Aviation and Railway Accident Investigation Board

Repot No. ARAIB/AIR-1001

AIRCRAFT SERIOUS INCIDENT REPORT

EMERGENCY USE OF OXYGEN BY THE FLIGHT CREW
ASIANA AIRLINES
A321-231, HL7730
300 NM SOUTH OF THE KANSAI INTERNATIONAL AIRPORT, JAPAN
16 JANUARY 2010

16 FEBRUARY 2011

AVIATION AND RAILWAY ACCIDENT INVESTIGATION BOARD
MINISTRY OF LAND, TRANSPORT AND MARITIME AFFAIRS
REPUBLIC OF KOREA

According to the provisions of the Article 30 of the Aviation and Railway Accident Investigation Act of the Republic of Korea, it is stipulated;

The accident investigation shall be conducted separately from any judicial, administrative disposition or administrative lawsuit proceedings associated with civil or criminal liability.

And in the Annex 13 to the Convention on International Civil Aviation, Paragraphs 3.1 and 5.4.1, it is stipulated and recommended as follows;

The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents, and it is not the purpose of the activity to apportion blame or liability. Any judicial or administrative proceedings to apportion blame or liability should be separate from any investigation conducted under the provisions of this Annex.

Thus, this investigation report issued as the result of the investigation on the basis of the Aviation and Railway Accident Investigation Act of the Republic of Korea and the Annex 13 to the Convention on International Civil Aviation, shall not be used for any other purpose than to improve aviation safety.

In case of divergent interpretation of this report between the Korean and English languages, the Korean text shall prevail.

Aircraft Serious Incident Report

Aviation and Railway Accident Investigation Board. Emergency use of oxygen by the flight crew, Asiana Airlines, A321-231, HL7730, 300 NM south of Kansai International Airport, Japan, 16 January 2010. Aircraft Serious Incident Report ARAIB/AIR-1001. Seoul, Republic of Korea

The Aviation and Railway Accident Investigation Board (ARAIB), Republic of Korea, is a government organization established for independent investigation of aviation and railway accidents, and the ARAIB conducts accident investigation in accordance with the Aviation and Railway Accident Investigation Act of the Republic of Korea and Annex 13 to the Convention on International Civil Aviation.

The objective of the investigation by the ARAIB is not to apportion blame or liability but to prevent accidents and incidents.

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Contents

Emergency use of oxygen by the flight crew

Asiana Airlines, Republic of Korea
A321-231, HL7730
300 NM south of the Kansai International Airport, Japan
Latitude: N 30° 00′ 12″, Longitude: E 137° 14′ 18″
16 January 2010, about 05:22 (20:22 UTC)[1)]

Synopsis

On 16 January 2010 at about 05:22, the Asiana Airlines Flight 119 (A321-231, registration HL7730, hereinafter referred to as "HL7730"), which departed the Saipan International Airport, United States of America, for the Kansai International Airport, Japan, was cruising at an altitude of 37,000 feet, when it made an emergency descent due to the sharp increase[2)] of the cabin pressure altitude near the way point TAXON (over high seas about 300 NM from the Kansai International Airport), and after the emergency descent it continued to fly at 10,000 feet and landed at the Kansai International Airport.

The HL7730 was a scheduled international passenger service flight which departed the Saipan International Airport for the Incheon International Airport via a stopover point the Kansai International Airport. A total of eight (8) crew members including the captain and fifty one (51) passengers were on board at the time, but there was no injury to persons on board and no damage to aircraft due to this incident.

This event occurred over high seas and constitutes a serious incident under the Enforcement Regulation of Aviation Act, Republic of Korea, Article 8. The Aviation and Railway Accident Investigation Board (hereinafter referred to as "ARAIB") instituted investigation pursuant to ICAO Annex 13 5.3 and the Aviation and Railway Accident Investigation Act, Republic of Korea, Article 18, and notified ICAO and the BEA of France pursuant to ICAO Annex 13 4.1.

The ARAIB determines that the cause of Emergency use of oxygen by the flight crew, Asiana Airlines, was that 「the seal of the right air conditioning pack valve duct were damaged, hot air leaked, and because of this the left and right air conditioning

1) Unless otherwise indicated, all times in this report are Korea Standard Time (KST, UTC+9).
2) Decrease of cabin pressurization

pack valves were closed. So that the regulating function of the cabin pressure altitude was lost, and cabin pressure altitude increased. The flight crew put on the oxygen masks and executed an emergency descent according to the specified procedures.」

Contributing to this serious incident was that 「Both left and right air leak detection loops are located in the pack bay made of one compartment, so if air leaked from the pack duct on either side, depending on the direction, shape and flow of the air leakage, both air leak detection loops might be able to detect the leaked air.」

As a result of its investigation of this serious incident, the ARAIB makes safety recommendations to the Asiana Airlines and to the Airbus Industries, France.

1. Factual Information

1.1 History of Flight

The HL7730 with eight crew and 51 passengers on board departed Saipan International Airport at about 02:55 and was cruising under visual flight conditions at an altitude of 37,000 feet on the preplanned route.

At about 05:22 when the HL7730 was passing near the way point TAXON (over high seas about 300 NM south of the Kansai International Airport), "AIR L WING LEAK" was displayed on ECAM[3] and at the same time “ENG 1 BLEED FAULT” and “PACK 1 FAULT” were displayed.

While the flight crew were taking ECAM action on this, “AIR R WING LEAK”, “ENG 2 BLEED FAULT”, and “PACK 2 FAULT” were displayed again, and subsequently the cabin pressurization decreased sharply with the cabin pressure altitude exceeding 8,800 feet.

The flight crew immediately executed "Cabin Pressurization Altitude Excess" procedures and made an emergency descent to 10,000 feet, and then continued flying at 10,000 feet to make a normal landing at 06:31 at the Kansai International Airport, a stopover point. The pressurization altitude increased[4] up to 11,000 feet during the emergency descent and the final fuel remaining was 7,800 lbs.

1.2 Injuries to Persons

Injuries	Crew	Passenger	Total	Other
Fatal	0	0	0	0
Serious	0	0	0	0
Minor / No injury	8	51	59	0
Total	8	51	59	0

3) ECAM: Short for Electronic Centralized Aircraft Monitoring, it is a computer system for centralized monitoring of the aircraft operating condition

4) When the pressurization altitude reaches 10,000 feet a “CAB PR EXCESS CAB ALT" warning comes on, and when it reaches 14,000 feet, passenger oxygen masks drop automatically.

1.3 Damage to Aircraft

There was no damage to the aircraft due to this incident.

1.4 Other Damage

There was no other damage due to this incident.

1.5 Personnel Information

1.5.1 The Captain

The captain (age 53, male) held valid Airline Transport Pilot Licence[5], A320 Type Rating, Class 1 Airman Medical Certificate[6], Radio Operator Certificate[7], and Level 4 in English Proficiency.

His total flying time was 9,955 hours including 2,084 hours on A321, 162 hours for the latest three months and 68 hours for the latest one month. He completed a proficiency check in November 2009 and a line check in February 2009, and took a rest at hotel before the flight of 16 January after he arrived at Saipan on 13 January 2010.

1.5.2 The First Officer

The first officer (age 39, male) held valid Commercial Pilot Licence[8], A320 Type Rating, Class 1 Airman Medical Certificate[9], a Radio Operator Certificate[10], and Level 4 in English Proficiency.

His total flying time was 3,657 hours, including 1,994 hours on the A321 aircraft, 174 hours for the latest three months, and 55 hours for the latest one month. He completed a proficiency check in April 2009 and line check in May 2009, and after he arrived in Saipan on 13 January 2010, he took a rest at hotel before the flight on January 16.

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5) Qualification number: 1998 (passed on 8 May 2002)
6) Certificate number: 062-7533 (expiry: 31 December 2010)
7) Certificate number: 98-34-1-0131
8) Qualification number: 6044 (Passed on 23 February 2006)
9) Certificate number: 062-6582 (Expiry: 31 March 2010)
10) Certificate number: 06-34-2-0014

1.6 Aircraft Information

1.6.1 Aircraft History

The HL7730 was manufactured[11] by Airbus Industries of France in April 2004, and introduced by the Asiana Airlines and registered[12] on 14 May 2004, and had a valid certificate of airworthiness[13]. Its total service time were 19,413 hours and the number of takeoff and landing were 8,485 cycles. All seals of the air conditioning system were exchanged[14] on 20 June 2007.

1.6.2 Weight and Balance

The weight and balance data of the HL7730 were as follows;

- Zero fuel weight (ZFW)..... 124,363 lbs (Maximum 157,631 lbs)
- Takeoff fuel (TOF)..... 29,800 lbs
- Takeoff weight (TOW)..... 154,163 lbs (Maximum 196,212 lbs)
- Trip fuel (TIF)..... 20,499 lbs
- Landing weight (LDW)..... 133,664 lbs (Maximum 166,449 lbs)
- Landing weight, center of gravity (LDW C.G ％ MAC): 22.23 ％ MAC

1.6.3 Aircraft Systems

1.6.3.1 Engine Bleed Air

Bleed air bled from the aircraft engine compressor[15] is used for air conditioning, cabin pressurization, pneumatic actuators, de-icing, etc.

The A321 aircraft has two similar engine bleed air systems, and each system is designed to select the compressor stage to use as a source of air, to regulate the bleed air temperature and to regulate the bleed air pressure.

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11) Manufacturing number: 2226
12) Number: 2008-196
13) Number: AB05012 (issued on 9 May 2005)
14) Exchanged at a cycle of 12,000 hours of flying time or 48 months, which ever comes earlier.
15) Supply is possible from APU (auxiliary power unit) or ground equipment.

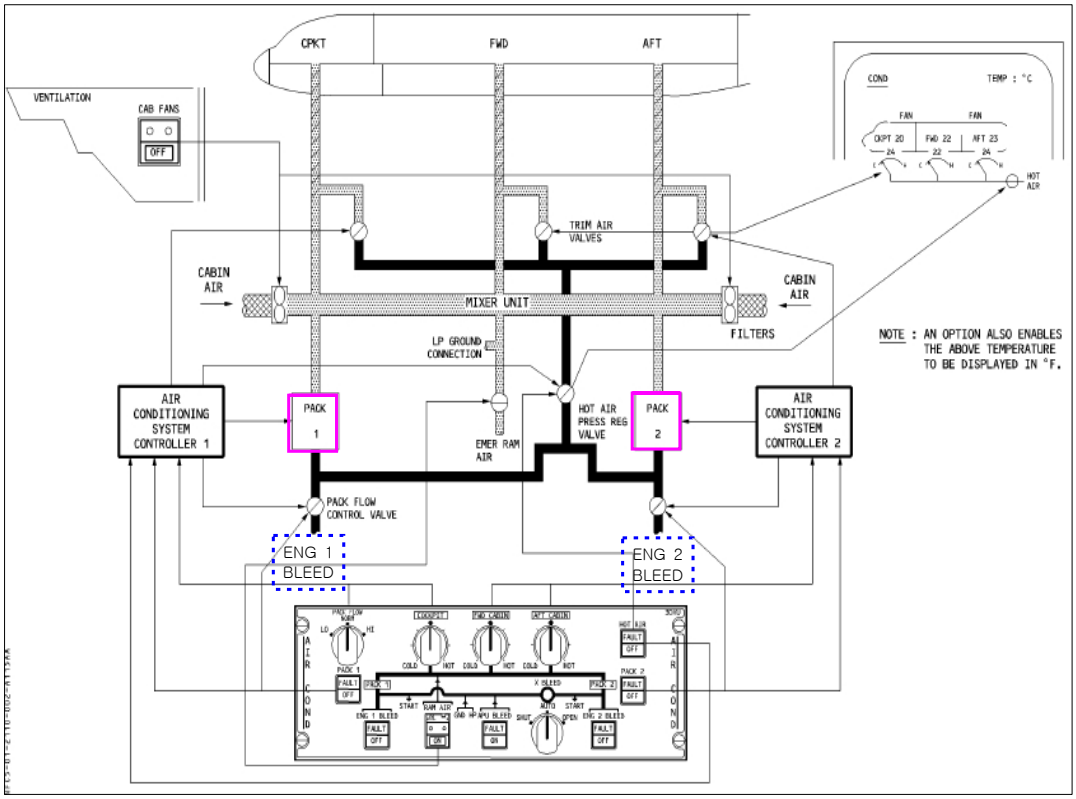
For the two bleed air systems, two bleed monitoring computers are mounted, and these computers monitor the pressure and temperature of bleed air and information on valve position, and control the bleed air systems.

Each Bleed Monitoring Computer is connected with other systems using air or information from the bleed air system and the other Bleed Monitoring Computer. Each supplies indications and warnings to the ECAM.

If one Bleed Monitoring Computer fails, the other one takes over most of the monitoring functions. Each bleed valve is pneumatically operated and controlled electrically by its associated Bleed Monitoring Computer.

1.6.3.2 Air Conditioning Pack

As shown in [Fig. 1], the HL7730 had two packs mounted, and these packs convert engine bleed air flowing in from the pneumatic system into air of very low temperature necessary for air conditioning.



[Fig. 1] Illustration of air conditioning system

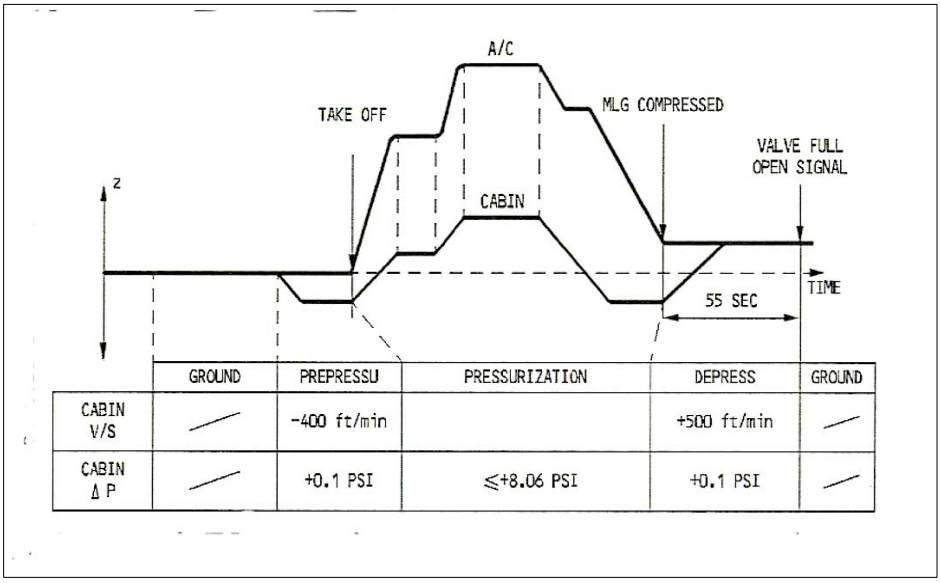
The engine bleed air that came into the primary heat exchanger through the pack valve is cooled before it goes into the Air-cycle machine (ACM) to be compressed to high temperature and high pressure. This compressed air of high temperature and high pressure is re-cooled at the primary heat exchanger and goes into the turbine of the air circulation system and expands to drive the compressor and cooling fan of ACM. At this time energy is removed to generate air of very low temperature.

The air conditioning system mixes air of very low temperature cooled through the pack and hot air extracted from engine and adjust it to a temperature set at the cockpit and cabin and supplies it to the cockpit and cabin. These packs operate automatically and independently of each other.

1.6.3.3 Cabin Pressurization

Pressurization is adjusted completely automatically as shown in [Fig. 2]. The pressurization system can be set automatically, semi-automatically or manually, but in normal operation condition the flight crew set it to auto.

When the cabin pressure altitude reaches 10,000 feet, the warning (CAB PR EXCESS CAB ALT) that the cabin pressure excess the cabin pressure altitude comes on, and when it reaches 14,000 feet, passenger oxygen masks drop automatically for passengers to wear them.

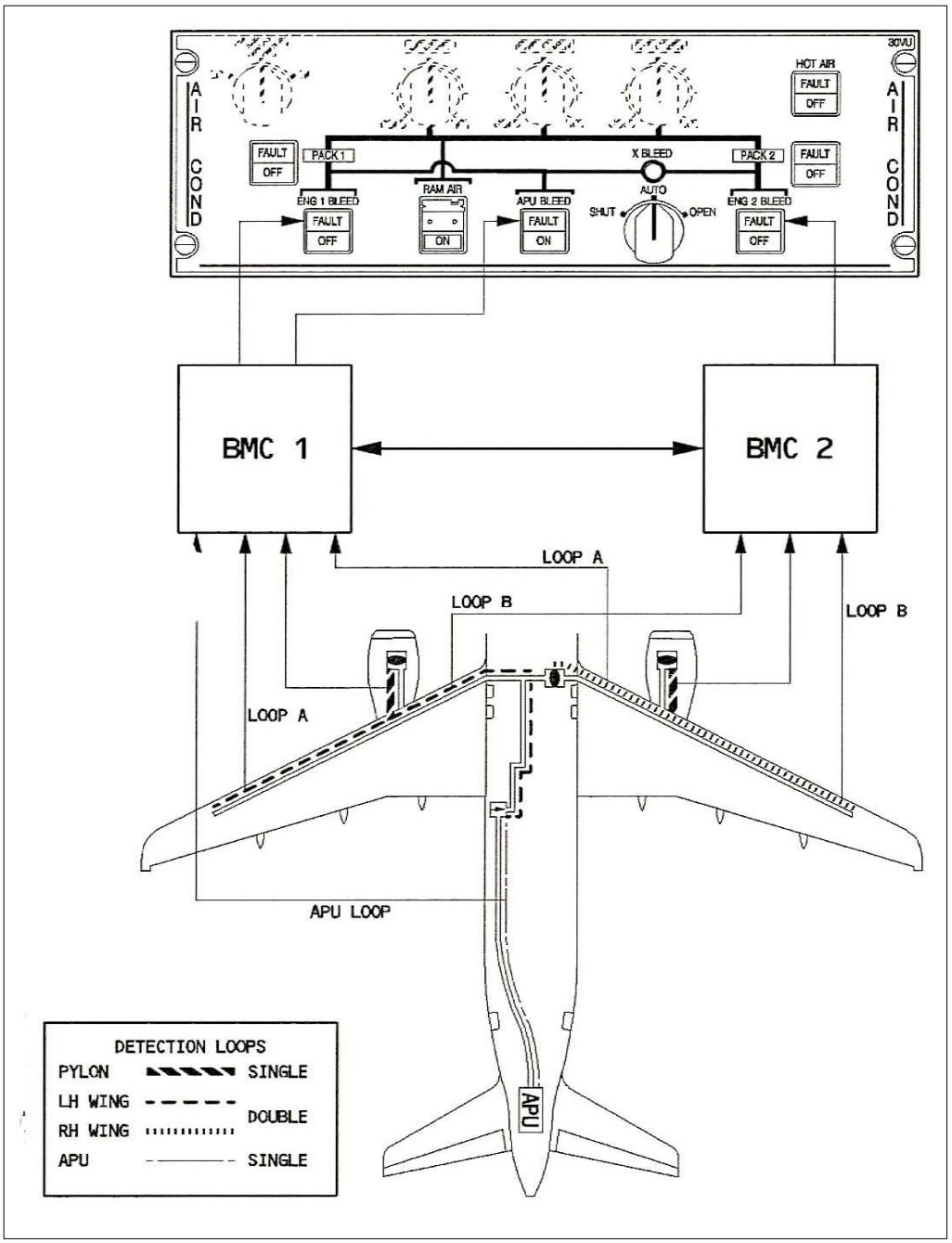


	GROUND	PREPRESSU	PRESSURIZATION	DEPRESS	GROUND
CABIN V/S		-400 ft/min		+500 ft/min	
CABIN Δ P		+0.1 PSI	≤+8.06 PSI	+0.1 PSI	

[Fig. 2] Cabin pressurization control

1.6.3.4 Bleed Air Leak Detection

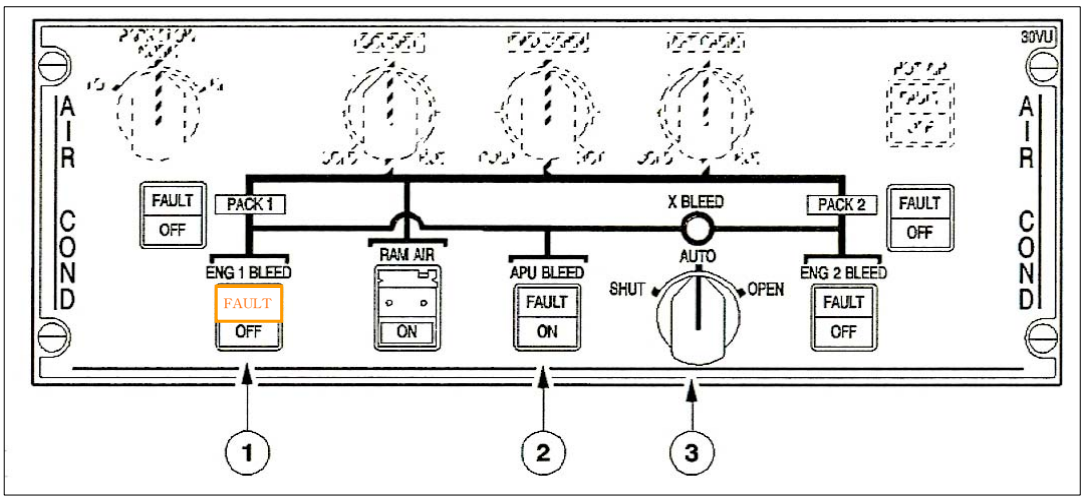
As shown in [Fig. 3], single leak detection loops are mounted in pylon and APU, and double leak detection loops are mounted in wings and fuselage. These air leak detection loops detect overheat near hot air ducts of high temperature.



[Fig. 3] Illustration of bleed air leak detection

In [Fig. 4], ① is the bleed air pressure valve switch of No. 1 engine, and an amber "FAULT" light comes on, and an ECAM caution appears, if :

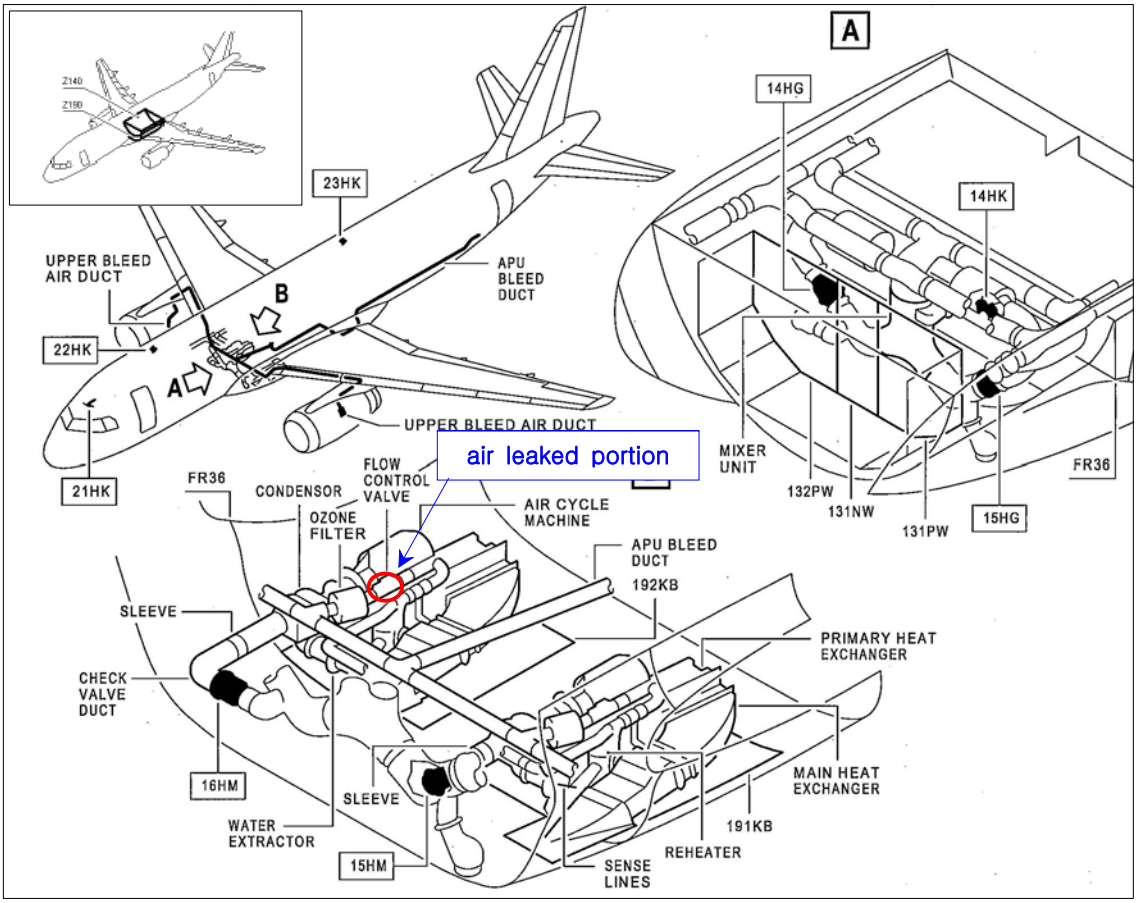
- ○ There is an overpressure downstream of the bleed valve.
- ○ There is a bleed air overheat.
- ○ There is a wing or engine leak on the related side.
- ○ The bleed valve is not closed during engine start.
- ○ The bleed valve is not closed with APU bleed on.



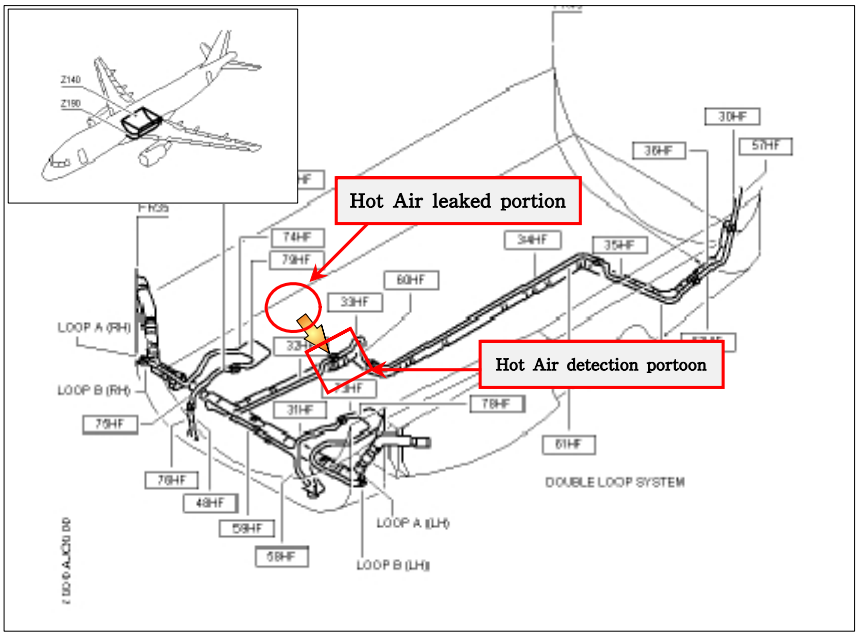
[Fig. 4] Air conditioning control panel

If the leak detection loops on either side detect overheat, the relevant pack valve is automatically shut and the pack stops automatically. At this time the other pack increases air flow up to 120 percent to compensate for this.

As shown in [Fig. 5] and [Fig. 6], the left and right leak detection loops are located together in a pack bay made of one compartment. Because of this, if air leaked from either pack duct like this incident, depending on the direction, shape and flow of the air leakage, both leak detection loops could detect leak. But it was confirmed that the same case like this incident has never been reported to Airbus Company.



[Fig. 5] Portion where hot air leaked in the pack bay

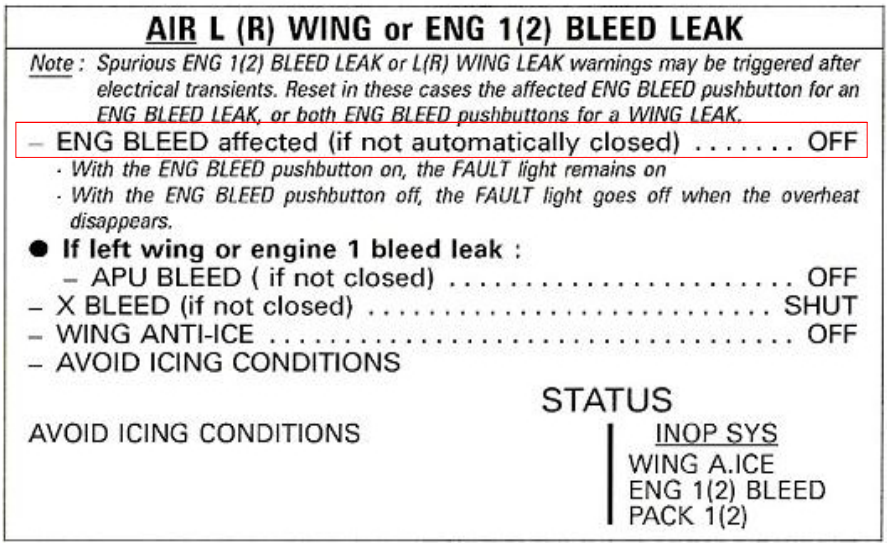


[Fig. 6] Air leak detection loop in the pack bay

1.6.4 Abnormal Procedures

1.6.4.1 Bleed Air Leak

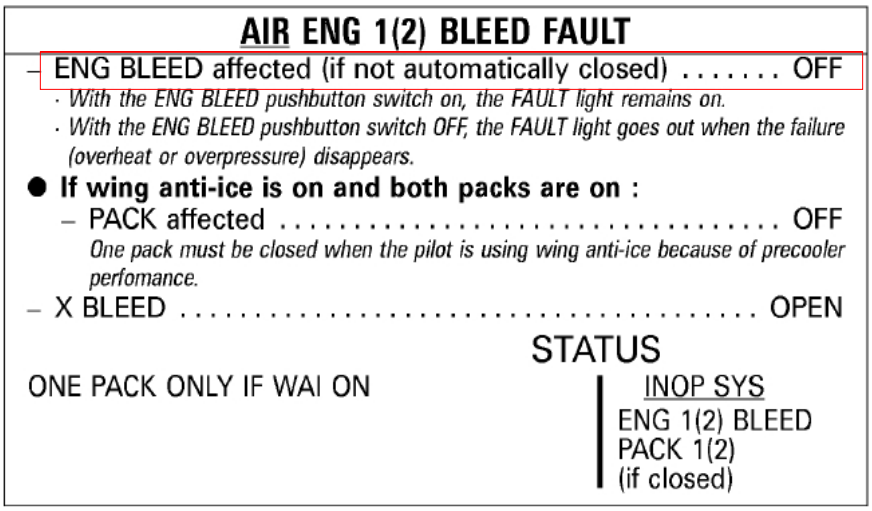
The procedures to be taken when the “AIR L(R) WING LEAK” or “ENG 1(2) BLEED LEAK” message is displayed are as shown in [Fig. 7].



[Fig. 7] The procedures when bleed air leaks

1.6.4.2 Bleed Fault

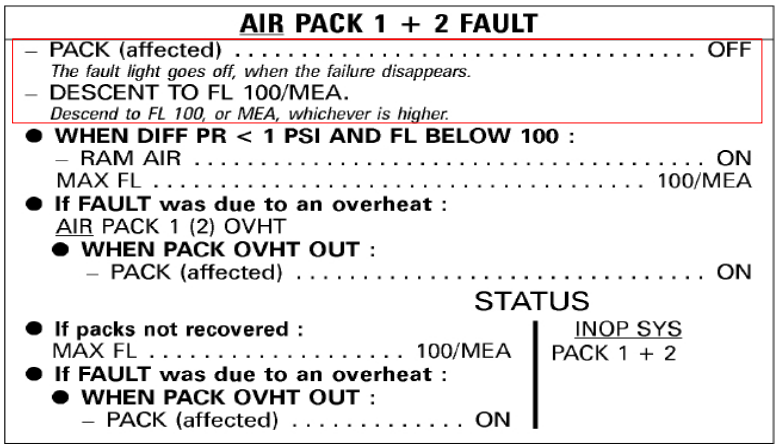
The procedures to be taken when the “AIR ENG 1(2) BLEED FAULT” message is displayed are as shown in [Fig. 8].



[Fig. 8] The procedures when bleed air system faults

1.6.4.3 Pack Fault

The procedures to be taken when the "AIR PACK 1 + 2 FAULT" message is displayed are as shown in [Fig. 9].



AIR PACK 1 + 2 FAULT

– PACK (affected) . . . . . OFF
The fault light goes off, when the failure disappears.
– DESCENT TO FL 100/MEA.
Descend to FL 100, or MEA, whichever is higher.

● **WHEN DIFF PR < 1 PSI AND FL BELOW 100 :**
– RAM AIR . . . . . ON
MAX FL 100/MEA

● **If FAULT was due to an overheat :**
AIR PACK 1 (2) OVHT
● **WHEN PACK OVHT OUT :**
– PACK (affected) . . . . . ON

STATUS

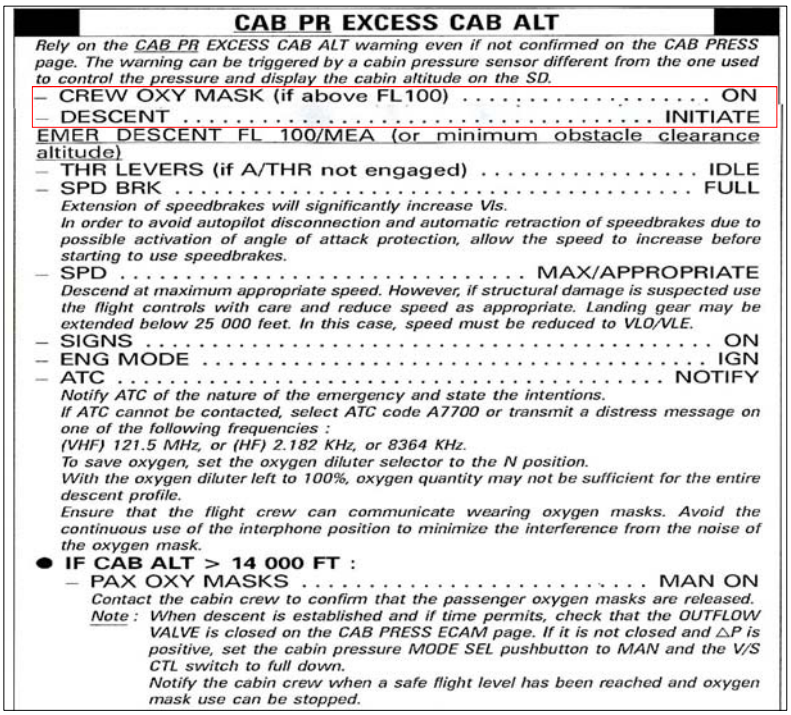
● **If packs not recovered :**
MAX FL 100/MEA
● **If FAULT was due to an overheat :**
● **WHEN PACK OVHT OUT :**
– PACK (affected) . . . . . ON

INOP SYS
PACK 1 + 2

[Fig. 9] Procedures when the air pack faults

1.6.4.4 Cabin Pressurization Altitude Excess

If pressurization exceeded or is expected to exceed the appropriate altitude to be maintained, the flight crew first wear the oxygen mask and takes the procedures of [Fig. 10], starting an emergency descent.



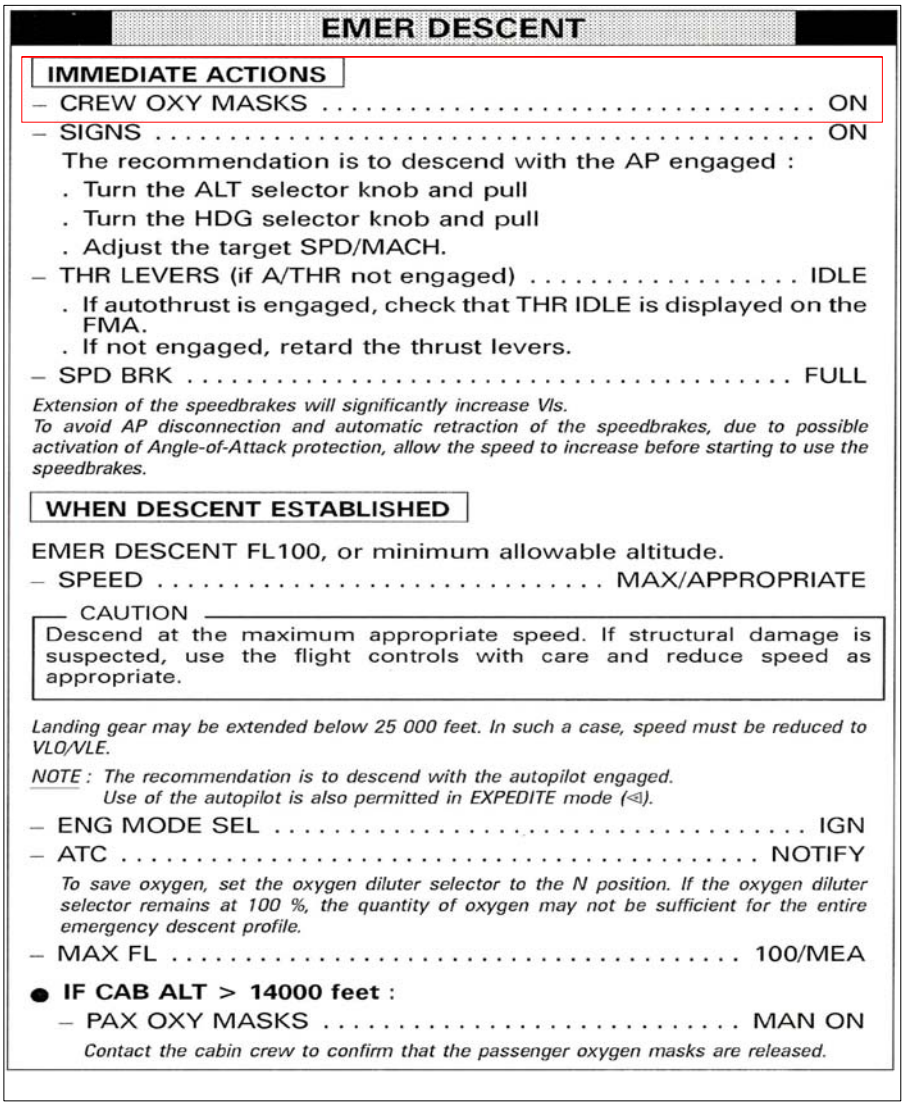
CAB PR EXCESS CAB ALT

Rely on the CAB PR EXCESS CAB ALT warning even if not confirmed on the CAB PRESS page. The warning can be triggered by a cabin pressure sensor different from the one used to control the pressure and display the cabin altitude on the SD.
– CREW OXY MASK (if above FL100) . . . . . ON
– DESCENT . . . . . INITIATE
EMER DESCENT FL 100/MEA (or minimum obstacle clearance altitude)
– THR LEVERS (if A/THR not engaged) . . . . . IDLE
– SPD BRK . . . . . FULL
Extension of speedbrakes will significantly increase Vls.
In order to avoid autopilot disconnection and automatic retraction of speedbrakes due to possible activation of angle of attack protection, allow the speed to increase before starting to use speedbrakes.
– SPD . . . . . MAX/APPROPRIATE
Descend at maximum appropriate speed. However, if structural damage is suspected use the flight controls with care and reduce speed as appropriate. Landing gear may be extended below 25 000 feet. In this case, speed must be reduced to VLO/VLE.
– SIGNS . . . . . ON
– ENG MODE . . . . . IGN
– ATC . . . . . NOTIFY
Notify ATC of the nature of the emergency and state the intentions.
If ATC cannot be contacted, select ATC code A7700 or transmit a distress message on one of the following frequencies :
(VHF) 121.5 MHz, or (HF) 2.182 KHz, or 8364 KHz.
To save oxygen, set the oxygen diluter selector to the N position.
With the oxygen diluter left to 100%, oxygen quantity may not be sufficient for the entire descent profile.
Ensure that the flight crew can communicate wearing oxygen masks. Avoid the continuous use of the interphone position to minimize the interference from the noise of the oxygen mask.
● **IF CAB ALT > 14 000 FT :**
– PAX OXY MASKS . . . . . MAN ON
Contact the cabin crew to confirm that the passenger oxygen masks are released.
Note : When descent is established and if time permits, check that the OUTFLOW VALVE is closed on the CAB PRESS ECAM page. If it is not closed and △P is positive, set the cabin pressure MODE SEL pushbutton to MAN and the V/S CTL switch to full down.
Notify the cabin crew when a safe flight level has been reached and oxygen mask use can be stopped.

[Fig. 10] Procedures when pressure cabin altitude exceeded

1.6.4.5 Emergency Descent

The emergency descent procedures when pressurization exceeded or is expected to exceed the appropriate altitude to be maintained are as shown in [Fig. 11].



EMER DESCENT

IMMEDIATE ACTIONS

– CREW OXY MASKS . . . . . ON
– SIGNS . . . . . ON
The recommendation is to descend with the AP engaged :
. Turn the ALT selector knob and pull
. Turn the HDG selector knob and pull
. Adjust the target SPD/MACH.
– THR LEVERS (if A/THR not engaged) . . . . . IDLE
. If autothrust is engaged, check that THR IDLE is displayed on the FMA.
. If not engaged, retard the thrust levers.
– SPD BRK . . . . . FULL

Extension of the speedbrakes will significantly increase Vls.
To avoid AP disconnection and automatic retraction of the speedbrakes, due to possible activation of Angle-of-Attack protection, allow the speed to increase before starting to use the speedbrakes.

WHEN DESCENT ESTABLISHED

EMER DESCENT FL100, or minimum allowable altitude.
– SPEED . . . . . MAX/APPROPRIATE

CAUTION
Descend at the maximum appropriate speed. If structural damage is suspected, use the flight controls with care and reduce speed as appropriate.

Landing gear may be extended below 25 000 feet. In such a case, speed must be reduced to VLO/VLE.

NOTE : The recommendation is to descend with the autopilot engaged.
Use of the autopilot is also permitted in EXPEDITE mode (◁).

– ENG MODE SEL . . . . . IGN
– ATC . . . . . NOTIFY
To save oxygen, set the oxygen diluter selector to the N position. If the oxygen diluter selector remains at 100 %, the quantity of oxygen may not be sufficient for the entire emergency descent profile.
– MAX FL 100/MEA

● **IF CAB ALT > 14000 feet :**
– PAX OXY MASKS . . . . . MAN ON
Contact the cabin crew to confirm that the passenger oxygen masks are released.

[Fig. 11] Emergency descent procedures

1.7 Meteorological Information

There was no the meterological trouble while the HL7730 was flying.

1.8 Aids to Navigation

There was no trouble with the aids to navigation while the HL7730 was flying.

1.9 Communications

There was no communications failure while the HL7730 was flying.

1.10 Aerodrome Information

Not appliable

1.11 Flight Recorders

1.11.1 Cockpit Voice Recorder

The HL7730 was equipped with a solid-state cockpit voice recorder which was manufactured[16] by the Honeywell Company and can record for 120 minutes.

But 120 minutes passed without the protection of the recording after taking action on the emergency situation, so the relevant recording did not exist.

1.11.2 Flight Data Recorder

The HL7730 was equipped with a solid-state flight data recorder which was manufactured[17] by the Honeywell Company and can record for at least 25 hours.

The ARAIB reviewed the recording from the time when the fault occurred to the time when the aircraft landed at the Kansai International Airport.

1.12 Wreckage and Impact Information

When the relevant parts were checked after landing, it was confirmed that hot air was actually leaking from the duct connecting the right pack valve and the primary heat exchanger as shown in [Photo 1].

The inside of this duct was checked to find that the seal of pack valve was pressed and torn as shown in [Photo 2]. But the air leak detection loops of the left and right wings/fuselage were good without any place pressed or torn.

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16) Part Number: 980-6022-001, Serial Number: 0612
17) Part Number: 980-4700-042, Serial Number: 11524

[Photo 1] Right pack valve duct

[Photo 2] Damaged Seal(Left)

[Photo 3] Normal Seal(Right)

1.13 Medical and Pathological Information

The flight crew members of the HL7730 held valid Class 1 Airman Medicate Certificates, and testified that they had not taken any particular medication or alcoholic beverage before the flight.

1.14 Fire

Not applicable

1.15 Survival Aspects

Not applicable

1.16 Tests and Research

In order to confirm whether the air leak detection loops of the left and right wings/fuselage are defective or not, the Asiana Airlines sent the measured values (See [Fig. 5] and [Table 1]) of impedance of these to Airbus Company, which confirmed there were no defect in the relevant air leak detection loops.

Detected Loop No.	Impedance	Continuity
79HF	227K	1.9
75HF	235K	1.9
60HF	145.4K	1.4
61HF	153.2K	1.4
62HF	258K	1.1
63HF	400K	1
74HF	220K	1
47HF	212K	1
32HF	149.2K	1.4
33HF	149.2K	1.4
34HF	145.4K	1.4
35HF	267K	1.5
36HF	335K	1.5

[Table 1] Measured values of the impedance of the air leak detection loops

1.17 Organizational and Management Information

Not applicable

1.18 Additional Information

1.18.1 Service Bulletin

Experience has shown that the present standard of pack seal, made of silicone, could lose their sealing qualities after some time in-service. This could lead to air leakages and subsequent equipment wear.

Because of this, Airbus Company recommended on 24 June 2005 through Service Bulletin (SB 21-1153) that the seal of silicone material that has been in use so far be replaced by the seal of Teflon synthetic material for the reliability improvement of the seal and the equipment.

But the grade[18] of this service bulletin was classified as "DESIRABLE," so it was not an item that must be executed by an airline company. Considering the age[19] of relevant aircraft and that there have been no such defects, the Asiana Airlines deferred[20] execution of this service bulletin on condition that they will be replaced in case defects occur in future.

On 1 October 2009, the Asiana Airlines decided to execute it when Service Bulletin SB 21-1153 is reexamined, so the replacement with seals of new material was under way for the aircraft that had periodical seal replacement time coming up, but only one aircraft[21] had it replaced until 16 January 2010 when this incident occurred.

After this incident, Airbus Company sent a letter to the Asiana Airlines to recommend execution of Service Bulletin SB 21-1153 for the improvement of seal reliability and

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18) **MANDATORY**: Service Bulletin must be accomplished, **RECOMMENDED**: Service Bulletin recommended to be accomplished to prevent significant operational disruptions, **DESIRABLE**: Service Bulletin to introduce improvements, **OPTIONAL**: Service Bulletin for convenience or option.

19) The number of relevant aircraft was eight (8), which were manufactured between November 2000 and May 2004.

20) Because of this, there was periodical seal replacement for the HL7730, but it was not replaced with seal of new material but with the conventional silicone seal.

21) HL7729 (Completed on 4 January 2010)

prevention of defects, so the Asiana Airlines executed the seal replacement work[22)] with seals of new material for ten (10) aircraft.

1.18.2 Air Leak Check on the Pack Components

It is described in Maintenance Manual (36-22-00-790-051) that air leak check on the pack components of the A321 aircraft is to be done by a visual check method for the portion having a possibility of air leak.

22) Completed on 1 May 2010

2. Analysis

2.1 General

The HL7730 flight crew were certified and qualified, and took appropriate rest prior to the scheduled flight. And no medical factors which might have adversely influenced their performance, were found.

The aircraft held a valid airworthiness certificate and the landing was conducted within the regulatory limitations of the weight and balance.

2.2 Aircraft System Operations

According to the recording of ECAM messages, “AIR L WING LEAK”, “AIR ENG 1 BLEED FAULT”, and "AIR PACK 1 FAULT" were displayed at about 05:22, and “AIR R WING LEAK”, “AIR ENG 2 BLEED FAULT” and “AIR PACK 2 FAULT” were displayed at about 05:23.

If we put together the above data, actually hot air leaked through the damaged seal of right pack valve duct and the left air leak detection sensor detected this first, and then the right air leak detection sensor also detected this.

Because of this, the system operated automatically to make the left and right pack valves shut, and due to this all air going to packs was cut off. Thus, it is judged that both packs did not operate, which led to loss of all pressurization function so as to make pressurization altitude start to increase eventually.

Because A320 series aircraft have both left and right air leak detection loops located in the pack bay made of one compartment, it is judged that if air leaked from the pack duct on either side, depending on the direction, shape and flow of the air leakage, the air leak detection loop on the other side could detect this.

Therefore, it is judged that in the HL7730, despite air leaked from the right pack valve, not only the right but also left air leak detection sensors detected this, so eventually both packs came to be in an inoperable situation.

2.3 Flight Crew Performance

When the HL7730 was passing near the waypoint TAXON, “AIR L WING LEAK” was displayed in ECAM, and the same time “ENG 1 BLEED FAULT” and “PACK 1 FAULT” were displayed.

While the flight crew were taking ECAM action on this, “AIR R WING LEAK” was displayed, “ENG 2 BLEED FAULT” and “2 PACK FAULT” were illuminated, and then the cabin pressure altitude exceeded 8,800 feet.

That both “AIR L WING LEAK” and “AIR R WING LEAK” messages were displayed means that bleed air leaked so the temperature detection sensor detected this, and if leak of bleed air is detected, the air valve is automatically closed in the system to cut off engine bleed air.

Therefore, it can be judged that because both of the left and right engine bleed air were cut at the time, the “AIR ENG 1(2) BLEED FAULT” message, which means there is a fault in engine bleed air, came on, and also the “AIR PACK 1 + 2 FAULT” message, which means all engine bleed air going to the pressurization system was cut off, came on.

If the engine bleed air going to the pressurization system is cut off, the cabin altitude increases. It is specified that if the cabin pressure exceeded or is expected to exceed the proper altitude the flight crew first wear oxygen masks and take the “cabin pressure excess (CAB PR EXCESS CAB ALT)” procedures.

At the time the flight crew, immediately after perceiving “AIR L(R) WING LEAK”, “AIR ENG 1(2) BLEED FAULT”, “AIR PACK 1 + 2 FAULT” messages displayed and pressurization altitude increasing beyond 8,800 feet, made an emergency descent to 10,000 feet. Because of this, the pressurization altitude did not exceed maximum 11,000 feet.

Therefore, considering the operating results of the aircraft systems and Flight Manual, the action taken by the flight crew on the abnormal situation were judged appropriate.

2.4 Service Bulletin

In the course of checking the defects after arriving at the Kansai International Airport, it was found that the seal of the right pack valve duct was pressed and torn, and this is judged that it was deformed as it had been used for a long period since installation as mentioned by Airbus Company in Service Bulletin (SB 21-1153).

The Asiana Airlines had already received in June 2005 the Service Bulletin which recommended replacement of the seal of silicone material with a seal of Teflon synthetic material for the improvement of seal reliability, but since whether or not to follow the Service Bulletin was at the discretion of the airline company, the Asiana Airlines deferred it on condition that it will be replaced when there is a defect. Although there was a periodical replacement work for the HL7730 in June 2007, it was not replaced with a seal of new material.

Later, in October 2009, it was decided to follow the Service Bulletin and the seal replacement work on the relevant aircraft was under way, but only one (1) of ten (10) relevant aircraft, that it, HL7729, had the seal replaced, and other nine (90 aircraft including HL7730 had not the seals replaced.

Since this Service Bulletin (SB 21-1153) was not issued with such a classification that the airlines must take action on but was issued with such a classification that action taking was at the discretion of the airline company, deferring action on the Service Bulletin cannot be a problem.

But if we consider the background of issuing the Service Bulletin, the cause of frequent air leaks from the pack seal is not the age of the aircraft but is related to the service duration of the pack seal. Therefore, it is judged to have been much more desirable if it had been decided to take action on the Service Bulletin for the aircraft that fell under the periodical seal replacement time rather than deferring when deciding whether or not to take action on the Service Bulletin (SB21-1153) in June 2005.

2.5 Air Leak Check on the Pack Components

According to the air leak check procedures for the air conditioning system in the **1.** Maintenance Manual (36-22-00-790-051), it is specified that the portion having a

possibility of air leak is to be checked by a visual check method without using specific equipment or tool.

But the pack duct is located inside where it is difficult to access and leaking air is of high temperature and invisible with the naked eye, so it is judged desirable to check whether the air is leaking or not in an effective way by using a specific tool or temperature sensor, etc.

3. Conclusions

3.1 Findings Related to Risk

1. The HL7730 flight crew were certified and qualified, and took appropriate rest prior to the relevant flight. And no medical factor which might have adversely influenced their performance, was found.

2. The aircraft held a valid airworthiness certificate, and the landing was conducted within the regulatory limitations of the weight and balance.

3. It is specified that if cabin pressure exceeded or is expected to exceed the proper altitude to be maintained the flight crew first wear oxygen masks and take emergency descent procedures.

4. The standard of pack seal, made of silicone, could lose their sealing qualities after some time in-service. This could lead to air leakages and subsequent equipment wear.

5. The Service Bulletin (SB 21-1153) dated 24 June 2005, which recommended to replace seals inside the pack valve duct with seals of improved material, was issued with a classification of "DESIRABLE."

6. The Asiana Airlines deferred to take action on the Service Bulletin on condition that all seals of the relevant types of aircraft be replaced in case defects occur, considering the classification of the Service Bulletin (SB 21-1153), the age of relevant aircraft, and defects of related systems.

7. In June 2007 there was a periodical pack valve seal replacement work on the HL7730, but the seal was not replaced with a seal of new material because the acton on the relevant Service Bulletin was deferred.

8. It was decided to take action on the Service Bulletin (SB 21-1153) when it is reexamined on 1 October 2009, and at the time of the incident the seal replacement work on the relevant types of aircraft was under way.

9. It is specified in the Maintenance Manual (36-22-00-790-051) that air leak check on the pack components be done by the visual check method without using a specific tool or equipment.

3.2 Causes

The Aviation and Railway Accident Investigation Board determines that the cause of Emergency use of oxygen by the flight crew, Asiana Airlines, was that 「the seal of the right air conditioning pack valve duct were damaged, hot air leaked, and because of this the left and right air conditioning pack valves were closed. So that the regulating function of the cabin pressure altitude was lost, and cabin pressure altitude increased. The flight crew put on the oxygen masks and executed an emergency descent according to the specified procedures.」

Contributing to this serious incident was that 「Both left and right air leak detection loops are located in the pack bay made of one compartment, so if air leaked from the pack duct on either side, depending on the direction, shape and flow of the air leakage, both air leak detection loops might be able to detect the leaked air.」

3.3 Comments from the BEA, France

In accordance with the ICAO Annex 13, Paragraph 6.3, the ARAIB, the State conducting the investigation of the HL7730 serious incident, sent a copy of the draft Final Report to the BEA (the State of Design and Manufacture) on 8 November 2010, inviting their comments, and received the BEA's comments to the draft Final Report on 10 December 2010.

After then, the ARAIB exchanged the opinion on the draft Final Report with the BEA three times, and the draft Final Report was amended accordingly. However, since not all of the BEA's comments were able to be accommodated, with an agreement of the BEA forwarded on 8 February 2011, it was decided to append them in this Final Report.

4. Safety Recommendations

As a result of an investigation into the HL7730 serious incident occurred on 16 January 2010 over high seas about 300 NM south of the Kansai International Airport, the ARAIB makes the following safety recommendations;

To the Asiana Airlines

1. It is required that the Asiana Airlines expedite to take action in accordance with the Service Bulletin (SB 21-1153) recommending to replace the existing seals with the new material seals. (AIR1001-1)

   ※ The Asiana Airlines completed the seal replacements with new material for the ten (10) relevant aircraft as of 1 May 2010.

2. It is required that the Asiana Airlines devise a scheme to carry out periodic air leak checks, including the air leak checks of pack ducts in the regular check items. (AIR1001-2)

To the Airbus Industries, France

1. It is required that the Airbus Industries, France, device a proper measure for improving the air leak detection system so that one of the bleed air leak detection loops does not detect the air leak of the other side pack duct like the case of this serious incident. (AIR1001-3)

2. Considering that the pack duct is located in a place to which access is somewhat difficult, it is required that Airbus Industries, France, specify it in the Maintenance Manual (36-22-00-790-051) that a proper tool, such as a specific tool or temperature sensor, etc, is to be used when checking on the pack air leak. (AIR1001-4)

Appendix

Comments from the BEA, France

This is to confirm that we studied different solutions to improve the segregation between the bleed 2 pipe and the APU bleed detection loop. All these solutions had serious drawbacks or risks to degrade the overall reliability of the system.

Considering the facts that only one case has been reported on the entire fleet and the origin of the leak (silicone seal) has been fixed through a service bulletin, we believe that the recommendation (AIR1001-4) is not appropriate.