heard a PA announcement from the pilot-in-command prior to the emergency descent.

At 18:12, the automatic emergency descent announcement stopped and the CP and CAs took off their oxygen masks; they did not experience any breathing difficulty afterwards.

About 18:20, the pilot-in-command instructed the CP to advise the passengers to keep their masks on and to have the CAs perform a cabin check although the aircraft was then at a safe altitude.

About 18:23, the pilot-in-command informed the CP that the passengers could take off their oxygen masks. Soon after the communication, the passenger in Seat 11D (hereafter “Passenger A”), who looked pale, complained to the CP, in a faint voice, of feeling ill despite having worn an oxygen mask.

The CP had never seen similar symptoms before and therefore did not know what was wrong with the passenger or whether the condition was severe or weak. However, he inferred that possibly passenger A was suffering from hypoxia from the rapid depressurization that had taken place. He thought that the condition was not severe because Passenger A was conscious and able to talk with him.

The CP promptly provided Passenger A with a portable oxygen mask, setting the flow selector to “LO” and running it for approx. three minutes. He then set the selector to “HI”, as Passenger A did not appear to be recovering. After a while, Passenger A appeared to be feeling better and the CP set the selector to “LO” again. He thinks that he ran the equipment for a total of approx. 30 minutes in the “HI” and “LO” positions.

The pilot-in-command asked the CP about the condition of the passengers. He answered that the passengers were all right. The pilot-in-command informed the CP that he judged that the aircraft should continue flying to Miyazaki rather than returning to Haneda since there were no passengers who were seriously ill and the aircraft was intact and had descended to a safe altitude.

The CP advised the passengers over the PA system that the oxygen masks remained deployed due to the occurrence of a failure in the cabin pressurization system but that everything was now safely back to normal and therefore the aircraft would continue on to Miyazaki.

About 18:50, Passenger A appeared to have almost completely recovered, so the CP took off the oxygen mask from the passenger. Then, the CP made a verbal report to the cockpit crew, saying that Passenger A was now all right and no longer needed an oxygen mask.

At 19:03, the cockpit crew signaled that the aircraft reached 10,000 feet (by flashing the seat-belt sign twice).

After landing at Miyazaki Airport, a ground staff member of the company brought Passenger A to a hospital for medical attention. Later, the CP was told by his boss that Passenger A was diagnosed with hyperventilation.

This serious incident occurred about 18:05, in the air above the sea approx. 170 km east-northeast of Kushimoto VORTAC.

(See Figure 1 and Photo 1)

2.2 Injuries

While in flight, one of the passengers temporarily felt bad.

2.3 Damage to the Aircraft

Of the two blowout panels located in the ceiling of the aft cargo compartment (see Section 2.11.2), the forward panel was found to be slightly open.

(See Figure 3 and Photo 2)

2.4 Damage Other than to the Aircraft

None

2.5 Pilot Information

(1) Pilot-in-command Male, 47 years old

Airline transport pilot certificate (Airplane) June 10, 2002

Type rating for airplane multi-engine (land)	June 10, 2002
Type rating for Boeing 737	June 10, 2002
1st class aviation medical certificate	
Validity	Until June 3, 2005
Total flight time	13,764 hrs and 19 min
Flight time in the last 30 days	87 hrs and 22 min
Flight time on the aircraft type	9,624 hrs and 23 min
Flight time in the last 30 days	87 hrs and 22 min

(2) First officer Male, 35 years old

Commercial pilot certificate (Airplane)	February 19, 1990
Type rating for airplane multi-engine (land)	November 24, 1992
Type rating for Boeing 737	June 10, 2002
1st class aviation medical certificate	
Validity	Until February 7, 2006
Total flight time	6,159 hrs and 2 min
Flight time in the last 30 days	67 hrs and 52 min
Flight time on the aircraft type	2,199 hrs and 25 min
Flight time in the last 30 days	67 hrs and 52 min

(3) Senior cabin attendant Male, 30 years old

Total flight time on duty	1,602 hrs and 5 min

2.6 Aircraft Information

2.6.1 Aircraft

Type	Boeing 737-400
Aircraft serial number	27168
Date of manufacture	February 9, 1993
Certificate of airworthiness	DAI-16-147
Validity	June 10, 2005
Categories	Airplane, Transport category
Total flight hours	33,325 hrs and 59 min
Flight time since last C03 inspection (October 5, 2004)	760 hrs and 4 min

Since the time that the aircraft was put into service by the company, the forward galley and lavatory have not been modified.

(See Figure 2)

2.6.2 Cabin Altitude Warning Horn

The cockpit of the aircraft was equipped with a cabin altitude warning horn. The horn issues an audible alarm when the cabin altitude exceeds approx. 10,000 feet. The horn stops when the cabin altitude drops back to approx. 10,000 feet or below, and also when the cutout switch on the overhead panel is manually pushed.

2.6.3 Passenger Oxygen System

The cabin of the aircraft was equipped with a passenger oxygen system. When the cabin altitude reaches approx. 14,000 feet, a pressure switch trips and causes the oxygen masks in the cabin to be deployed automatically. When the system is activated, the following lights come on: the "Pass Oxy ON" light on the cockpit overhead panel, the system indicator "OVERHEAD" light on the glare shield, and the master caution light.

2.6.4 Equipped CPC

The CPC with which the aircraft was equipped at the time of the serious incident had already been used for 3,275 hours and 1 minute when the company first put the aircraft into service. The company continued to use the CPC on the same aircraft.

According to the company's Maintenance Manual, the company did not categorize the CPC in question as equipment requiring removal from the aircraft for regular maintenance based on the duration in service or times of use. In addition, the CPC had not experienced removal from the aircraft due to problems. For these reasons, the CPC had been used for 7,223 hours and 36 minutes before the serious incident took place. The CPC had never been removed from the aircraft during the company's previous regular maintenance operations.

2.7 Meteorological Information

(1) The aeronautical meteorological observation data for Miyazaki Airport around the time of the serious incident and one hour after that timing was as follows:

18:00 Direction of wind...280°; Velocity of wind...8 knots; Prevailing visibility...3,000 m; Current weather...light rain and haze; Clouds: amount...1/8, type...cumulus, ceiling...1,000 ft; amount...4/8, type...cumulus, ceiling...2,000 ft; amount...7/8, type...stratocumulus, ceiling...3,000 ft; Temperature...9°C; Dew point...7°C; Altimeter setting (QNH)...29.62 in. Hg

19:00 Direction of wind...270°; Velocity of wind...4 knots; Prevailing visibility...15 km or more; Clouds: amount...1/8, type...cumulus, ceiling...2,000 ft; amount...4/8, type...stratocumulus, ceiling...4,500 ft; amount...7/8, type...altocumulus, ceiling...7,000 ft; Temperature...9°C; Dew point...8°C; Altimeter setting (QNH)...29.63 in. Hg

(2) The observation data in the aviation weather report by Tokyo International Airport around the time of the serious incident and one hour after that timing was as follows:

18:00 Direction of wind...40°; Velocity of wind...18 knots; Prevailing visibility...15 km or more; Clouds: amount...7/8, type...stratocumulus, ceiling...2,200 ft; Temperature...6°C; Dew point...1°C; Altimeter setting (QNH)...29.92 in. Hg; Wind shear...on Runway 34L

19:00 Direction of wind...40°; Velocity of wind...16 knots; Prevailing visibility...20 km or more; Cloud: amount...7/8, type...stratocumulus, ceiling...2,000 ft; Temperature...6°C; Dew point...1°C; Altimeter setting (QNH)...29.89 in. Hg

(3) The aerodrome advisory issued by the Miyazaki Airport's Weather Observatory for 09:00 to 21:00, February 24, 2005 included low-level wind shear, but was subsequently canceled at 18:00.

2.8 Information on DFDR and Cockpit Voice Recorder

The aircraft was equipped with a DFDR (P/N 980-4100-DXUS) and a cockpit voice recorder (P/N 980-6020-001; hereafter called "CVR"), both made by Honeywell Inc. of the United States of America.

The DFDR retained all the data recorded during the serious incident. However, the DFDR which was equipped to the aircraft does not record cabin altitude. The CVR on the aircraft was capable of repeated 30-minute recording; the recorded data during the serious incident was overwritten and erased as the aircraft continued operation after the serious incident.

2.9 Information on the Serious Incident Site

2.9.1 Location of the Serious Incident Site

The serious incident occurred in the air, at approx. 33,700 ft above the sea, approx. 170 km east-northeast of Kushimoto VORTAC.

(See Figure 1)

2.9.2 Aircraft Conditions at the Time of the Serious Incident as Derived from DFDR Records

The DFDR records included no parameters showing abnormalities regarding the aircraft's cabin pressurization system at the time of the serious incident.

2.9.3 Aircraft Conditions After Landing at Miyazaki Airport

The oxygen masks near the CA seat in the right aft cabin were deployed and entangled with each other. Also, of the two blowout panels located in the ceiling of the aft cargo compartment, the forward panel was slightly open.

(See Figure 3 and Photos 1 and 2)

2.10 Fact-Finding Tests and Research

Investigation was carried out in terms of the following aspects.

2.10.1 Soundness of the Aircraft Wiring Related to the Cabin Pressurization System

In order to assess the soundness of the aircraft wiring related to the cabin pressurization system, the wiring was tested for continuity and insulation as per the company's maintenance manual. No abnormalities were found.

2.10.2 Airtightness

As per the company's maintenance manual, the aircraft was checked for excessive air leakage. Leakage was found through the entry, service and cargo doors, and at multiple drain ports in the bottom of the airframe. No leakage was found elsewhere, including skin panel joint area.

2.10.3 Soundness of Cabin Pressurization System Components

In order to assess the soundness of the cabin pressurization system components, those that were on the aircraft at the time of the serious incident (i.e., the CPC, mode selector panel, forward outflow valve, cabin pressurization outflow valve, and two safety relief valves) were removed from the aircraft and investigated in detail as per the company's maintenance manual.

None of the components investigated showed any functional abnormalities. In terms of physical condition, all the components were normal except the CPC.

External and internal visual inspection conducted on the CPC revealed that the top surface of the CPC case had partially turned brown and one of the CPC component circuit boards was also partially discolored.

The circuit board was related to the control system of both "AUTO MODE" and "STBY MODE."

2.10.4 CPC Circuit Boards

The CPC was located on the equipment rack (hereafter called "the E-1 rack") in the aircraft with the CPC circuit boards in a vertical position.

In the discolored portion of the CPC circuit board mentioned in Section 2.10.3 above, there existed a contamination that would have leaked onto it from outside and dried there. The deposit consisted primarily of the following components: nickel, tin, potassium, calcium, sulfur, chlorine, sodium, magnesium, copper, zinc, carbon, and oxygen.

2.10.5 Condition of the Inside of the E-1 Rack

Around the location of the aircraft where the CPC was installed, there are wastewater pipes from the forward galley and forward lavatory. There was no sign of water leakage from these pipes.

The waterproof sheet provided between the pipes and the top of the E-1 rack on which the CPC was installed in such a way that it would have prevented water from leaking into the CPC even if the piping had been leaky.

The company inspected all its aircraft of the same type as the aircraft involved in the serious accident, and found no sign of water leakage in the area in question.

(See Photos 3, 4 and 5)

2.11 Other Relevant Information

2.11.1 History of Past Failures of the Cabin Pressurization System on the Aircraft

The flight logbook was reviewed for in-flight failures of the system dating back for a period of approx. three months from February 24, 2005. The review revealed one case of failure, which is described below.

Details of the failure:

On February 18, 2005, when the aircraft was at an altitude of approx. 2,400 feet during a landing descent with the cabin pressurization system in "AUTO MODE," the first officer had an uncomfortable feeling in his ear. He checked the cabin pressurization system mode selector panel and found that the cabin pressurization outflow valve was fully open, rendering cabin pressure equal to the outside pressure. There was no caution or warning alarm accompanying the event. After landing, the cabin pressurization system functioned normally.

Maintenance action:

Prior to the above-mentioned event, the cabin pressurization system on the aircraft had not experienced any failures. During the event, no related caution or warning alarm was activated. The maintenance crew that subsequently inspected the system on the ground found no abnormalities and, therefore, did not take any further action.

2.11.2 Pressure Equalization Valves and Blowout Panels

The maintenance manual applicable to the aircraft says as follows:

The aircraft is equipped with a Pressure Equalization Valve and two Blowout Panels in each cargo compartment(forward and aft). During flight, it is designed that between the cargo compartments(forward and aft) and the cabin have almost separated flow of air, but the Pressure Equalization Valve keeps no large differential pressure between them. If there is a sudden pressure change in either or both the cabin and the cargo compartment(forward and aft) and the difference between the two pressures reaches approx. 1 psi or more, one or both of the two blowout panels provided in each fwd/aft cargo compartment open(s) depending on the magnitude and changing rate of the pressure difference, in order to cancel out the pressure difference and thus protect the airframe structure.

(See Figure 3)

2.11.3 Procedures to Follow in the Event of Rapid Depressurization in Flight

The following is described in Chapter 8 Emergency Action, 8-3 Required Action in Emergency, 8-3-1 Equipment Failure, 2. Cabin Pressurization System Failure of the Operations Manual (hereafter called "OM") of the company. (Extracts)

If decompression occurs in flight due to cabin pressurization system failure or damage to the aircraft, the following shall be applied:

(1) Actions the flight crew must take

*① The pilot-in-command must immediately lower the aircraft to 10,000 ft or the MEA[*4], whichever is highest, in accordance with the procedure specified in the Airplane Operations Manual.*

If the situation requires the aircraft to descend to or below the MEA, the target altitude shall never be lower than 2,000 ft above any obstacle in the flight path.

② When making a descent as mentioned in ① above, the pilot-in-command must pay maximum attention to avoid collision while at the same time ensuring prompt communication with ATC.

③ Upon leveling off following the emergency descent, the pilot-in-command must promptly notify the cabin crew of the current state.

In addition, when the cabin altitude has dropped to 10,000 ft or below, the pilot-in-command must notify the cabin crew that the passengers no longer need to use oxygen.

(2) Actions the cabin crew must take

① If the oxygen masks deploy as a result of a drop in the cabin pressure, each cabin crewmember must immediately put on a nearby mask and take a close-by seat.

② Upon leveling off following an emergency descent, the cabin crew must check the condition of the passengers and have those who no longer need oxygen supply take off their masks while giving necessary first aid as conditions require.

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*4 According to AIM-J(Aeronautical Information Manual - Japan), MEA(minimum en-route altitude) is the lowest published altitude between radio fixes which assures acceptable navigational signal coverage and meets obstacle clearance requirements between those fixes.

2.11.4 Procedures to Follow in the Event of Cabin Altitude Warning Horn Activation / Rapid Depressurization and Emergency Descent

Chapter 4 Operation in Emergency or System Failure (separate volume) of the Airplane Operations Manual (hereafter called "AOM") of the company describes the procedures under "CABIN ALTITUDE WARNING OR RAPID DEPRESSURIZATION" and "EMERGENCY DESCENT." The following is an extract from the manual.

CABIN ALTITUDE WRNING OR RAPID DEPRESSURIZATION

Condition: One or more of the following conditions exist(s).

- *The cabin altitude warning horn sounds.*
- *There is rapid loss of cabin pressure with the airplane altitude above 14,000 ft.*

OXYGEN MASKS AND REGULATOR ....ON, 100% PLT[*5]

CREW COMMUNICATIONS..............................ESTABLISH PLT

PRESSURIZATION MODE SELECTOR ....MAN[*6] *PNF*

OUTFLOW VALVE SWITCH ....CLOSE PNF

If pressurization is restored, continue manual operation to maintain proper cabin altitude.

PASSENGER SIGNS...ON PNF

If cabin altitude is uncontrollable:

Activate passenger oxygen if cabin altitude exceeds or is expected to exceed 14,000 ft.

Perform the EMERGENCY DESCENT checklist if the airplane is above 14,000 ft MSL[*7] *and control of cabin pressure is not possible, or cabin pressure is lost.*

EMERGENCY DESCENT

Condition: Unable to control cabin pressure with airplane above 14,000 ft MSL or conditions require a rapid descent.

EMERGENCY DESCENT..................................ANNOUNCE PF

The captain will advise the passenger cabin, on the PA system, of impending rapid descent. The first officer will advise ATC and obtain the area altimeter setting.

[*5] In Chapter 2 Normal Operation of the AOM, "PLT" is defined as all flight crewmembers.

[*6] In Chapter 0 General of the AOM, "MAN" is defined as MANUAL. In the above context, "MAN" should denote "MANUAL AC MODE" or "MANUAL DC MODE."

[*7] According to AIM-J, "MSL" is an acronym for Mean Sea Level.

(From "ENGINE START SWITCHES" to "TARGET SPEED" skipped.)

LEVEL-OFF ALTITUDE.....................................LOWEST SAFE ALTITUDE OR 10,000 FT, whichever is higher PF

(From "SPEED BRAKE" to "ENGINE START SWITCHES" skipped.)

The new course of action is based on weather, oxygen, fuel remaining and available airports. (hereafter omitted)

2.11.5 Conditions Causing AUTO FAIL Light to Illuminate

The Auto Mode Operation (CPCS) section in 8-2-40 Pressurization System Description, Chapter 8 Systems of the AOM of the company includes the following description regarding the "AUTO FAIL" light. (Extract)

The amber AUTO FAIL light comes on if any one of the following conditions occurs:

- *Loss of AUTO AC power*
- *Excessive rate of cabin pressure change (1890 ft/min at sea level)*
- *High cabin altitude (13,875 ft)*

The pressure controller automatically shifts into STANDBY mode as soon as the AUTO FAIL light comes on, but the Pressurization Mode Selector remains in AUTO. Positioning the Mode Selector to STBY extinguishes the AUTO FAIL light.

2.11.6 Hyperventilation and Hypoxia

Chapter VI HUMAN SAFETY in the EMERGENCY HANDBOOK used by the Cabin Crew in the company includes the following description outlining hyperventilation and hypoxia. (Extract)

1. HIGH ALTITUDE PHYSIOLOGY (AVIATION MEDICINE)

1) (Skipped)

2) Hypoxia

(2) How hypoxia relates to breathing and blood flow

We know that a decrease in the amount of oxygen in the air breathed in leads to a range of disorders. Apart from climbing a high mountain or being aboard an airplane, a person who experimentally breathes in air (artificially made gas by mixing helium or nitrogen with oxygen) with a 10% oxygen content, or about half the normal oxygen content, experiences increased pulse and breath rate, or high blood pressure. If he/she breathes in such air for an extended time, decrease in consciousness level, lips turning blue, or *difficulty in moving limbs will result.*

3) (Skipped)

4) Others

(1) Hyperventilation

① *Symptoms*

Some typical symptoms include headache, dizziness, tunnel vision, lightheadedness and stiff limbs.

② (Skipped)

③ *Hyperventilation and hypoxia*

Both hypoxia and hyperventilation reduce the pilot's ability to control the aircraft, but these syndromes result from different causes and therefore require different treatment. However, they have a close causal relationship and some factors in common, which very often makes it difficult to distinguish between them. First, remember that they produce similar symptoms. If you are uncertain whether the problem is hyperventilation or hypoxia, use the following tips rather than taking a long time to make a determination.

④ *Treatment for hyperventilation*

If the disordered person is obviously suffering from hyperventilation, holding his/her breath for a while will help. However, hyperventilation may often accompany hypoxia as described in another part of this handbook; in such a case, breath holding will only aggravate hypoxia. For this reason, if it is uncertain whether the difficulty is hyperventilation or hypoxia, use the following method:

First, select the 100% position for regular oxygen supply and then have the person inhale deeply and hold his/her breath. This should have an effect on recovery if the cause is hyperventilation.
If this fails to improve the condition, then other causes should be sought.

3. ANALYSIS

3.1 The pilot-in-command and the first officer of the aircraft both possessed proper airman competency certification and a valid aviation medical certificate.

3.2 The aircraft had been certified for airworthiness and had been maintained/inspected in accordance with the specified program.

3.3 Based on the facts listed below with regard to the process leading to rapid depressurization while the aircraft was in ascent, it is estimated that the cabin altitude reached approx. 10,000 feet when the aircraft was at FL347 while in a climb, thus triggering the cabin altitude warning horn, and then the cabin altitude reached 14,000 feet one minute or less later, and the cabin oxygen masks deployed automatically; it is also estimated that by that time, the aircraft reached an altitude almost equal to the target altitude of FL350 and was in the process of transition to cruising.

(1) The DFDR records discussed in 2.1.1 show that, at 18:05:15, the cabin altitude warning horn in the cockpit was activated when the aircraft was at FL347 while in a climb.

(2) As discussed in 2.6.2, the cabin altitude warning horn was activated when the cabin altitude reached approx. 10,000 feet.

(3) As discussed in 2.1.2 (1), the pilot-in-command stated that the oxygen masks in the cabin were automatically deployed soon after the cabin altitude warning horn was activated and that the rate of cabin altitude change at that time was approx. 4,000 feet/minute.

(4) As discussed in 2.6.3, the oxygen masks in the cabin were automatically deployed at a cabin altitude of approx. 14,000 feet.

3.4 Based on the discussions in 2.1.1 (1) and 2.1.2 (2), it is estimated that, faced with rapid depressurization while in a climb, the pilot-in-command and the first officer donned oxygen masks, switched the cabin pressurization system to "MANUAL AC MODE" and operated the cabin pressurization outflow valve towards the closing direction in accordance with the OM procedure discussed in 2.11.3 and the AOM procedure in 2.11.4, while at the same time making an emergency descent to FL140, followed by a descent to a final altitude of 10,000 feet.

3.5 As discussed in 2.1.1, the ATC communications record indicates the following: The flight crew of the aircraft contacted Fukuoka Control at 18:42, stating that the aircraft was maintaining FL140; Fukuoka Control responded with notification of a QNH 29.60 inches Hg.

The lowest usable flight level[*8] for the QNH 29.60 inches Hg in Instrument Flight Rules is FL150, and the Air Traffic Control Procedures says that aircraft shall cruise either at FL150 or higher, or 13,000ft or lower. However, considering the condition in which the aircraft had to declare an emergency and make descent, it is not considered inappropriate to continue to fly at FL140 although it deviated from the rules. But on the one hand, approval of flight at FL140 based on a request from the captain means approval of flight at 29.92inHg, on the other hand, there was a possibility to cause a confusion about which reference should be used in flight. Therefore it was considered appropriate that Fukuoka Control explain their intention to notify QNH to the aircraft flying at FL140.

3.6 According to the relevant procedure specified in Chapter 4 Operation in Emergency or System Failure of the AOM as discussed in 2.11.4, if rapid depressurization occurs with the aircraft above 14,000 feet, the flight crew must commence a descent to a safe altitude and then the pilot-in-command should make decisions on the items listed in the AOM with regard to subsequent flight.

It is estimated that the pilot-in-command concluded that it was not necessary to make an emergency landing at the nearest airport and would continue the flight on to Miyazaki Airport after having reviewed all the relevant aspects listed below.

(1) As discussed in 2.1.2 (1), the pilot-in-command was informed by the CP that the cabin crewmembers and the passengers were all right.

(2) The cabin altitude had eventually stabilized at or below 10,000 feet.

(3) The aircraft had sufficient fuel remaining in the tank.

(4) As discussed in 2.7, the atmospheric low was moving east and also, while the weather at Miyazaki Airport was not favorable when the pilot-in-command checked, the weather there was forecast to have improved by around 19:00, the expected arrival time.

(5) Although a wind shear warning had been issued for both Tokyo International Airport and Miyazaki Airport, the pilot-in-command deemed that wind shear would no longer be a problem by the time they arrived at Miyazaki.

3.7 Because the results of investigation discussed in 2.10.1, 2.10.2, and 2.10.3 did not provide data having a bearing on the problem, and because the functional abnormalities of the aircraft

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[*8] According to AIM-J, the "lowest usable flight level" is the flight level determined for each QNH altimeter setting to ensure safe vertical separation between aircraft flying in the QNH airspace and in the flight-level airspace even when the local atmospheric pressure drops to or below the standard atmospheric pressure. And according to the Air Traffic Control Procedure Manual, published by the Civil Aviation Bureau, Ministry of Land, Infrastructure and Transport, the lowest usable flight level in the case of QNH 29.60inHg is FL150.

and its equipment could not be reproduced, it was not possible to clarify the process through which rapid depressurization took place during the aircraft's climb and then the cabin pressure control system of the aircraft restored.

However, the following facts may be suggestive of the factors contributing to the process:

(1) As discussed in 2.1.2 (1) and (2), both the pilot-in-command and the first officer stated that there had been no other abnormality indications before, during or after the series of cabin pressurization system alarms.

(2) As discussed in 2.9.2, the DFDR records included no abnormal parameters related to the aircraft's cabin pressurization system.

(3) As discussed in 2.1.2 (3), immediately before the rapid depressurization, the B Area Attendant heard a loud "hissing" noise coming from the lower right area behind the galley.

(4) As discussed in 2.3, after the aircraft arrived at Miyazaki Airport, the forward one of the two blowout panels located in the ceiling of the aft cargo compartment was found to be slightly open.

(5) As discussed in 2.1.2 (2), after the occurrence of rapid depressurization and while the aircraft was in an emergency descent, the first officer switched the cabin pressurization system to "MANUAL AC MODE" and operated the cabin pressurization outflow valve towards the closing direction. Subsequently, he could set a cabin altitude of 6,000 feet after the aircraft had reached an altitude of 10,000 feet.

(6) As discussed in 2.11.1, six days before the serious incident, the aircraft experienced sudden and full opening of the cabin pressurization outflow valve at approx. 2,400 feet during a landing descent but the system returned to normal after landing.

When putting together the above facts, it is considered possible that the following series of events occurred:

When the aircraft was climbing from FL310 to FL350, the cabin pressurization outflow valve opened suddenly and excessively, which allowed a substantial amount of cabin air to flow out of the aircraft through the valve. As a result, the pressure difference between the cabin and the aft cargo compartment increased quickly and caused the forward one of the two blowout panels in the ceiling of the aft cargo compartment to open. Also, a substantial amount of cabin air discharging through the cabin pressurization outflow valve generated a "hissing" sound, which was heard from the lower right area behind the galley where the valve was located.

It is considered that the rapid depressurization resulting from excessive opening of the cabin pressurization outflow valve raised the cabin altitude at a rapid rate, and when it reached 14,000ft the oxygen masks in the cabin automatically deployed.

It is also considered that the cabin pressurization system could have been controlled when the system was placed in "MANUAL AC MODE."

3.8 Regarding the past failure experienced by the aircraft, as discussed in 2.11.1, it is considered likely that the caution/warning alarms were not activated because the aircraft was approaching airport and already at low altitude and the "AUTO FAIL" light illumination condition discussed in 2.11.5 was not satisfied created although the cabin pressurization system was in "AUTO MODE" at that time. On the other hand, regarding the rapid depressurization in this serious incident, it is considered likely that at least the "High Cabin Altitude (13,875 feet)" condition was satisfied for the "AUTO FAIL" light illumination. It is estimated that, with the illumination of the "AUTO FAIL" light, the CPC automatically switched to "STBY Mode," causing the "STBY" light to come on.

3.9 As to the sudden and excessive opening of the cabin pressurization outflow valve, the following are considered, but it was not possible to clarify the process.

(1) From the condition of the inside of the E-1 rack discussed in 2.10.5, the location of the CPC on the E-1 rack near the wastewater pipes from the forward galley and lavatory, and the results of analysis of the contamination of the CPC circuit board as discussed in 2.10.4, it is considered possible that the contamination was comprised of urine and calcium hypochlorite. The latter is usually added to flush water for cleanliness and deodorization of the lavatory.

(2) From what is mentioned in (1) above, it is considered possible that the contamination on the circuit board was drops of wastewater that leaked from the forward lavatory piping and dripped onto the CPC, then fell onto the circuit board through a CPC air vent and contaminated this vent. However, because there was no evidence of water leakage from the piping in the aircraft or in other aircraft of the same type that the company operates, and because a waterproof sheet was installed between the piping and the CPC as revealed by the inspection discussed in 2.10.5, it is considered likely that the contamination was not formed after the company started using the aircraft.

(3) For the reasons enumerated below, it is considered possible that wastewater, which was part of the small amount of wastewater that had dripped onto the CPC case, made its way onto the circuit board and dried there during the time that the aircraft was operated by the previous operator and the CPC was transferred to another aircraft that had a similar forward lavatory layout; subsequently, the dried wastewater gradually corroded the circuit board.

- As discussed in 2.6.4, the CPC possibly experienced long-time use before its installation on the aircraft and the company did not modify the forward galley or lavatory specifications since placing the aircraft into operation.
- As discussed in (1) above, it is considered possible that the contamination on the

upper section of the CPC case and on one of the CPC component circuit boards consists of urine and calcium hypochlorite.

- As discussed in (2) above, it appears likely that the contamination was not formed after the company started using the aircraft.

(4) It is considered likely that the circuit board in question, which constituted a component of the CPC that was subsequently installed back in the aircraft and was related to "AUTO MODE" and "STBY MODE" control as discussed in 2.10.3, had deteriorated to an extent that would not have been sufficient to cause a permanent cabin pressurization system fault, but would have been sufficient for the CPC to output uncontrolled signals to the cabin pressurization outflow valve and in turn cause the valve to open excessively whenever moisture and other conditions around the CPC change even slightly to satisfy a fault-causing condition during flight.

This assumption agrees with what is described in 2.1.2 (2) and 2.11.1 of the two faults that occurred within a period of a week, both in "AUTO MODE."

3.10 It is estimated based on the statements made by the first officer in 2.1.2 (2) and by the CP and CAs in 2.1.2 (3) that the pilot-in-command did not announce to the cabin over the PA system that an emergency descent was to be performed as per the "EMERGENCY DESCENT" procedure discussed in 2.11.4, while the rapid depressurization triggered the automatic emergency descent announcement.

3.11 As 2.1.2 (3), the C Area Attendant stated that, during the emergency descent, she tried to put on an oxygen mask that had deployed right in front of her but because the cord of the mask was entangled with the cord of another mask, she was prevented from wearing it. Not being able to quickly put on an oxygen mask in an immediate emergency could have the risk of hypoxia.

Oxygen masks must be properly inspected and stowed in accordance with the relevant maintenance manual.

3.12 As 2.1.2 (3), the CP stated that he thought that Passenger A was suffering from hypoxia after the occurrence of rapid depressurization and therefore promptly administered first aid accordingly. Later, a doctor who examined Passenger A diagnosed him as suffering from hyperventilation.

As discussed in 2.11.6, hyperventilation and hypoxia sometimes have similar symptoms; this requires CPs to carefully follow the relevant instructions in the EMERGENCY HANDBOOK and use caution in determining the condition. In addition, since the causes and treatments differ greatly between the two, an effective safety measure is to seek advice and/or help from a doctor who may be onboard.

4. PROBABLE CAUSE

It is considered that the serious incident was caused by rapid cabin depressurization that resulted from sudden and excessive opening of the cabin pressurization outflow valve during the flight.

While it was not possible to establish the cause of the sudden excessive opening of the cabin pressurization outflow valve, it is considered possible that the contamination deposit on a circuit board of the cabin pressurization system deteriorated the board over time to the extent that it caused the electrical circuitry to malfunction.

5. REFERENTIAL MATTERS

After the serious incident, the company put in place improvements including the following for operation of the aircraft involved in the incident and all aircraft of the same type that it owns.

(1) The cabin oxygen masks including those for the cabin crew were rechecked for automatic deployment function and stowage, on all aircraft that the company operates.

(2) The Cabin Crew Manager issued a company notice to all cabin crewmembers on the correct method for distinguishing hypoxia and hyperventilation. The contents of the notice were added to the EMERGENCY HANDBOOK.

(3) The Flight Operations Manager notified all cockpit crewmembers of the serious incident and the company reviewed the relevant procedures for necessary amendments.

Figure 1 Estimated Flight Route

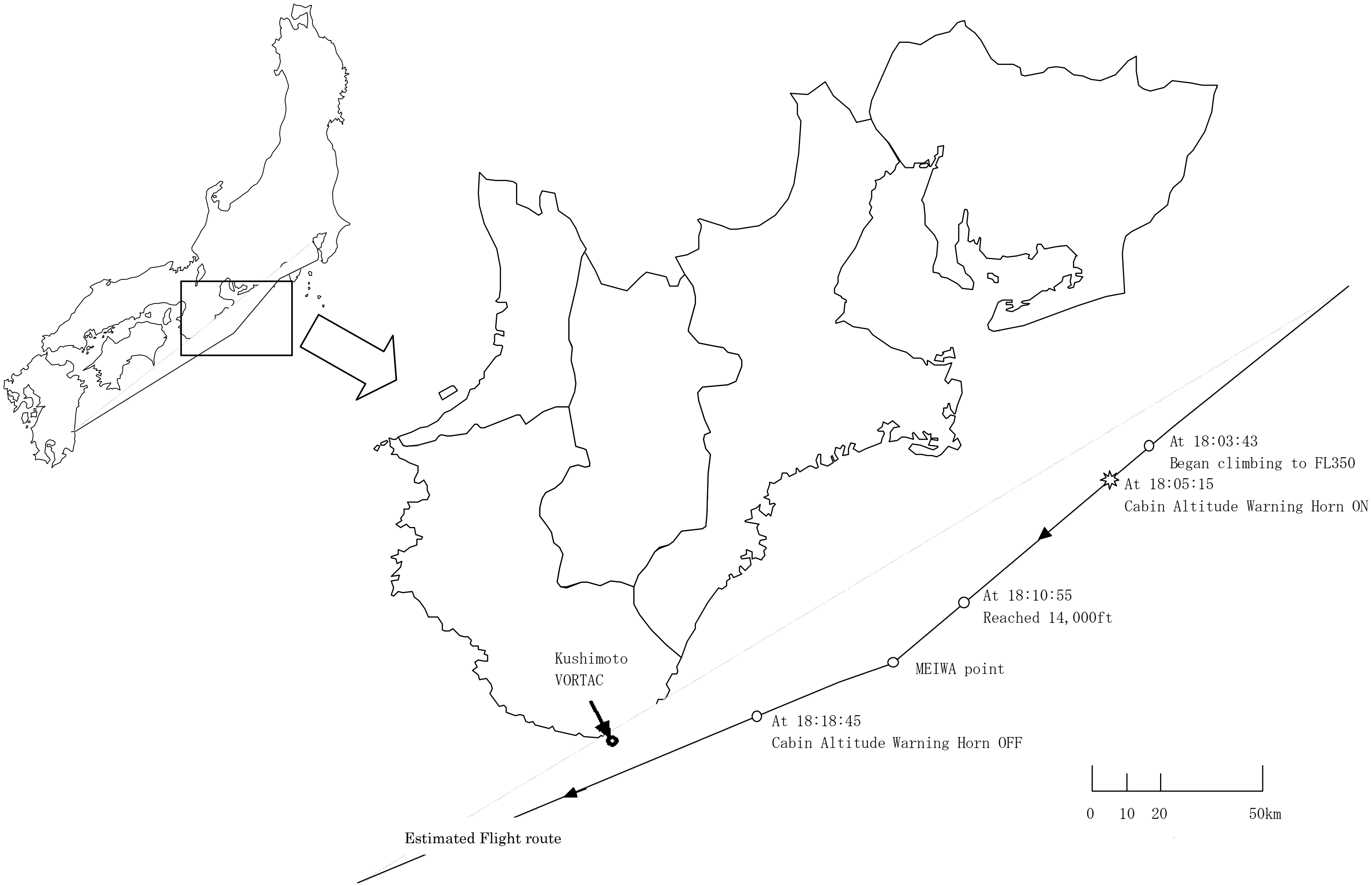

Figure 2　Three angle view of Boeing 737-400

Unit : m

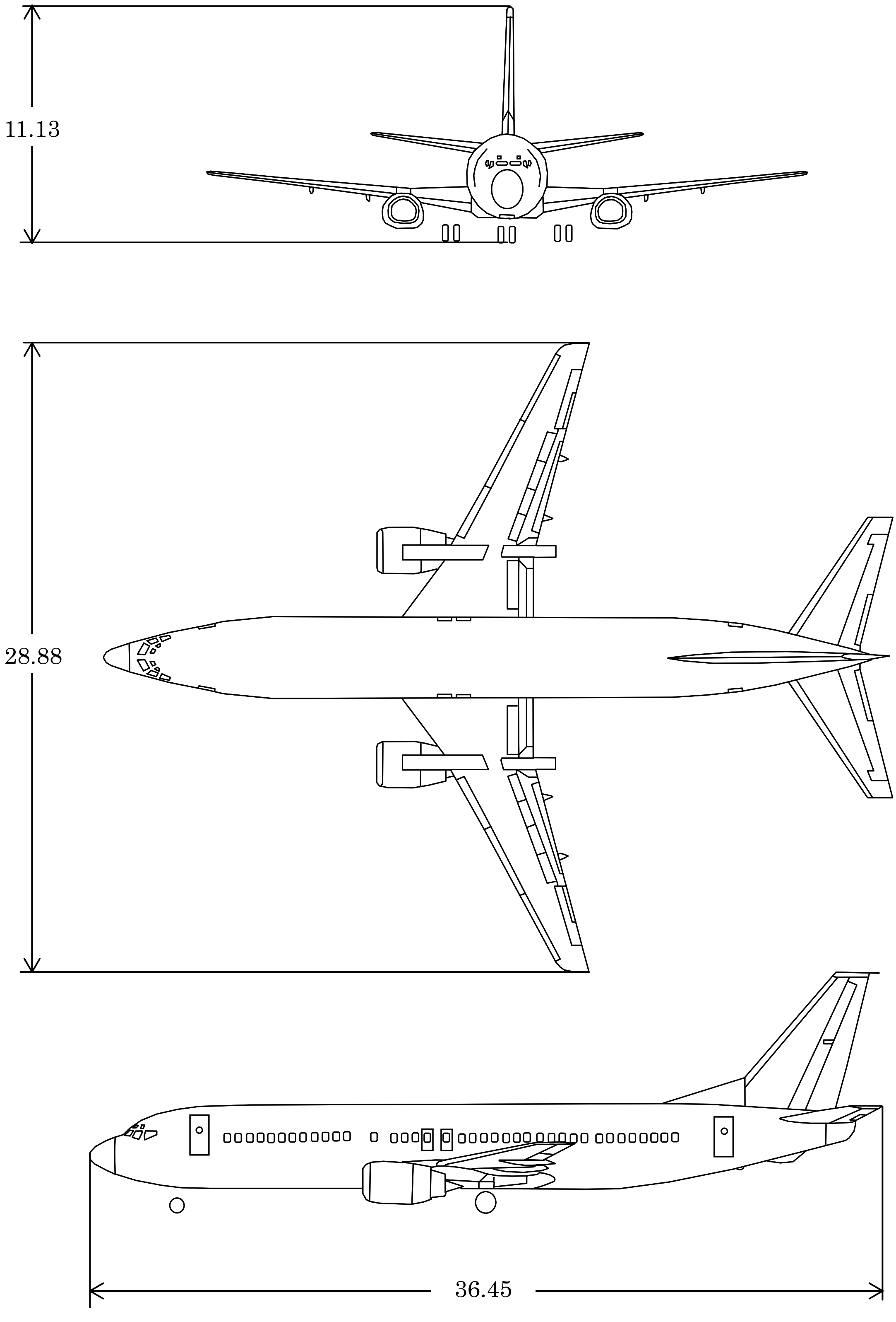

Figure 3　Aft Cargo Compartment

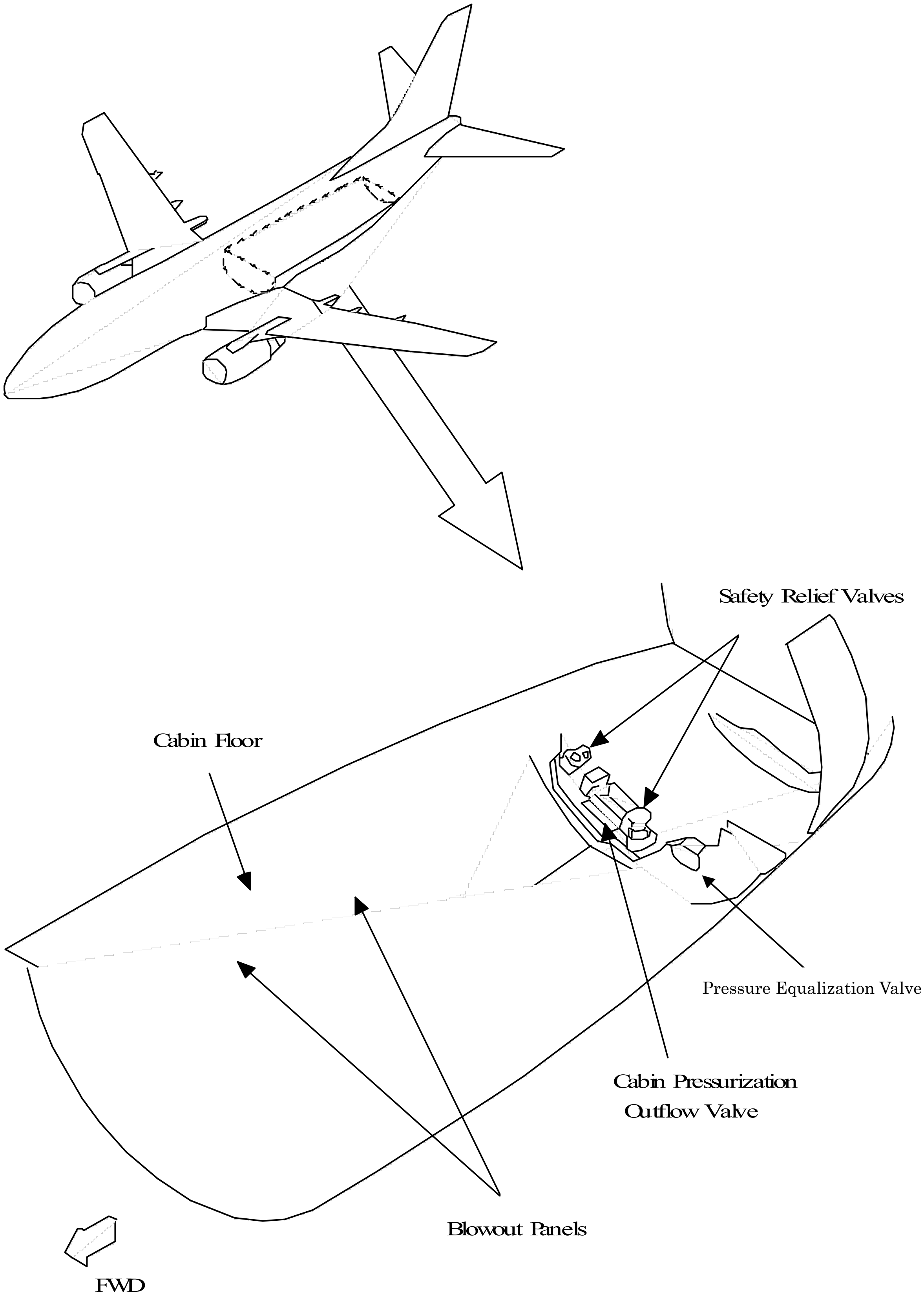

Photo 1　Intertwined two Oxygen Masks

Photo 2　Unclosed Forward Blowout Panel

Photo 3　Upper Housing of ＣＰＣ

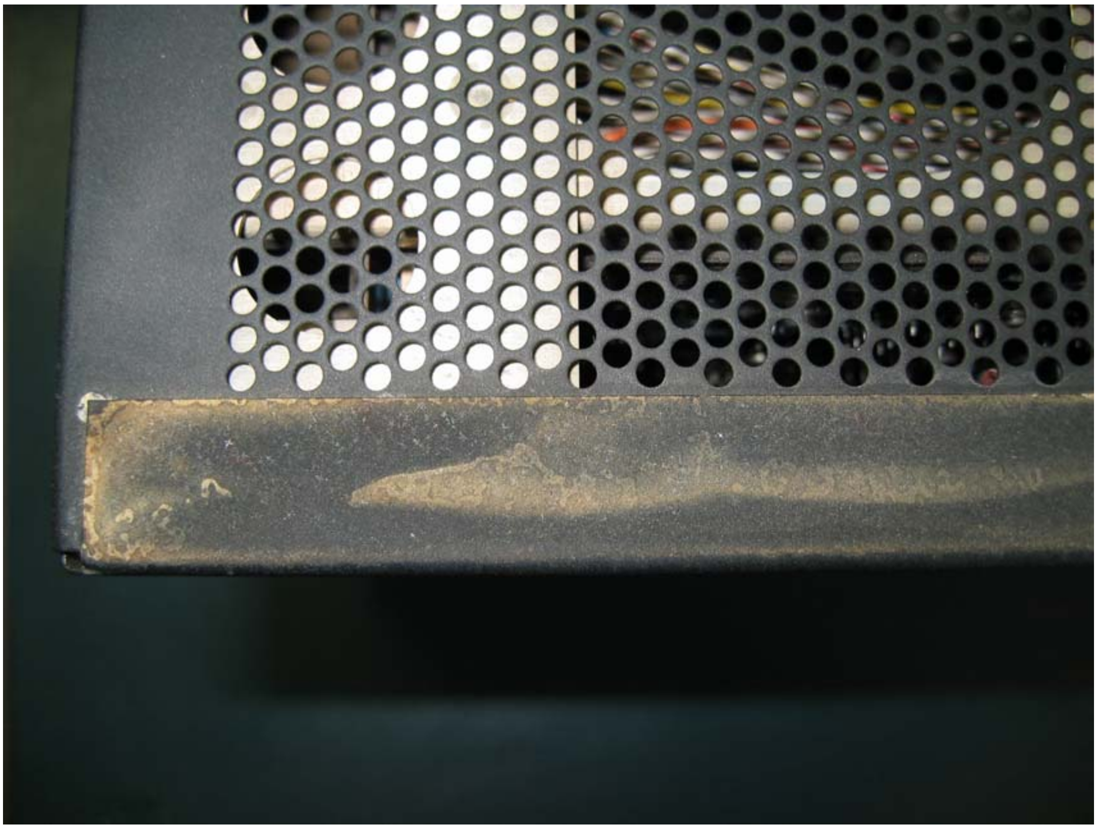

Photo 4　The circumference of the upper part of CPC

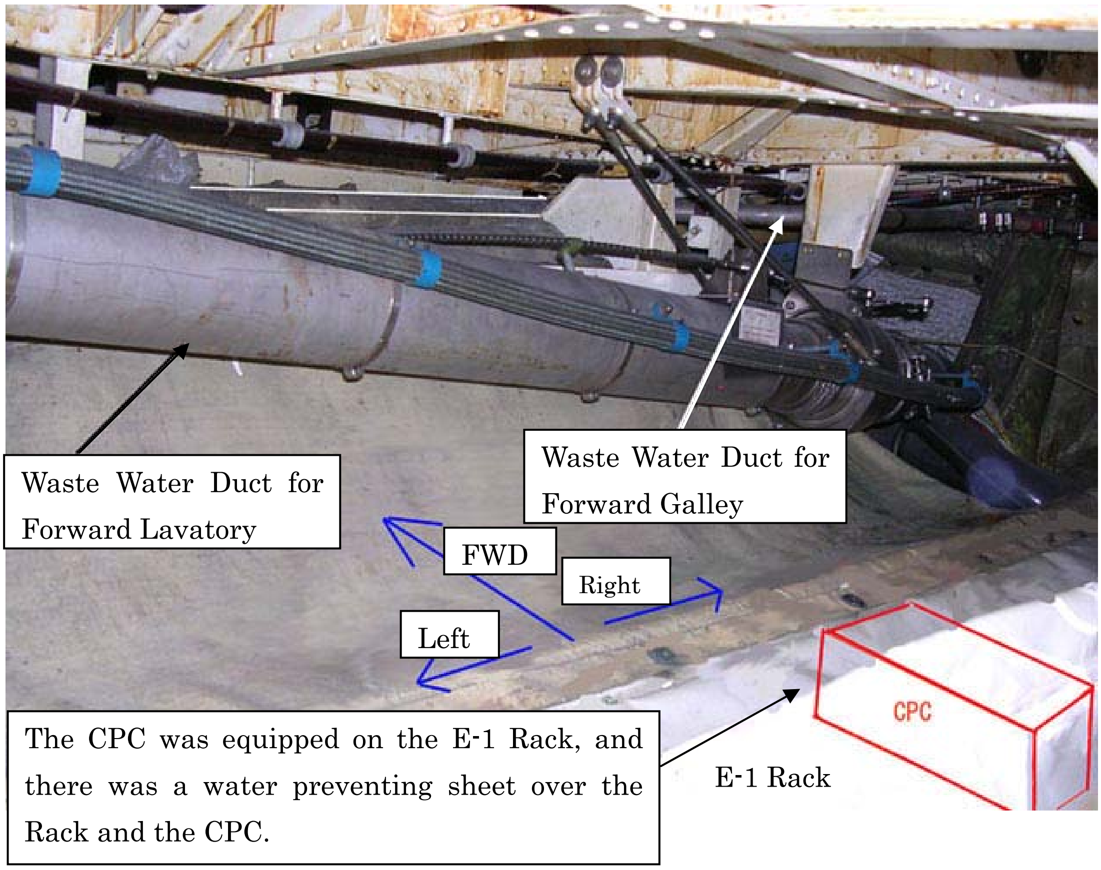

Photo 5　Contamination of Circuit Board