Aviation Occurrence Report

ASC-AOR-10-08-002

Emergency descent due to temporary
Interruption in the bleed air system
Supply During Initial Descent

Cathay Pacific Airways Flight CX521
AIRBUS A330-300, B-HLH
September 14, 2008

AVIATION SAFETY COUNCIL

Aviation Occurrence Report: Emergency descent due to temporary interruption in the bleed air system supply during initial descent, Cathay Pacific Airways Flight CX521, AIRBUS A330-300, B-HLH, September 14, 2008

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According to Article 5 of the Aviation Occurrence Investigation Act of The Republic of China:

The objective of the ASC's investigation of aviation occurrence is to prevent recurrence of similar occurrences. It is not the purpose of such investigation to apportion blame or liability.

Further, the Section 3.1, Chapter 3, Annex 13 of International Civil Aviation Organization (ICAO):

"The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability."

Thus, based on both the ICAO Annex 13, as well as the Aviation Occurrence Investigation Act of the Republic of China, this aviation occurrence investigation report shall not be used for any other purpose than to improve safety of the aviation community.

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Executive Summary

On September 14, 2008 at 1614 Taipei local time1, Cathay Pacific Airways (CPA) Flight number CX521, an Airbus A330-300 aircraft with registration number B-HLH, flew from Narita International Airport, Japan to Taipei/Taiwan Taoyuan International Airport (Taipei International Airport, TPE), Taiwan, Republic of China. The flight departed with 72 occupants on board including 59 passengers, 11 cabin crew members and 2 flight crew members. The aircraft encountered interruptions of the bleed air system supply at 38,544 ft during descent from flight level FL400. Flight crew members conducted an emergency descent and landed safely at Taipei international airport at approximately 1929. The aircraft was not damaged and none of the 72 occupants were injured.

CX521 was a scheduled flight from Narita to Hong Kong. Due to a typhoon, the flight was rescheduled from Narita to Taipei. During the pre-flight check, the flight crew acknowledged that the aircraft was dispatched in accordance with Minimum Equipment List (MEL) 36-11-02 with the #1 engine bleed air system inoperative. The #1 engine bleed air valve was secured closed.

The flight took-off at 1614 and cruised at FL400 en-route. The CM2 was the pilot flying (PF) and the CM1 was pilot monitoring (PM). The weather in TPE at that time was affected by typhoon Sinlaku. The PM contacted Taipei Area Control Center (TACC) at approximately 1847. At 1852, TACC cleared CX521 to descend to FL140 at the pilot's discretion. CX521 initiated descent at 1854. When passing through FL380, the PM observed an ECAM (Electrical Centralized Aircraft Monitor) message "AIR

[1] All times contained in this report is Taipei local time (UTC plus 8), unless otherwise noted.

ABNORM BLEED CONFIG”, followed by “AIR ENG 2 BLEED FAULT”. The PM attempted to reset the #2 engine bleed switch without success and the cabin altitude began to climb. The PF selected OP DES and deployed the speed brake, increasing the rate of descent.

At 1856:42, TACC instructed CI5321：“Dynasty five three two one contact Taipei approach one two five decimal one”[2]. The PM answered：“One two five one, bye bye”. The master warning appeared at 1857:39 while “EXCESS CAB ALT” message displayed on ECAM during the descent and the VHF 125.1 MHz was selected. The cabin altitude was 9,700 ft at the time when the master warning appeared. The flight crew commenced their emergency descent procedures and donned oxygen masks right after master warning sounded. The cabin oxygen masks were dropped manually by the flight crew during the emergency descent and the maximum cabin altitude reached 13,424 ft during the emergency descent. From 1858:00 to 1859:54, the PM transmitted Mayday calls 3 times on frequency 125.1 MHz, and 1 time at the Guard frequency (121.5 MHz). At 1858:14, Taipei Approach confirmed “Cathay five three one Confirm Mayday”[3]. At 1901:50, Taipei Approach cleared CX521 descend to FL100.

At 1906:21, cabin crew reported a strong burning smell in the cabin. At 1907:03 the flight crew requested priority landing to Taipei International Airport. The flight was cleared for priority approach and landed on RW 24 RCTP. All ground service units were standing by for emergency. The aircraft stopped off runway at taxiway Sierra Papa (SP) to check for any smoke. After the aircraft stopped on the taxiway SP, the

[2] Confirmed existing discrepancy: ATC transcript was ”Dynasty five three two one contact Taipei approach one two five decimal one”, CVR transcript was “Dynasty three two one contact Taipei approach one two five decimal one”

[3] At that moment CX521 was in the TACC control space, but calling Taipei Approach radio. Meanwhile CX531 was in Taipei Approach control space, Taipei Approach was trying to verify if CX531 declaring MAYDAY.

CM2 went to the cabin and checked Door #4 area for burning smells. The CM2 confirmed the smell was caused by the activation of the oxygen generators. The airport fire engine also checked the exterior of aircraft and reported there was no smoke.

According to the Investigation Act and Annex 13 to the Convention on the International Civil Aviation (Chicago Convention), which is a administered by the International Civil Aviation Organization(ICAO), the Aviation Safety Council(ASC), an independent government agency of ROC, which is responsible for Civil aircraft accident investigation in the territory of ROC, immediately launched an investigation of this occurrence. The state of manufacture, represented by the France BEA, the liason officer of operator, represented by Hong Kong CAD and the Civil Aeronatics Administration(CAA) of CAD were invited to participate in the investigation.

On March 13, 2009, ASC held the Factual Data Verification Meeting in Taipei. On November 26th, 2009, ASC held the 1st Technical Review Meeting and followed by the 2nd Technical Review Meeting by BEA and Airbus's request. All party members of the investigation team were invited to attend the meeting.

The ASC issued a Final Draft report on April 12, 2010 and granted 60 days for comments, in accordance with ICAO Annex 13, paragraph 6.3. Based on a review of the comments, the ASC completed its investigation eport, which was approved by the ASC Council Members on July 27, 2010, at the 135th Council Meeting.

The Safety Council presents the findings derived from the factual information gathered during the investigation and the analysis of the occurrence. The findings are presented in three categories: findings related to probable causes, findings related to the risk, and other findings.

Findings related to the probable causes identify elements that have been shown to have operated in the accident, or almost certainly to have operated in the accident. These findings are associated with unsafe acts and conditions, or safety deficiencies that are associated with safety significant events that played a major role in the circumstances leading to the accident.

Findings related to the risk identify elements of risk that have the potential to degrade aviation safety. Some of the findings in this category identify unsafe acts and conditions, or safety deficiencies that made this accident more likely; however, they can not be clearly shown to have operated in the accident. They also identify risks that increase the possibility of property damage and personnel injury and death. Further, some of the findings in this category identify risks that are unrelated to the accident, but nonetheless were safety deficiencies that may warrant the future safety actions.

Other findings identify elements that have the potential to enhance aviation safety, resolve an issue of controversy, or clarify an issue of unresolved ambiguity. Some of these findings are of general interest and are not necessarily analytical, but they are often included in ICAO format accident reports for informational, safety awareness, education, and improvement purposes.

Findings related to the probable causes

1. Giving the de-activated of the No.1 engine bleed air valve per MEL 36-11-02, the no.2 engine bleed air was the only one compressed air source for the two air conditioning systems. The no.2 engine bleed air valve operated in a high demand status. During aircraft descent, the compressed air automatically bled from high pressure stage which provided the compressed air with higher pressure and higher temperature. This led the pre-cooler downstream temperature air getting higher. Due to the THC's grid filter contaminated from which to reduce the muscle air pressure to control fan air valve that resulted in the fan air valve could not open properly to

provide sufficient cooling air to pre-cooler. The no.2 engine bleed air valve was shut down automatically due to bleed air overheat. Both air conditioning systems lost the compressed air source and thereby aircraft lost its pressurization capability.

Findings related to the risk

1. The repeated defects of the numerous dual bleed air system and number one engine bleed air defects prior to the occurrence revealed the deficiency of the bleed air system' reliability and potential operation risk.

2. The flight crew might have confused the similar call signs on the same control frequency. The crew were distracted by the system failure when they did not adhere to company communication procedures by inadvertently omitting the CX521 flight number at the end of one of the transmissions, which contributed to the premature change of frequency.

3. The flight crew omission of the CX521 flight number the fact that the transmission was stepped on resulted in a lost opportunity for the pilot and the controller to correct the mistake and prevent the premature change of frequency.

4. Approach controller should be aware the existing similar call sign situation and follow the ATMP regulation for pilot' distinguishing when the CX521 acknowledged instruction and read back frequency change incorrectly for other aircraft.

5. The ATMP English version and Chinese version 2-4-15 regarding emphasizing to aid in distinguishing between similar sounding aircraft are inconsistent: English version is mandatory while the Chinese version is not.

6. Approach controller did not acknowledge the CX521 distress message immediately on Guard frequency until the second one one minute latter.

7. The ATMP request controllers to provide maximum assistance and first priority to distress aircraft; consider pilot workload and human factor of radio communication. The late information handling, frequent frequency change instructions and instructed distress aircraft to follow speed restriction were not in accordance with ATMP.
8. Duplicated questions asking regarding ground assistance showed lack of coordination and information exchange internally from both the TPE Tower and the Approach controllers.
9. All TACC controllers selected Mekong radio station which resulted in TACC controllers failed to receive the CX521 “Mayday” call at 1859:56 on 121.5 Frequency until 1900:52.
10. Guard frequency 121.5 stations situated at Datum Mt and Mekong. The two frequencies unable to cover each other due to the 140NM distance and geographic influence.
11. TACC North Sector guard frequency test omitted the occurrence neighbor area waypoint SALMI. The omitted way point test may have resulted in TACC controllers missing Mayday call from CX521.
12. Some cabin crew members whose oxygen mask did not drop down, did not try to open their access panels or using portable oxygen bottle around their seats.
13. Some cabin crew members may not be familiar with the cabin masks design features and operation with regard to pulling down on the cord to activate oxygen flow and not be fully aware of the normal operation of the cabin masks.
14. Some cabin crew members who were not to or not able to use their oxygen masks may have misled passengers into thinking that wearing the mask was not required.

15. These side effects of the chemical oxygen generators did not list in any cabin related manual and training course. This may have increased the injury risk if cabin crews unfastened their seat belt and tried to find out the suspected fire source.

Other findings

1. Both flight crew members were certified and qualified in accordance with Hong Kong Civil Aviation Regulations.

2. There was neither evidence indicate the crew have any physical or psychological problems, nor usage of alcohol or drugs.

3. The crew did not select the APU after interrupting the AIR DUAL BLEED FAULT checklist to initiate the EMERG DESCENT checklist in response to the CAB PR EXCESS CAB ALT message.

4. The FDR data indicated that the cabin altitude never exceeded 14,000ft during the occurrence, there was no requirement for the crew to manually deploy the cabin masks.

5. The “CAB PR EXCESS CAB ALT” and “EMER DESCENT” procedures were inconsistent regarding the selection of 7700.

6. According to ATC radar control video play back, there was no evidence indicating that the flight crew had selected 7700 SSR on the transponder.

7. It was deem necessary that the flight crew took the immediate action and performed the emergency descent to a safer altitude when dual bleed system fail.

8. The highest cabin altitude aircraft experienced was within the airworthiness standard during the emergency descent operation.

9. The leakage rate of B-HLH was within the Aircraft Maintenance Manual

specification.

10. The Operator complied with the MEL 36-11-02 prescriptions.

11. Refer to the tear down inspection result of the no.1 PRV; the shop findings also could not confirm the indication problem.

12. The CVR revealed there were temporary communication, poor radio signal quality, poor readability and difficulties during the 1903 to 1907 period. No evidence showed the TACC VHF system had anomaly at the time of occurrence.

13. Some passengers were not wearing their oxygen masks revealed that some passengers either not fully understand the instructions from the automatic announcement or they did not follow the instructions.

Safety Recommendations

<u>To Hong Kong CAD</u>

1. Require Cathay Pacific Airways consider evaluating or revising the MEL procedure to reduce the depressurization risk under one engine bleed air fail, and recover the cabin pressurization capability with APU in a timely manner when the second engine bleed air system also failed.(ASC-ASR-10-08-004)

2. Require Cathay Pacific Airways consider evaluating the maintenance program for ThC shop-in service or overhaul interval before the new grid filter design or modification come to effect. (ASC-ASR-10-08-005)

3. Require Cathay Pacific Airways consider evaluating the MEL restriction regarding aircraft been dispatched from home base with an inoperative system to lower the dual bleed system failure risk. (ASC-ASR-10-08-006)

4. Require Cathay Pacific Airways to review air dual bleed fault and emergency descent procedures and revise related inconsistent procedures accordingly. (ASC-ASR-10-08-007)

5. Require Cathay Pacific Airways cabin crew members to review cabin depressurization related procedures including: provide oxygen bottle side effect information, manually opening the oxygen cover panel to initiate oxygen flow; enhance cabin crew depressurization training. (ASC-ASR-10-08-008)

To the DGAC France

1. Require manufacturer to modify or redesign the ThC grid filter to reduce the risk of A330 dual bleed system failure. The manufacturer should evaluate the maintenance program for ThC shop-in service or overhaul interval before the new design or modification come to effect. (ASC-ASR-10-08-009)

2. Require manufacturer to review air dual bleed fault and emergency descent procedures and revise related inconsistent procedures accordingly. (ASC-ASR-10-08-010)

3. Require manufacturer considering to take the in-service fleet events and family fleet problem solving experiences into Product Safety Process account and form the problem solving task force in an earlier time as proactive risk mitigation measure. (ASC-ASR-10-08-011)

To Cathay Pacific Airways

1. Consider evaluating the MEL dispatch or reviews other procedures under one engine bleed air fail to recover the cabin pressurization capability with APU in a timely manner in case of the second engine bleed air system failed to reduce the depressurization risk. (ASC-ASR-10-08-012)

2. Consider evaluating the maintenance program for ThC shop-in service or overhaul interval before the new grid filter design or modification come to effect. (ASC-ASR-10-08-013)

3. Consider evaluating the MEL of restrict aircraft being dispatched from home base with an inoperative system and suffered the system's reliability. (ASC-ASR-10-08-014)

4. Review air dual bleed fault and emergency descent procedures and revise related inconsistent procedures accordingly. (ASC-ASR-10-08-015)

5. Require cabin crew members to review cabin depressurization related procedures including: provide oxygen bottle side effect information, manually opening the oxygen cover panel to initiate oxygen flow; enhance cabin crew depressurization training. (ASC-ASR-10-08-016)

<u>To CAA Taiwan</u>

1. Require controller followed ATMP procedures, emphasize similar flight numbers or call sign and informed the flight crew for distinguishing. (ASC-ASR-10-08-017)

2. Review and revise the ATMP Chinese version 2-4-15 word meaning in accordance with the English version 1-2-1. (ASC-ASR-10-08-018)

3. Enhance controller emergency response and situation awareness when handling the distress aircraft in accordance with the ATMP procedure. Assuring the controller handled the nature of emergency and pilot expectation in a timely and efficiency manner, provide the utmost assistance, highest priority and considered the pilots' workload and human factor of radio communication. (ASC-ASR-10-08-019)

4. Review the ATMP procedure regarding the frequency change instruction for distress

aircraft that might increased flight crew workload. (ASC-ASR-10-08-020)

5. Enhance ATC internal coordination, communication during emergency situation includes the training, checking and handling of distress aircraft. (ASC-ASR-10-08-021)
6. Carefully selected appropriate radio communication stations as backup system to avoid communication performance degrade. (ASC-ASR-10-08-022)
7. Revise the TACC Guard frequency radio test inclusive at SALMI waypoint. (ASC-ASR-10-08-023)

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1 Factual Information

1.1 History of Flight

On September 14, 2008 at 1614 Taipei local time4, Cathay Pacific Airways (CPA) Flight number CX521, an Airbus A330-300 aircraft with registration number B-HLH, flew from Narita International Airport, Japan to Taipei/Taiwan Taoyuan International Airport (Taipei International Airport, TPE), Taiwan, Republic of China. The flight departed with 72 occupants on board including 59 passengers, 11 cabin crew members and 2 flight crew members. The aircraft encountered interruptions of the bleed air system supply at 38,544 ft during descent from flight level FL400. Flight crew members conducted an emergency descent and landed safely at Taipei international airport at approximately 1929. The aircraft was not damaged and none of the 72 occupants were injured.

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The flight took-off at 1614 and cruised at FL400 en-route. The CM2 was the pilot flying (PF) and the CM1 was pilot monitoring (PM). The weather in TPE at that time was affected by typhoon Sinlaku. The PM contacted Taipei Area Control Center (TACC) at approximately 1847. At 1852, TACC cleared CX521 to descend to FL140 at the pilot’s discretion. CX521 initiated descent at 1854. When passing through FL380, the PM observed an ECAM (Electrical Centralized Aircraft Monitor) message “AIR

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ABNORM BLEED CONFIG”, followed by “AIR ENG 2 BLEED FAULT”. The PM attempted to reset the #2 engine bleed switch without success and the cabin altitude began to climb. The PF selected OP DES and deployed the speed brake, increasing the rate of descent.

At 1856:42, TACC instructed CI5321：“Dynasty five three two one contact Taipei approach one two five decimal one”5. The PM answered: “One two five one, bye bye”. The master warning appeared at 1857:39 while “EXCESS CAB ALT” message displayed on ECAM during the descent and the VHF 125.1 MHz was selected. The cabin altitude was 9,700 ft at the time when the master warning appeared. The flight crew commenced their emergency descent procedures and donned oxygen masks right after master warning sounded. The cabin oxygen masks were dropped manually by the flight crew during the emergency descent and the maximum cabin altitude reached 13,424 ft during the emergency descent. From 1858:00 to 1859:54, the PM transmitted Mayday calls 3 times on frequency 125.1 MHz, and 1 time at the Guard frequency (121.5 MHz). At 1858:14, Taipei Approach confirmed “Cathay five three one Confirm Mayday”6. At 1901:50, Taipei Approach cleared CX521 descend to FL100.

At 1906:21, cabin crew reported a strong burning smell in the cabin. At 1907:03 the flight crew requested priority landing to Taipei International Airport. The flight was cleared for priority approach and landed on RW 24 RCTP. All ground service units were standing by for emergency. The aircraft stopped off runway at taxiway Sierra Papa (SP) to check for any smoke. After the aircraft stopped on the taxiway SP, the CM2 went to the cabin and checked Door #4 area for burning smells. The CM2

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[6] At that moment CX521 was in the TACC control space, but calling Taipei Approach radio. Meanwhile CX531 was in Taipei Approach control space, Taipei Approach was trying to verify if CX531 declaring MAYDAY.

confirmed the smell was caused by the activation of the oxygen generators. The airport fire engine also checked the exterior of aircraft and reported there was no smoke.

1.2 Injury to persons

No injury.

1.3 Damage to Aircraft

No damage.

1.4 Other Damage

None.

1.5 Personnel Information

The basic information of the flight crews are shown as table 1.5-1.

Table 1.5-1 The basic information of the flight crews

Item	CM1	CM2
Gender	Male	Male
Age	36	34
Date of entry	Oct. 26, 1996	Sep. 13, 2004
Certificate type	ATPL	ATPL
Type rating	A330	A330
Expired date	Apr, 29 2014	June 17, 2018
Medical class/expired data	July 10 2008	Feb.06 2008
Latest flight check	June. 20, 2008	May, 04, 2008
Total flight time	10,994:00 hrs	8,749:00 hrs
Flight time in last 12 months	632:00 hrs	736:00 hrs
Flight time in last 90 days	164:00 hrs	216:00 hrs
Flight time in last 7 days	15:00 hrs	21:00 hrs
A330 flight time	2,396:00 hrs	980:00 hrs
Flight time on the occurrence day	3:20 hrs	3:20 hrs

1.5.1 The CM1

The CM1, age 36, was hired by Cathay Pacific Airways on Oct. 26 1996. He held airline transport pilot's license (ATPL) with a type rating of Pilot in Command in BE 76 and A330, and co-pilot in A330 and A340. The CM1's first assignment with Cathay Pacific Airways was as a Second officer (S/O) on B747-400 aircraft type. He was appointed as a First Officer (FO) on A340 aircraft type in August 2000, and then was qualified as the Captain on A330 on June 20 2008. The CM1 had accumulated a total of 10, 994 flight hours, including 2, 396 flight hours as an A330 Captain.

According to Cathay Pacific Airways' training record, the CM1 completed his recurrent training and proficiency check on June, 19 and 20 2008 and performed his annual line check on July 12 2008. No anomaly specified. The CM1 last completed his recurrent emergency training on November 6 2007.

The CM1's most recent class one medical certificate was issued on July 10 2008 with no restriction.

The CM1 had two days off on September 11 and 12 in Madras. On September 13, he conducted the flight from Chennai international airport (MAA) to Hong Kong.

1.5.2 The CM2

The CM2, age 34, was hired by Cathay Pacific Airways on Sep. 13 2004. He holds ATPL with a type rating of Pilot in Command in BE 76. The CM2's first assignment with Cathay Pacific Airways was as an S/O on the A340 aircraft type, and then he was transitioned as the F/O on A330 in 2007. The CM2 had accumulated a total of 8,749 flight hours, including 980 flight hours as an A330 F/O.

According to Cathay Pacific Airways' training record, the CM2 completed his recurrent training and proficiency check on May 3 and 4, 2008, and completed his upgrade training on September 1 2008. No anomaly specified.

The CM2's most recent class one medical certificate was issued on February 06 2008 with no restriction.

The CM2 had two days off at home on September 12 and 13.

1.5.3 Cabin crew

There were eleven cabin crew members on this flight. All of the cabin crewmembers had completed emergency training (as per requirement) within the previous twelve months. The Cabin Crew training information is shown as table 1.5-2.

Table 1.5-2 The Cabin Crew training information

Category	Position	Date of Joining	Date of completion of Last Safety Training
QIMON	ISM	16th Dec 1985	25th October 2007
QSPON	SP2	8th January 1990	28th February 2008
QFPOJ	FP2	4th April 1995	18th January 2008
QFPOK	FP5	18th January 2000	10th April 2008
QFPOK	FP6	24thFebruary 2000	14th December 2007
QBCON	J1	26th May 2005	1st May 2008
QBCON	J2	2nd March 2006	19th March 2008
ABCOY	Y1	4th August 2008	18th August 08
QBCNN	Y2	2nd March 2006	20th February 2008
QBCON	Y3	6th January 2003	19th March 2008
ABCOY	Y4	30th June 2008	14th July 08

1.5.4 Air Traffic Controller

The basic information and the duties in the 72 hours prior to the occurrence of relevant air traffic controller are shown as table 1.5-3.

Table 1.5-3 Basic information and activities of ATC controllers

Controller	Qualifications	Activities in 72 hours prior to the Occurrence
Radar Controller of the North Sector, TACC	Oct 1991: Tower Control Feb 1995: Radar Control	September 12: controller at 0800 to 1300 September 13: day off September 14: controller at 1300 to 2100
Coordinator of the North Sector, TACC	March 1990: Tower Control August 1993: Radar Control May 2008: Coordinator	September 12: day off September 13: coordinator at 1300 to 1900 September 14: coordinator at 1300 to 2100
Radar Controller 1 (08-19 hr) of the Taoyuan South Sector, Taipei APP	January 2001: Tower Control July 2007: Radar Control	September 12: controller at 0900 to 1900 September 13: day off September 14: controller at 0800 to 1900
Radar Controller 2 (19-08 hr) of the Taoyuan South Sector, Taipei APP	July 2002: Tower Control February 2008: Radar Control	September 12: controller at 0730 to 1730 September 13: controller at 0900 to 1900 September 14: controller at 0830 to 1430 and 1900 to 0800 next day
Supervisor of Taipei APP	December 1985: Tower Control June 1992: Radar Control April 2004: Coordinator February 2007: Supervisor	September 12: supervisor at 0830 to 1430 and 2030 to 0830 next day September 13: day off September 14: supervisor at 1430 to 2030

1.6 Aircraft Information

1.6.1 Basic Information

The airplane basic information is shown in Table 1.6-1 and engine basic information is shown in Table 1.6-2. After the occurrence, the #1 engine bleed air valve and the #2 engine fan air valve and thermostat were removed for maintenance purpose. The basic information for these components is shown in Table 1.6-3.

Table 1.6-1 Aircraft Basic Information

Aircraft		
No.	Item	Description
1	Nationality	Hong Kong, China
2	Nationality mark & registration number	B-HLH
3	Owner	Cathay Pacific Airways Limited
4	Operator	Cathay Pacific Airways Limited
5	Registration certificate number	420
6	Airworthiness certificate number	282-10
7	Valid date of airworthiness certificate	Feb 05 2008 –Feb 19 2009
8	Total flying hours	37666:01
9	Total landing cycles	13880
10	The last letter check	A4 (600 Hrs frequency)
11	Date of last letter check	Sept 08 2008
12	Flying hours since the last letter check	42:38
13	Landing cycles since the last letter check	23
Fuselage		
No.	Item	Description
1	Manufacturer	Airbus
2	Type	A330-342
3	Series number	121
4	Year of manufacture	1996
5	Maximum takeoff weight	217,000kgs

Table 1.6-2 Engine Basic Information

Engine		
No.	Item	Description
1	Manufacturer	Rolls Royce
2	Type	Trent 772-60
3	Series number	41057 / 41022
4	Total service time	24943:39 / 30797:09

Table 1.6-3 Removed Components Information

Item	P/N	S/N	TSI (FH)	TSN (FH)	MTBF (FH)	Installation date
Fan Air valve	6733A030000	00156	17,305	25,203	39,216	21 Jun 2002
Bleed valve	6764B040000	00573	7,895	7,895	4,550	10 Jun 2007
Thermostat	398E020000	00163	10,145	31,547	10,460	6 Apr 2005

1.6.2 Maintenance Records

The maintenance records for the three months preceding the occurrence related to this incident extracted from the Aircraft Maintenance Log are shown in Appendix 2. They are summarized as follows,

▲Repeated defects related to “ENG 1 BLEED PRESSURE LOW” found since July 29, 2008.

▲Repeated defects related to “ENG 1 BLEED NOT CLOSED” found since August 19, 2008.

▲On September 13, 2008, flight from ICN to HKG, the defect was “AIR ENG BLEED NOT CLOSED THIS TIME OCCURING DURING ENGINE WIND DOWN AFTER ENG MASTER SX'D OFF.” Action taken was “NO 1 ENG BLEED VALVE SECURED. CLOSED A/C DISPATCHED PER MEL. ON BLEED PAGE NO 1 ENG BLEED INDICATION SHOWING OPEN ALL THE TIME.” The MEL reference was 36-11-02 (referred to appendix 3).

▲ After dispatching with MEL 36-11-02, the aircraft continued 6 flights (HKG-MNL-HKG-MNL-HKG-NRT-TPE) including the occurrence flight. According to the Aircraft Maintenance Log, none of these flights were ETOPS flight.

▲On September 14, 2008, the defect related to cabin included “CAB PR EXCESS

CAB ALT ALL OXY MASKS DROPPED DOWN & SOME OXY GENERATOR ACTIVATED", the action taken was "15AC, 30AC, 31FG, 32AC, 33HK, 36AC, 36HK, 37HK, 42DE, 45DE, 54HK, 57AC, 62DE, 62FG, 63AC, 63HK, 64AC, 64DE, 64HK, 65DE, 65AC, 65FG, 65HK, 66AC, 66HK, 67AC, 67HK, 68HK DOOR 3L, 4L(*2), 3R, 4R(*2), G5 ACTIVATED, THE OTHERS RESTOWED A/C FERRY FLT BACK TO HKG, NO CABIN CREW ON BOARD, TO CABIN LOG ZADD 225 ALSO SADD RAISED (56PAX SEATS 7CABIN CREW SEATS)"

Deferred defects before the occurrence flight are list in Appendix 4. An item SADD617 related to this occurrence was "AIR ENG BLEED NOT CLOSED THIS TIME OCCURING DURING ENGINE WIND DOWN AFTER ENG MASTER SX'D OFF." which was raised on September 13.

The maintenance current flight report for CX521 is listed as Appendix 5. The report indicated that the aircraft suffered an "AIR ENG 2 BLEED FAULT" during cruise and that the fault was related to "THRM (5HA2)/FAN AIR-V".

The replacement of the fan air valve control – thermostat filter of #2 engines was performed on July 19, 2008. The maintenance record of this work is list in Appendix 5.

1.6.3 Dual bleed system fail events

CPA provided a report which includes some previous events related to bleed air supply being interrupted. The first event occurred on Apr. 10 2008. The aircraft lost the #2 bleed system first, followed shortly by the #1, during climb at FL110. The #1 Engine Overpressure Valve (OPV) and Fan Air Valve (FAV) Thermostat (ThC) were removed and sent to Liebherr for investigation. The investigation found that the ThC filter was contaminated/blocked. The blockage prevented sufficient pressure from entering the FAV in order for it to open. If the FAV does not open, allowing cooler air to the precooler, the bleed air temperature can continue to increase and can cause an OVERTEMP condition and resulting in the bleed air system automatically shutting off. The investigation also confirmed the failure of the OPV.

The second event happened on May 28 2008. The aircraft had been released to service IAW the MEL with the #1 Engine bleed system inoperative. The #2 bleed system failed on descent due to a low pressure condition. The investigation found the FAV ThC was fault on the #1 system. The #2 Engine bleed system failure was caused by a Bleed Air Valve (PRV) failure.

The third event occurred on June 13 2008. The aircraft suffered a momentary interruption in bleed air supply during cruise in icing conditions with the Engine and Wing Anti Ice selected on. The investigation found that the dual bleed loss was caused by OVERTEMP on both bleed systems. The #1 Engine FAV was confirmed as the cause of the #1 Engine bleed loss. The #2 Engine bleed system failure was caused by a leak in the sense line between the FAV and FAV ThC.

1.6.4 Weight and Balance

The maximum takeoff weight of this aircraft is 217,000 kg, the maximum landing weight is 179,000 kg, the maximum zero fuel weight is 169,000 kg. The center gravity at the time of the incident was 36.48% MAC (Mean Aerodynamics Chord). See Table 1.6-4 for weight and balance data of this occurrence. According to A330 FCOM, the takeoff and landing weight limitation is 15% to 41% MAC; the cruising center of gravity is 14% to 42%.

Table 1.6-4 CX521 Weight and Balance Data

Zero Fuel Weight	138,881 kg
Takeoff Fuel	33,100 kg
Takeoff Weight	171,839 kg
Center of Gravity at Takeoff	25.87% M.A.C.
Consumed Fuel in Flight	16,300 kg
Landing Weight	155,681 kg

1.7 Meteorological Information

According to the Typhoon Warnings issued by Taipei Aeronautical Meteorological Center, Typhoon "Sinlaku" became weaker and was centered at approximately 13 NM north of Taipei International Airport at 1700-2000. The forecast track was moving from NNE turning to NE and radius of the storm was 60 NM. Figure 1.7-1 is the infrared satellite image at 1900.

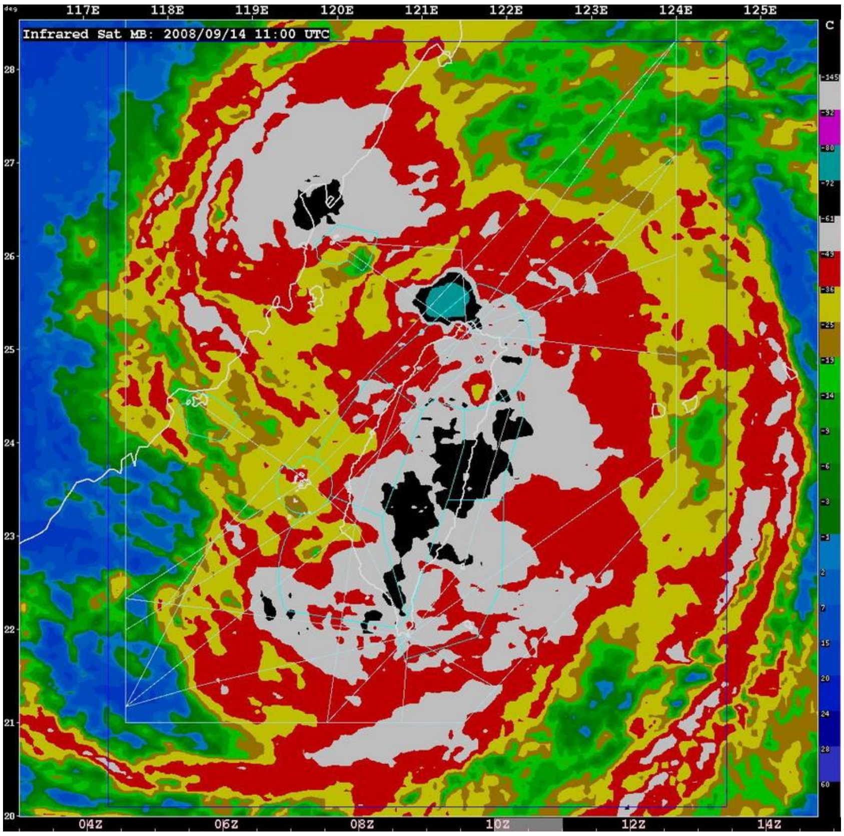

Figure1.7-1 The infrared satellite image at 1900

Taipei International Airport took the following surface weather observations at 1930 as follows, "Wind–220 degrees at 15 knots; Visibility–4,500 meters; Present Weather–shower rain; Clouds–scattered 500 feet broken 1,000 feet few 1,200 feet Cb broken 1,500 feet; Temperature–26 degrees Celsius; Dew Point–24 degrees Celsius; Altimeter Setting–991 hPa; Supplementary Information–RWY 23/24 Wind shear; Trend Forecast–visibility 4,500 meters and shower rain; Remark–Cb at E-SW." (ATIS B)

1.8 Navigation Aids

Not applicable.

1.9 Communications

According to the records of daily radio test at TACC and Taipei Approach, all radio frequencies including 121.5 MHz were normal.

The frequencies used by Taipei ATC were TACC (125.5), Taipei Approach (125.1/124.2), Taipei Tower (118.7), and Taipei Ground (121.7).

1.10 Airport Information

Not applicable.

1.11 Flight Recorders

1.11.1 Cockpit Voice Recorder

The occurrence aircraft was equipped with a Honeywell Solid-State Cockpit Voice Recorder (SSCVR), part number 980-6022-001, and serial number 1562. The total recording of 120 minutes and 55 seconds (recording time 1023:59 ~ 1224:54[7]) was

[7] The CVR and FDR recordings were synchronized by VHF keying before the recorders stopped. The time format for the

downloaded properly. Quality of the recording was good.

The SSCVR recording consisted of four channels of good quality audio information. One channel captured the audio from the CM1's panel, another captured the audio from the CM2's panel, a third captured the audio from the cockpit area microphone (CAM), and the fourth SSCVR channel captured from the passenger public address system. The transcript began at 1054:14.4, the time the aircraft started descent from FL400, and ended at 1124:37.5, the time when contact with Taipei tower was established. A transcript was prepared of the 30-minute 23-second recording.

1.11.2 Flight Data Recorders

The aircraft is equipped with a Honeywell Solid-State Flight Data Recorder (SSFDR), part number 9800-4700-003, serial number 1253. The total recording of 26.24 hours of data was downloaded properly.

After the occurrence, according to the technical document provided by Airbus[8], A total of 450 parameters were recorded in the SSFDR. All the recorded parameters are listed in Appendix 6. The summary of the SSFDR readout is as follows:

1. The Flight Data Recorder complies with ICAO Annex 6 "Type 1" Flight Data Recorder. It satisfies the recording of the 32 mandatory parameters.

2. The occurrence flight took off at 0814:04, keeps recording until 1422:05 (about 2 hours 39 minute after the aircraft landed at RCTP airport).

3. During 1055:46 and 1119:01, the parameters of "Flow CTL valve 1 disagree" and "Flow CTL valve 2 disagree" were activated as "disagree" mode, during which the

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transcript has been converted to Taipei local time (UTC + 8 hr) while the FDR data were described in UTC format.

8 Airbus Flight Data Recording Library V1.9, A330-300，Engine Type：RR Trent 772, FDIU：SFIM ED43B1D7, recording rate 128 words/sec.

aircraft standard pressure altitude decreased from 38,544 ft to 6,384 ft.

4. Between 1057:39 and 1057:42, the parameter of “master warning” was activated. At 1057:39, the aircraft was at the altitude of 30,320 ft, airspeed of 311 knots, and on a magnetic heading of 232 deg. The latitude and the longitude were N26.5136 deg, E123.233 deg. The aircraft was on A1 airway, 122NM north of waypoint “APU”.

5. Between 1057:39 and 1112:23, the parameter of “Exceed Cabin Alt.” was activated, and the relevant standard pressure altitude decreased from 30,064 ft to 8,000 ft.

6. At 1129:11, the aircraft landed at RWY 24, RCTP airport. At 1143:00, the aircraft stopped.

After the occurrence, ASC acquired the QAR raw data and engineering parameters from CPA. The QAR data records the parameter of “cabin altitude”.

Summary of the cabin altitude and pressure altitude are recorded as follows:

1. Between 0840:11 and 1054:40, the cabin altitude remained at 7,952 ft and the standard pressure altitude was about 40,000 ft.

2. At 1057:39, the excessive cabin altitude warning activated, the cabin altitude was 9,680 ft.

3. Between 1054:41 and 1102:28, the cabin altitude continued increasing to 13,424 ft and the standard pressure altitude decreased from 39,612 ft to 13,512 ft.

4. During 1102:29 and 1112:24, the cabin altitude decreased from 13,424 ft to 9,328 ft, the standard pressure altitude decreased from 13,464 ft to 9,328 ft.

1.12 Wreckage and Impact Information

None.

1.13 Medical and Pathological Information

Not applicable.

1.14 Fire

None.

1.15 Survival Aspects

The 11 cabin crews' duty code and assigned seat are plotted on the Fig1.15-1.

1.15.1 Events in the Cabin

The CM1 briefed the ISM (purser) and the cabin crew during the pre-flight briefing that due to Typhoon Sinlaku, they could expect bumpy conditions when arriving TPE. The CM1 instructed the cabin crew members to make sure that the cabin was secured and prepared the cabin for landing prior to the top of descent. The company internal cabin crew reports described that the initial descent was bumpy but not as bad as expected. The cabin safety check was prepared earlier before descent, and all cabin crews were seated and strapped by the time the CM1 made the announcement.

The investigation team had no confirmed factual information about the time when the oxygen masks were deployed. After the oxygen masks were deployed, the cabin lights came on and the automatic PA activated. The automatic PA informed passengers to fasten their seatbelts and donned their oxygen masks. The automatic emergency descent PA was made in English, Cantonese and Japanese.

Shortly after the masks were dropped, cabin crew FP6, and Y3 seated at door R4, noticed a plastic burning smell from the galley area. FP6 immediately contacted the flight deck and the ISM, reported the smell at 1906:21. The ISM requested FP6 to rank the seriousness of the smell from one to five, five being the strongest; FP6 replied with the rank of four. Before landing, the ISM made several calls to FP6 to check the status of the smell, and FP6 stated that the smell remained until landing. Other cabin crew members also noticed a burning smell and the increasing of the cabin temperature.

The CM1 called the ISM at 1911:16 and informed her that they would be landing at Taipei International Airport, CM1 instructed the ISM to prepare the cabin for landing.

According to the CVR transcript, the CM1 made a PA announcement at 1911:38 and announced that they were doing a rapid descent due to depressurization problem. The aircraft was now stable at a safe altitude and passengers were able to breathe normally. They were on approach into Taipei and expect to land in 15 to 20 minutes. The CM1's PA was then translated into Japanese & Cantonese. The ISM then called all stations and informed the cabin crewmembers to prepare for landing.

According to the CVR transcript, the CM1 requested the emergency equipment to stand by at the Taipei International Airport at 1914:40.

The aircraft landed normally and taxied off the runway. The aircraft stopped on the taxiway SP so that the fire crews could perform a visual inspection for signs of fire, smoke or damage.

After the aircraft had stopped on the taxiway SP, the CM2 then went to the cabin to check the Door #4 area for the reported burning smell. The CM2 confirmed that the smell was caused by the activation of the oxygen generators.

The aircraft taxied into bay B4 where the ground staffs were standing by. All passengers disembarked normally through door L1 and the ground engineers boarded the aircraft and commenced the repacking of the unused oxygen masks.

1.15.2 Passenger Oxygen

The passenger emergency oxygen system supplies oxygen to passengers and cabin crew members in case of emergency. The passenger emergency oxygen system has oxygen containers. Each container has a chemical oxygen generator and two or more continuous-flow oxygen masks with flexible supply hoses. The oxygen masks are released automatically if there is a loss of cabin pressurization. If an electrical release latch does not operate, the container door can be opened with a manual release tool. The chemical emergency oxygen-containers are installed above the passenger seats, in the lavatories, above the cabin attendant seats and galley working areas. Each container may equip with 2, 3 or 4 masks oxygen depending on the location.

1.15.3 Oxygen Mask

No other emergency equipment was used except the oxygen masks. Among the 59 passengers, a total of 56 passenger oxygen masks were activated. According to the cabin report, several passengers did not don their oxygen masks. Eight out of the eleven crew members said that their masks were available while the remaining three (ISM,FR2,J1) had no access to their masks. Out of those eight available, three crew members (Y1,Y3,Y4) thought their masks were not working properly. Of the eight cabin crew whose masks deployed, only three (J2,Y1,Y2) that their masks were sused. After the occurrence, maintenance checked and found out that these masks were unable to deploy owing to their access panels being struck. (See Table 1.15-1)

Table 1.15-1 Cabin Crew Mask description

Cabin	Cabin	Mask	Oxygen	Oxygen Generator	Cabin Crew

Crew Position	Location	dropped	Mask used	Activated	Comment
ISM	L1	No	No	No	Mask panel only opened slightly
SP2	L2	Yes	Not used	No	Did not feel that the mask was needed
FP2	R1	No	No	No	Mask panel only opened slightly
FP5	R2	Yes	No	No	Did not feel the mask was needed
FP6	R4	Yes	No	Yes	Initial flow only. Second mask fell to the floor
J1	L1A1	No	No	No	Mask panel only opened slightly
J2	L1A2	Yes	Yes	No	Mask worked OK
Y1	R3	Yes	Yes	Yes	Did not feel the mask was working
Y2	L3	Yes	Yes	Yes	Only felt initial oxygen flow of about 10 seconds
Y3	R4A	Yes	No	Yes	Both masks that deployed failed to give any flow
Y4	L4	Yes	No	Yes	No Oxygen flow

Fig 1.15-1 showed the cabin configuration and oxygen mask conditions which depicts the location of the allocated passenger seats, the oxygen generators activated, crew seating and the masks that did not deploy.

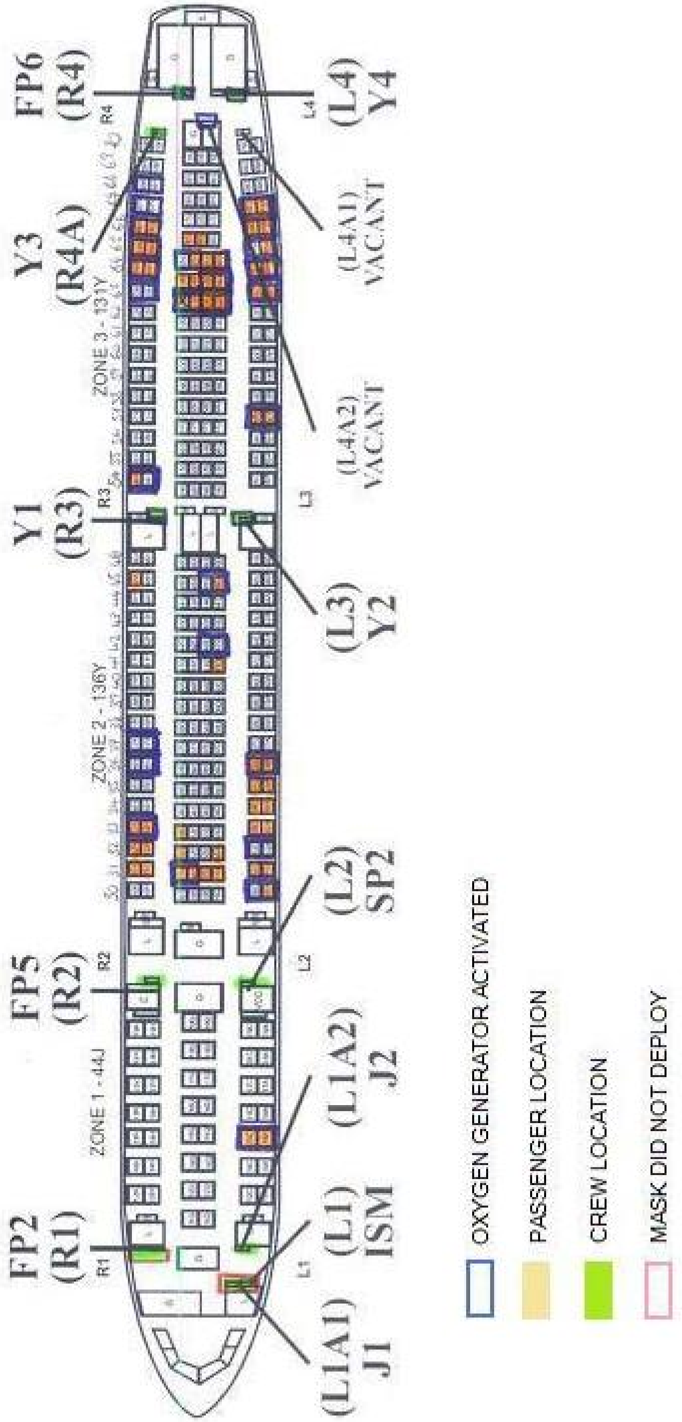

Figure 1.15-1 Cabin Configuration and Oxygen Mask Condition

1.15.4 Crew Training

All the cabin crews had completed their recurrent training within the 12 months preceding the occurrence. The last course also included emergency decompression response.

1.15.5 Aerodrome Emergency Response

According to the Taipei International Airport Fire Fighting logbook, the Flight Operation Division notified the Airport Fire Fighting team at about 1919 that CX521 had lost cabin pressure and would be landed on Runway 24. The Fire Fighting team transmitted this information to their South, West and East stations. All fifteen Fire Fighting trucks arrived at Apron 608, S2, North station and N6 at about 1924. After CX521 landing on Runway 24 at about 1928, three Fire Engines performed a visual inspection from Taxiway SP to Apron B3. After assuring that the aircraft was safe, all fire engines drove back to their respective stations at 1945.

1.16 Tests and Research

1.16.1 Leak rate test

After the occurrence, a leak rate test was performed by the maintenance personnel on September 14, 2008. Refer to Aircraft Maintenance Log, a record “TEST C/OUT IAW AMM 05-53-00-780-803-01 TEST SATIS A/L LEAK RATE APPROX 0.8 PSI/MM”.

1.16.2 Component test

The #1 engine PRV, #2 engines FAV and ThC were removed on September 14, 2008, by CPA maintenance personnel at Taipei Station. These components were then sent to the manufacturer “Liebherr-Aerospace” at Toulouse, France for testing. The test was performed on October 22 2008. The Liebherr-Aerospace hosted the test with approved test bench. Participants to the test included representatives from BEA, CPA, Airbus Design Office and Customer Services. The detailed test reports are referred as Appendix 7. Summary of the test results for each component are as follows,

Test Summary of FAV-ThC

The basic data of this THC is as follows, P/N: 398E020000, S/N: 00163, assembly date 05/1994, TSI 10145 FH, TSN 31547 FH. There was nothing unusual from the visual inspection. A complete hot GO NOGO test has been performed as per CMM 36-11-35 requirements. The unit under test was supplied air at temperature = 205℃ and pressure = 3 Bar. The reduced pressure was 266 mbar which was out of the tolerance, 300±20 mbar, as per CMM. The inlet filter was then removed for contamination check. The filter permeability check was 20 mbar for 100 mbar maximum. This indicated the inlet filter was clean. Further inspection found noticeable contamination on the grid filter. The test team decided to pierce the grid filter to measure the performance of the unit. With unit under the same test conditions as mentioned above, the reduced pressure was 317 mbar which is within the CMM requirement. This test has revealed a lower reduced pressure lower than required in the primary nominal testing condition. This test concluded that the removal of the ThC is confirmed due to the level of contamination at the grid filter location. The contamination level of the grid filter had caused a drift of the reduced pressure (muscle pressure) below the nominal tolerance to the FAV which could lead to prevent a correct full opening of the FAV, causing an over temperature condition on the bleed system of the # 2 engine. The source of the contamination of the grid filter was coming from expected atmospheric pollution going through the ThC past the primary filter.

Test Summary of FAV

The basic data of this FAV is as follows, P/N: 6733A030000, S/N: 00156, assembly date 10/1994, TSI 17305 FH, TSN 25203 FH. High level of external pollution was found during the visual inspection. A complete GO/NOGO test has been performed as per CMM 36-11-24 requirements. The valve passed the pneumatic test. This test has also revealed no indication of the FAV closing position due to wear between the switch lever and the lever that would have caused a drift of the initial switch setting. However AIRBUS said that the missing indication would have an impact in case of bleed low temperature only. This test concluded that the removal of the FAV is not confirmed/justified due to the over temperature condition of the # 2 engine bleed system.

Test Summary of PRV

The basic data of this PRV is as follows, P/N: 6764B040000 Admit a, S/N: 00573, assembly date 12/1999, TSI 7895 FH. Nothing unusual was observed during the visual inspection. A complete hot dynamic testing was performed as per CMM 36-22-35 requirements. This test revealed some minor drifts of the closing indication time and the level of the regulated pressure. Closing indication time at low supplied pressure (2 bars) was 3.1 seconds which was higher than the requirement, 3 seconds maximum per CMM. Regulated pressure was 3.636 bar which was also higher than the requirement, 3.6 bar maximum. The manufacturer, LTS, would consider this level of drift from CMM tolerance as minor. A complementary static test for closing indication issue was performed and revealed a minor drift of the initial switch setting which could affect the PRV closing time. However AIRBUS said the confirmation time to trigger the “bleed not closed” message is 10 seconds. The static test also revealed an external leakage and an actuator piston leakage out of the CMM tolerances. Both above finding were due to carbon seal wear. Tear down inspection also found some traces of corrosion on the piston which could also lead to degrading of the actuator piston seal. This corrosion could be explained by humidity environment in Asia area. This test concluded that the removal of the PRV is not confirmed/justified due to “BLEED NOT CLOSED” message and the PRV MEL configuration indicated open at cockpit.

1.16.3 Passenger Oxygen Mask Drop Test

During the emergency descent the cabin masks were deployed. All of the passenger masks and cabin crew masks deployed, except for those located at doors L1 and R1. A passenger oxygen mask drop test was performed IAW AMM 35-21-00, the test found that the faulty oxygen mask access panel was obstructed by an adjacent panel and prevented the mask from deploying. The oxygen container was repositioned and a subsequent test was conducted whereby all of the cabin masks deployed successfully.

To check the operation of all passenger oxygen mask panels when cockpit switch MASK MAN ON is actuated, a CPA Special Work card SWC-17585 was used by CPA Technical Services for the test. The contents are in accordance with AMM 35-23-00-720-059. A manual door stop was set at each panel to prevent the full deployment of the mask to simplify the restoration procedures. March27 2009, the aircraft B-HLI, A330-342, was parked at Bay T9 of HKIA. Ground power was supplied to the aircraft; APU was not operated during the test. The test was carried out fully in accordance with SWC-17585. CAD Senior Airworthiness Officer and CPA Technical Services Engineer witnessed the test. When the MASK MAN ON push button switch in the cockpit was actuated, all passenger oxygen mask panels opened and were held by the manual door stops to prevent full deployment. All passengers and cabin crew members’ positions were checked. The emergency announcement was operated simultaneously during the test.

As a result of the oxygen mask container door failed to open correctly on the occurrence flight, a 20% fleet check was conducted to confirm fleet serviceability. The fleet inspections revealed no further finding.

1.17 Organizational and Management Information

Not applicable.

1.18 Additional Information

1.18.1 Flight Crew Interview summary

1.18.1.1 CM1 interview

The flight was originally scheduled from Hong Kong to Narita and then from Narita to Hong Kong, but was re-dispatched from Narita to Taipei due to typhoon. The turn-around and takeoff were normal from Narita, the flight was normal in climb and cruise.

During descent from FL 400, TACC cleared CX521 to FL140, arrival at RW 24. The flight crew had already asked passengers and cabin crews to be seated and secured; the weather throughout the descent was heavy rain and moderate turbulence in TPE for the entire descent. The aircraft #1 engine, bleed had been secured and closed per MEL.

When the aircraft was descending through FL370, the ECAM message of air configuration associated with the #1 engine system appeared followed by the #2 engine bleed fault. The flight crew brought up the relevant bleed page and pressurization page, CM1 and CM2 confirmed the cabin pressure problem. The bleed page message was concurrent with the ECAM information.

The flight crew managed the descent, increased the rate of descent and donned the oxygen mask. When the ECAM emergency descent check list appearing, the flight crew followed the check list to conduct the emergency descent to the cleared level at

FL140 and declared Mayday. The rate of descent was 5K to 6K FPM initially.

When passing through approximately FL150, the flight crew requested further descent to FL100, which was granted, and landed on RW 24. During the descent, the flight crew informed ATC that they needed ground emergency services on standby and they were going to stop as soon as they were off the runway.

After the aircraft landing, the flight crew stopped on the runway for approximately 2 minutes and checked the aircraft status; then taxied to the gate after checking the aircraft and confirmed no further anomaly. The weather throughout the descent was heavy rain and moderate turbulence.

When the flight crew was reviewing the pressurization page, the cabin climb rate was about 1,000 FPM initially and increased quickly while the cabin differential pressure dropped rapidly, and the cabin altitude increased from 9 to 10 k feet with the differential pressure continuously dropping. This is confirmed that the pressurization system was abnormal.

The CM2 was the PF, the CM1 was the PM. The CM1 conducted the emergency procedure checks and radio communication, and then took over control at landing phase. The crew turned left initially off the airway about 5 miles east and then flew parallel to the airway and conducted the radio work during emergency descent. The cabin oxygen switch/light on was checked and the crew manually dropped the passenger oxygen masks during the emergency descent. The configuration during emergency descent was clean with speed brake out; the speed was approximate 300 knots, which was below the limit of 330 kts for this configuration. The CM1 did the bleed air system review and reset the system twice, first time was after finishing the emergency procedure; second time was when the aircraft was descending to about 8K feet altitude and the system recovered.

The flight crew noted the #1 engine bleed valve had been secured and closed prior to departure. There were minor operational aspects and the procedure was to ensure that the switch was selected off and the cross bleed selected open. Relevant details were included in the briefing.

The crew stated that the reason to ask the ground emergency service was for precautionary measures and the cabin crew reported the abnormal smell like smoke in the cabin.

1.18.1.2 CM2 interview

CM2 stated that the aircraft operation was normal in accordance with the MEL with #1 Eng. Bleed off. The flight was normal until the aircraft was descending from FL 400 to FL370. They got an ECAM message of air abnormal bleed configuration, (a known problem of the #1 Eng. bleed message) and then followed by #2 Eng bleed fault. The bleed and pressurization pages were checked and the flight crew found that the cabin pressure altitude was climbing and the cabin pressure was dropping.

The aircraft was descending at that time, the CM2 increased the descend rates when ECAM emergency descent procedure appearing. The CM2 was the PF and he increased the descend rate from 1k to 6k fpm, after confirming that the cabin pressure altitude was climbing quickly. The flight crew donned their oxygen masks.

The aircraft was turned to the left to deviate from the airway when CM2 heard CM1 making the Mayday call. While CM2 was concentrating on the flight to make the turn and parallel to the airway, CM1 made several Mayday calls. The flight crew received further descends clearance to 10k feet. After the aircraft reaching 10k feet and below, the flight crew completed the emergency descent procedure and the aircraft landed normally.

The CM2 stated that he did not have much time to check the cabin altitude. CM2 aware that CM1 tried to recover the system twice, but CM2 was not sure if the system had recovered or not. The CM2 was off 72 hours before his duty and he did not take any medicine before the flight.

The flight crew did ask for the emergency services before landing due to cabin crew had reported the burning smell the CM2 went back to check the cabin after landing and found no visible burning, CM2 then concluded the smell could came from the oxygen generators.

1.18.2 ATC Controllers Interview Summary

1.18.2.1 Radar Controller of the North Sector, TACC

The duty of the day started from 1300 to 2100, with a 30 minutes break for every 60 minutes watch. The controller worked at West Sector before 1830, took a break from 1830 to around 1900, and took over the North Sector at 1900. Everything was normal during the transfer of duty, with light traffic of about 5 aircraft under control. The preceding controller cleared CX521 to descend to FL140. After taking over the duty at 1900, the controller instructed an aircraft to descend. Before talked with CX521, the controller was notified by Taipei Approach via hotline that CX521 was conducting "Emergency Descent". The North Sector was then staffed with a radar controller and a data controller. After knowing the situation, both the Coordinator and Supervisor came to assist, and agreed Taipei Approach to clear CX521 to descend to 10,000 feet.

The Coordinator requested Taipei Approach to instruct CX521 switching frequency back to TACC. Then they tried to ask CX521 of the situation and assistance to render. Though all of them were trying to catch what CX521 said, none of them received clear messages from CX521 due to radio noise. Considering no conflicting traffic and better communication quality, the coordinator and supervisor coordinated with Taipei Approach, and decided to transfer this aircraft to Taipei Approach in advance.

Radio transmissions from the CX521 were garbled most of time, but communications with other flights were clear. Normally, controllers under such circumstances would ask aircraft to say again or to change to an alternate frequency. Since CX521 was approaching Taipei Terminal Control Area without other conflicting traffic, and intended to land at Taipei International Airport, Supervisor and coordinator considered that to change the frequency and handled by Taipei Approach would be more appropriate.

In accordance with facility directives, all radio frequencies should be tested in the morning shift and the test results should be recorded on a log by controllers. Being on duty in the afternoon, the controller was not obligated to test radio. The frequency of 121.5 MHz was turned on in speaker status. Normally, transmissions could be heard from the speaker, but no transmission from CX521 was heard during the occurrence.

1.18.2.2 Coordinator of the North Sector, TACC

The duty time of that day was from 1300 to 2100. There were 2 coordinators responsible for 2 sectors respectively in day shift. After 1900, there was only one coordinator, responsible for 4 sectors. Coordinators did not have fixed order of rotation or break and themselves must find appropriate break or meal time. Before 1900 the coordinator was responsible for West and South Sectors. At around 1857 prior to the transfer of duty, another coordinator told him aircraft in the North Sector requested deviation for weather. In addition to this, no special items was told. The coordinator was monitoring the duty changes at the West Sector before moved to the North Sector at around 1900. There were only four to five aircraft on radar display.

The coordinator was not aware of the situation when CX521 called Mayday, but he recognized it when Taipei Approach notified that CX521 was in its frequency. The first call from Taipei Approach was received by the data controller at North Sector, and he did not overhear the contents of conversation. The coordinator thought this aircraft under their control had changed to wrong frequency. Usually the transfer of radar identification to Taipei Approach should be made at 40 NM from ANBU VOR, with aircraft altitude of FL140 for Runway 23/24, and FL200 for Runway 05/06. Then CX521 was at about 90 NM from ANBU, where terminal radar used by Taipei Approach could not detect. Thinking of continuing to provide radar services, the coordinator requested Taipei Approach to change CX521 back their frequency. After establishing radio contact with CX521, they confirmed its call sign and situations, and asked about assistance possibly rendered. The response received was “unstable” or “standby” and they stopped bothering and asking the crew for not to interfere his operations. After this, the coordinator asked Taipei Approach to take over in advance, allowed it to handle the situation in time, and asked about the situations and assistance required. They applied automatic radar handoff, and transferred CX521 to Taipei Approach at 10,000 ft at about 60 NM from ANBU where Taipei Approach could be able to detect CX521 on radar display. After completing the transfer of radar identification, they instructed CX521 to switch radio frequency.

The occurrence happened during the period of duty and shift changes, and then the coordinator checked with the radar controller to see whether the controller had instructed the correct frequency. The coordinator was not sure whether CX521 had ever called on frequency 121.5. When they communicated with CX521, its transmissions were garbled probably because the flight crew were operating the aircraft and talked vaguely. This might not be radio problems. The coordinator was busy coordinating with Taipei Approach and had little time to monitor the radio.

1.18.2.3 Radar Controller 1 of the Taoyuan South Sector, Taipei Approach

The duty time was from 0800 to 1900. The controller took a break between 1800 and 1830, and took over the position after 1830, with a coordinator monitoring the radio. There was not much traffic, but the controller was busy for all aircraft requested weather deviation. Prior to transferring the duty to another controller, and clearing another aircraft turning to final, he heard a very weak voice calling “Mayday Mayday Mayday”. At the beginning, the controller thought the call was caused by radio interference. Then he focused his attention on CX531 due to similarity of call sign. Therefore he asked CX531 whether it was declaring emergency. CX531 answered no and wondered why he asked such a question. Thereafter the controller cleared CX531 for approach when it was about 15 NM from airport at four or five thousand feet.

Then CX521 called Mayday again. Since one typhoon just passed Taiwan, all aircraft requested weather deviation. The controller was busy arranging the approach sequence for arrival aircrafts, thought that aircraft was outside of his airspace of jurisdiction, and could not pay too much attention on the aircraft calling Mayday. The controller assumed that it was an aircraft changing to wrong frequency or noise caused by radio interference. The coordinator beside him also heard the call, and thought the call came from other facility or aircraft under other facilities control. Then CX521 called Mayday on channel 121.5 MHz Hearing the transmissions of Mayday again, the coordinator checked with the North Sector of TACC, and confirmed CX521 was under TACC control.

After the controller transferred his duty, the coordinator requested him to stand by behind should an emergency raised. The supervisor requested him to use 124.2 MHz providing services solely for CX521. The coordinator and supervisor coordinated with

TACC, and then TACC transfer CX521 to him. Trying several times, the controller finally established radio contact with CX521. Before he took over the control, no one informed him of reasons why CX521 was calling Mayday.

1.18.2.4 Radar Controller 2 of the Taoyuan South Sector, Taipei Approach

The duty on the day started from 1900 to 0800 next day. About 1856 or 1857, the controller was changing the duty and about to take over the position with complicated traffic. It was right after the Typhoon “Sinlaku”, and there was much inbound traffic from Hong Kong. The controller had 6 to 7 aircraft in hand simultaneously. Since the weather was pretty poor, and aircraft deviated from previously assigned routes, the radio communication workload was heavy that instructions to aircraft were always interrupted and that he must repeat each instruction for two or three times.

Before TACC completed the identification transfer, CX521 called him. At first, he was not sure who was calling because the call sign was similar to CX531 they had in hand. But it also sounded not like CX531 for it was on radar display at 5,000 feet with no reasons for an emergency descent. Therefore the controller restated the approach clearance to CX531. As soon as they heard Mayday, they relayed the information to the supervisor. The supervisor began to handle the situation while they continued to provide services to other aircraft. Latter confirmation unfolded that the aircraft calling Mayday was not in their area of jurisdiction. The supervisor told them the aircraft was still more than 100 NM away. The radar coverage of terminal radar was set at around 60 NM.

Runway 23 and 24 were in use. Considering the terrain elevation of Mt. Young-Ming and its location close to final approach course, ATC did not have enough room for vectoring aircraft. Radio communication was congested at the time, and they did their best to respond to requests from aircraft. When CX521 requested descend, he had no idea where and who it was. This was why he did not approve its request immediately due to that ATC's main task was to provide separation among aircraft. The supervisor was coordinating with TACC, and the controller cleared CX521 to descent to 10,000 feet as instructed by the supervisor.

The controller was too busy to collect information of the aircraft. He issued clearances as instructed by the supervisor. When CX521 was requesting descend, he tried to locate its position. Because the pilot should be very busy, having no time to report aircraft position, the supervisor requested him to change its frequency back to 125.5 MHz after a short while, CX521 called again, but the controller had so many aircraft in hand, and had no idea what was going on.

Eight to nine minutes later, CX521 cruised at 10,000 feet and his workload decreased gradually to some extent that he had more time to communicate with CX521. He requested CX521 to report its position. When it reported its DME from ANBU VOR, the controller observed the target just came out from the edge of radar display. He identified the aircraft by the track and position reported. TACC did not initiate the radar handoff. The controller thought the supervisor had done all the required coordination with TACC. After being identified, the aircraft requested to land at Taipei International Airport, and the controller asked about its preferred runway. Then the supervisor instructed him to transfer the aircraft to controller on frequency 124.2 MHz.

The quality of radio communication with the CX521 was poor when it was under his control. In addition, the call sign broadcasted by CX521 was not clear. Sometimes the crew called Cathy five two one; sometimes they called Mayday five two one. It was confusing and the controller could not fully comprehend its call sign. He guessed the crew probably had put on oxygen mask and that his voice was vague and distorted.

1.18.2.5 Supervisor of Taipei Approach

It was Sunday, and they did not have all positions operating to serve aircraft, with two controllers fewer than that in a weekday. If Taoyuan South Sector had heavy traffic, controller of Sonshan Sector would be asked to assist in taking care of inbound traffic and handing them over to the Taoyuan South Sector for vectoring aircraft to final approach course. Sonshan Sector was not in service that day. There were 2 controllers providing service in one sector. The occurrence happened during the changes from afternoon shift to night shift, with moderate traffic under control. When CX521 broadcasted on the frequency 125.1 MHz of the Taoyuan South Sector, its transmissions were not clear. Because it was calling “Taipei, Taipei”, they did not know which ATC facility it called due to the fact that both Taipei Control and Taipei Approach were called Taipei. The call sign broadcasted was loud and clear, but no controller had such an aircraft in hand. When CX521 called, the controller on that frequency was vectoring CX531 which had a similar call sign to that of CX521. Because there were several aircraft of Cathay Pacific Airways at that moment, the controller asked if CX531 was calling Mayday, and CX531 responded with “negative”. After confirming CX531, the controller thought the transmissions were caused by radio interference, and did not respond later.

After a short while, CX521 called Mayday again. They wondered what happen, but it became clear for they found the control strip of CX521 which was an inbound traffic, and should be with TACC before TACC handed over to Taipei Approach. Normally aircraft should be transferred by ATC automatic systems. So the Supervisor queried TACC what happened to CX521, and why TACC implemented radio transfer before completing radar identification transfer, but then TACC was not aware of the situations. When they realized CX521 requesting emergency descent, they coordinated with TACC to clear it to descend to 10,000 feet. Later TACC requested them to ask

CX521 to change frequency back to TACC. Radio communication between TACC and CX521 seemed not well established so TACC requested them to take over. The Supervisor requested TACC to change radio to a designated frequency of 124.2 MHz solely for CX521. Due to TACC internal problems in relaying the message, CX521 came back on 125.1 MHz again. At that time, the controller on 124.2 MHz was ready and had completed radar handoff procedures. The controller on 125.1 MHz was then very busy in ensuring separation among aircraft and vectoring them to final approach course, and wondered why TACC initiated radio transfer before completing radar identification transfer. This is why the controller asked CX521 of its position, and began, not as instantaneously as usually, to identify CX521. Later the Supervisor requested the controller to request CX521 to change frequency to 124.2 MHz after communication established with CX521 on 124.2 MHz, he instructed the controller to ask about aircraft status, ground services and assistance required. In addition, the runway CX521 intended had many aircraft ahead on final approach course. They first instructed it to reduce speed, but then for priority they vectored other aircraft ahead to another runway. The radio transmissions from CX521 were poor with unstable voice volume possibly due to problems concerned pilots or other reasons.

1.18.3 Sequence of events

The sequences of events summarized below are based on interview notes, ATC transcripts, and CVR and FDR data.

- The Flight Crew acknowledged that the #1 eng. bleed had been secured and closed for engineering reason as per MEL before departure.
- 1614:04：The aircraft took off.
- 1847:42：CX521 made initial contact with TACC.

- 1852:32：TACC cleared the aircraft to descend to FL 140.
- 1852:32：The selected altitude was reset to FL 140.
- 1854:14：CM2 called out “start descent altitude flight level one four zero”.
- 1854:21 to 1856:06：The VVI was stable at around -1,000 FPM. The TACC cleared CI5213 direct to Grace, CM1 called TACC to clarify if the clearance was cleared CX521 direct to Grace. The TACC answered negative dynasty five two one three direct to grace.
- 1855:46：The flow CTL valve #1 and #2 indicated “disagree” at altitude 38,544 ft.
- 1856:05：CM1 called out “air engine two bleed fault” and CM1 reconfirmed it.
- 1856:14：The flight crew found the cabin pressure was rising and decided to descent quicker.
- 1856:17 ~ 1856:39：The VVI was -2,016 FPM to -5,116 FPM.
- 1856:42：TACC instructed CI5321 to change frequency to Taipei Approach on 125.1.
- 1856:48：CM1 answered “one two five one bye bye”. The VVI was -6,016 FPM.
- 1857:01 to 1857:33：The flight crew was discussing the bleed fault advisory and CM1 suggested reducing the descend rate.
- 1857:22：The VVI was -8,416 FPM.
- 1857:39：The “Master Warning” and the “Excess Cabin ALT” initiated at FL 300. The VVI indicated -5,152 FPM. The aircraft position was around 122 NM from APU on A1 route.

- 1857:40：The CM1 called “okay emergency sounds”.
- 1858:00：CM1 called “Mayday, Mayday, Mayday” on frequency 125.1 MHz and confirmed they were in emergency descent.
- 1858:14：Taipei Approach answered “Cathay five three one confirm Mayday.”
- 1858:18 to 1859:04：The flight crew executed the emergency descent procedures.
- 1859:13：CM1 called Mayday again on Guard frequency 125.1 MHz
- 1859:34：Taipei Approach confirmed the Mayday call was from frequency 125.1 MHz.
- 1859:55：CM1 called Mayday and passing FL 200 on frequency 121.5 MHz.
- 1859:56：Taipei Approach used hotline informing TACC North Sector of Mayday broadcasted by CX521 in its control area on 121.5 MHz and inquiring TACC to acknowledge.
- 1900:20：TACC attempted to contact CX521.
- 1900:59：CM1 requested further descend.
- 1901:04：Taipei Approach instructed CX521 to report position.
- 1901:12：CM1 said reaching flight level one four zero and requested further descent.
- 1901:28：Taipei Approach used hotline to contact and coordinated TACC for clearing CX521 descend to 10,000 ft.
- 1903:03：CX521 was still under TACC Control. TACC asked Taipei Approach via hotline to instruct CX521 back to TACC.

- 1903:13：Taipei Approach instructed CX521 contact Taipei control on 125.5 MHz
- 1904:46：CX521 reached 10,000 ft.
- 1905:43：TACC and CX521 were unable to establish radio communication due to VHF noise. TACC coordinated with Taipei Approach to transfer CX521 earlier and use 124.2 MHz solely for CX521.
- 1906:21：The cabin crew reported there was strong burning smell in cabin.
- 1907:03：CM1 requested priority landing to Taipei.
- 1907:26：TACC completed radar handoff with Taipei Approach.
- 1907:38：TACC North Sector radar controller instructed CX521 to change frequency to 125.1 MHz
- 1907:48：CX521 read back of frequency change to 125.1 MHz
- 1907:52：TACC North Sector radar controller corrected previously delivered message and instructed CX521 to change frequency to 124.2 MHz CX521 did not read back.
- 1908:00：TACC informed Taipei Approach via hotline that CX521 already changed frequency to 125.1 MHz instead, not 124.2 MHz
- 1908:14：CM1 requested priority for approach.
- 1908:49：CM1 reported the position at 62 miles from APU.
- 1910:09：Taipei Approach cleared CX521 descend to 8,000 ft.
- 1911:14：Taipei Approach instructed CX521 to change frequency to 124.2 MHz
- 1912:23：The “excess Cabin ALT” cleared.

- 1919:00：The flow CTL valve #1 and #2 indicated “not D/A” at altitude 6,392 ft.
- 1919:14：CM1 tried to recycle the bleed.
- 1919:20：CM1 reported the bleed two had recovered.
- 1923:02：Taipei Approach instructed CX521 to contact Tower.
- 1929:17：The aircraft landed on Runway 24, Taipei/Taoyuan Airport.

1.18.4 Radar handoff process of Taipei Area Control Center and Taipei Approach

The sectorization of North Sector of TACC is as follow:

North of the lines by connecting 244600N 1240000E, 243900N 1213400E, 250000N 1212500E and 260000N 1200000E (excluding TMAs) and altitude is UNL/1200FT AGL. The sectorization of Taipei Terminal Control Area is as follow:

From the intersection of ANBU VOR 005 radial and 40 NM arc of Taipei/Songshan airport; then clockwise along the 40 NM arc to the intersection of ANBU VOR 205 radial and 40 NM arc of Taipei/Songshan airport; thence direct to 2422N 12100E; thence direct to 2448N 12025E, thence direct to the point of beginning. Altitude is FL200 (including)/1200FT AGL (including).

Figure 1.18-1 is the sectorization of TACC and Taipei Approach.

CX521 was an inbound aircraft to Taipei/Taoyuan International Airport. According to the “Letter of Agreement” and “Coordination Procedures of Departure and Arrival Aircrafts” of TACC and Taipei Approach, transfer point AN is a reference point for radar handoff of the A1 route. AN is located at 052 degree and 36 NM from ANPU VOR. Handoff altitude is FL140 when runway 23/24 is used.

According to Para 5-4-5, Controller Handoff, Air Traffic Management Procedures (ATMP), the transferring controller shall complete a radar handoff prior to an aircraft's entering the airspace delegated to the accepting controller, and comply with the provisions of Para 2-1-18, Radio Communication Transfer, to the extent possible, transfer communications when the transfer of radar identification has been accepted.

From the radar display records of TACC and Taipei Approach, TACC proceeded to handoff CX521 by radar automation systems at 1907:05. TACC and Taipei Approach completed radar handoff at 1907:26 and the distance from ANBU VOR to CX521 was around 71 NM at an altitude of 10,000 feet. TACC instructed CX521 to contact Taipei Approach at 1907:38.

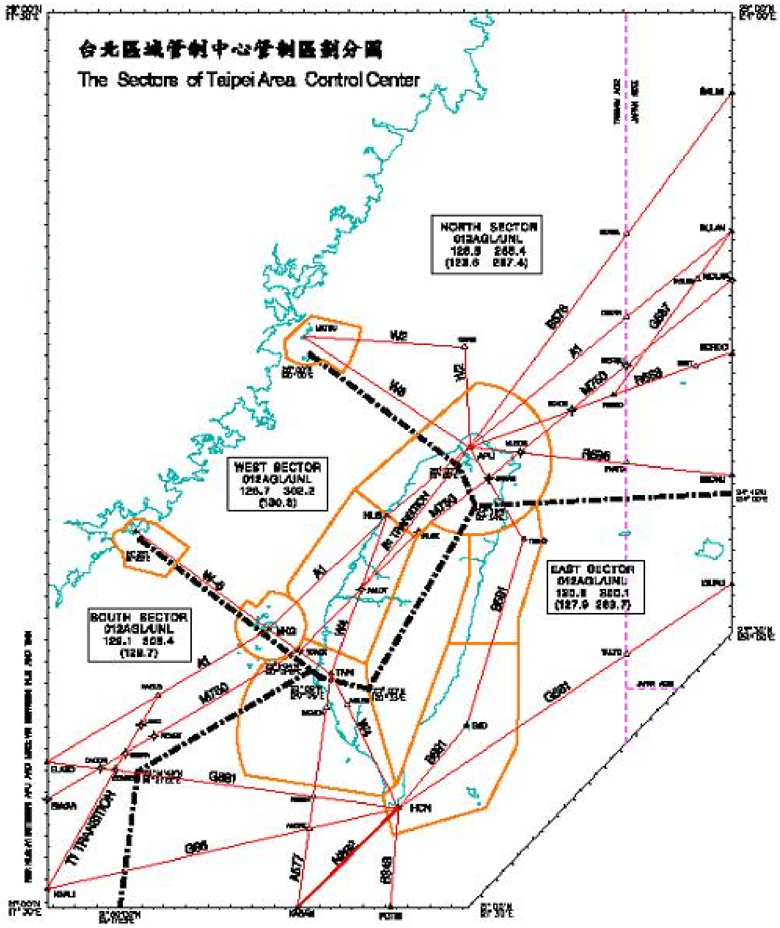

Figure 1.18-1 The sectorization of Taipei Area Control Center and Taipei Approach

1.18.5 A330 Bleed Air Supply System

Refer to Maintenance Manual, 36-00-00 PNEUMATIC – GENERAL –DESCRIPTION AND OPERATION, *A. Pneumatic Air Sources, The aircraft engines; the APU or a ground air source can supply compressed air to the pneumatic system. The distribution system supplies the compressed air from the different sources to the user systems.* (Schematic referred to Figure 1.18-2)

(1) The aircraft engines are the primary source of compressed air in flight. The air is bled from the 8th or 14th stage of the engine High Pressure (HP) compressor. The engine bleed air is temperature and pressure controlled.

(2) The Auxiliary Power Unit (APU) is the primary source of compressed air on the ground. The air is bled from the APU load-compressor module. You can also use the APU to supply bleed air to the user systems during flight. The APU can supply bleed air:

- *during the climb, from the ground until the aircraft reaches 23000ft. (7010 m),*

- *during the descent, from 21000 ft. (6400 m).*

Refer to the Aircraft Maintenance Manual, Chapter 36-11-00, *ENGINE BLEED AIR SUPPLY SYSTEM – DESCRIPTION AND OPERATION*

1. *General: The purpose of the engine bleed air supply system is to: select one of the two compressor stages of the engine HP compressor in agreement with the supplied pressure, regulate the bleed air pressure in order to prevent overpressure, to regulate the bleed air temperature in order to prevent over temperature. The engine bleed air system supplies the user systems (refer to 36-10-00) and is monitored by the Bleed Monitoring Computer (BMC). The engine of each wing normally supply air to one of the two identical air conditioning systems and their associated wing ice*

protection systems.

3. <u>*System description*</u>*: Each engine bleed air system includes three main sub-systems which are described hereafter:*

(1) Pneumatic transfer system

This sub-system enables the selection of the HP compressor stage from which air is to be bled. It includes two main components: the HP bleed valve and the IP bleed check valve. This sub-system bleeds the air from the intermediate or higher stages of the compressor depending on the available pressure and engine speeds as follows:

- *In the normal engine air bleed configuration, the air is bled from the compressor IP port (intermediate pressure, on the 8th stage) at high engine speed.*

- *At low engine speed, especially during aircraft descent, with engines at idle, the IP port pressure is insufficient. The air is automatically bled from the HP port (high pressure on the 14th stage) through the HP bleed valve and the pressure downstream of this valve causes the IP bleed check valve to close. When the IP port pressure exceeds the HP bleed valve target value, the HP bleed valve closes. Air bleed transfer from the HP port to the IP port is pneumatically achieved; air is directly bled from the IP stage through the IP bleed check valve. There are three cases of pneumatic operation:*

- *HP stage pressure lower than 40 psig (average value): Air is bled from the HP port through the HP bleed valve which is fully open. The IP bleed check valve is closed to prevent any air recirculation through the engine.*

- *HP stage pressure higher than 40 psig and lower than 185 psig, and IP stage pressure lower than 40 psig: Air is bled from the HP port through the HP bleed valve which regulates the downstream pressure at 40 psig. The IP bleed check valve* *is closed to prevent any air recirculation.*

- *IP stage pressure higher than 40 psig: If the solenoid of the HP bleed valve is not energized, air bleed transfer from the HP port to the IP port is pneumatically achieved. The IP bleed check valve is open.*

(2) Pressure limitation system

This sub-system includes a bleed pressure regulating valve designated bleed valve associated with a bleed valve control solenoid. This sub-system enables the aircraft systems to be supplied with air under a normal nominal pressure lower than or equal to 48 psig (cruise normal flow). The IP stage bleed air pressure (or HP stage pressure if the HP bleed valve fails in the open position) is limited downstream of the bleed valve. The bleed valve operates pneumatically in relation with the associated bleed valve control solenoid. The bleed valve control solenoid is connected to the bleed valve by a pneumatic sense line and is installed in the duct downstream of the precooler exchanger. The bleed valve control solenoid controls the bleed valve closure when the valve solenoid is energized by the BMC or by action on the ENG BLEED pushbutton switch or ENG FIRE. The bleed valve control solenoid reduces the bleed valve regulated pressure when the temperature exceeds 235 ^{0}C. In case of overpressure caused by the bleed valve failure, the overpressure valve closes.

(3) Temperature limitation system

This sub-system comprises the following components: a precooler exchanger and a fan air valve associated with a control thermostat. This sub-system enables the aircraft systems to be supplied with air under a normal temperature lower than or equal to 200 ^{0}C. A second level of control at 150 ^{0}C (adjustable) is available. It is activated by the BMC according to the demand of the air conditioning system. The bleed air is cooled down by modulating the air flow bled from the engine fan through the precooler *exchanger. At the precooler exchanger outlet, the control thermostat adjusts the fan air valve control pressure and thereby the valve butterfly position so as to limit the temperature at the above mentioned values.*

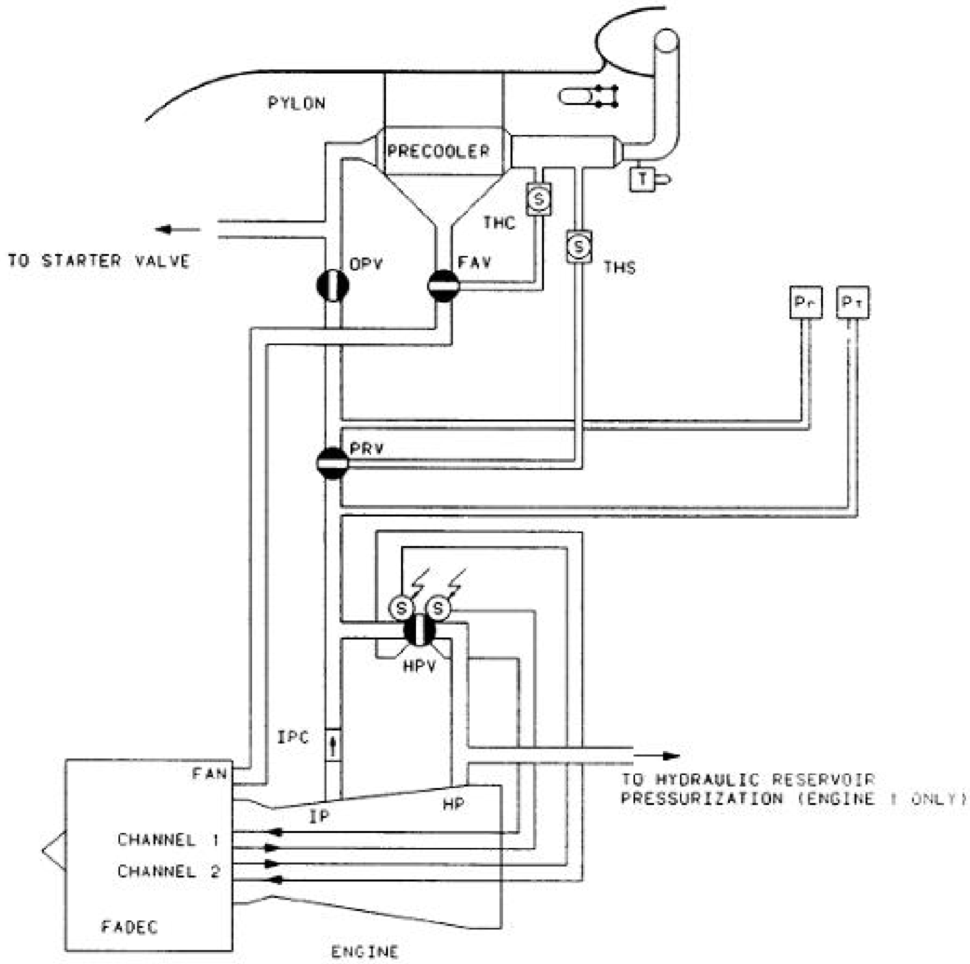

Figure 1.18-2 A330 FCOM pneumatic system description 1.36.10

1.18.6 A330 Air Conditioning System and Cabin Pressurization

According to the A330 Aircraft Maintenance Manual, Chapter 21-00-00,

Air Conditioning, General-Description and Operation: *The air conditioning system keeps the air in the pressurized fuselage compartments at the correct pressure, temperature and freshness. In normal conditions, the pneumatic system supplies air to* *the air conditioning system from: the main engine compressors, the APU compressor, or a high-pressure ground-air supply-unit. The hot compressed air is cooled, conditioned and supplied to the fuselage compartments and then discharged overboard through the outflow valves. You can also supply conditioned air to the distribution system through a low pressure ground-connection. The air conditioning system gives satisfactory values of pressure, temperature and freshness of the air in the pressurized fuselage. It has the subsequent subsystems: distribution, pressurization control, heating, air cooling, and temperature control.*

Refer to A330 Aircraft Maintenance Manual, Chapter 21-30-00：

3. System Description: The cabin pressure controller 311HL or 312HL controls the pressure in the fuselage. It follows a programmed law to give passenger and crew comfort. The cabin pressure controllers are the same and operate independently; only one operates at a time. They make sure that the pressure in the fuselage is not less than the atmospheric pressure at 8000 ft. (2438.35 m) when the aircraft is at maximum cruising altitude. They also control the rate of change of pressure in the fuselage. If a failure occurs, the pressure in the fuselage does not go below the atmospheric pressure at 15000 ft. (4571.91m).

7. Operation/ control and indicating, D. Failure Indications, (3) Excessive Altitude: If the cabin altitude exceeds the nominal limit of 9550 ft. (2910.78m) during cruise: a continuous repetitive chime is heard, the red MASTER WARN lights flash, on the EWD of the EIS, CAB PRESS EXCESS CAB ALT and the necessary steps are shown, on the SD of the EIS, the PRESS page comes on, the cabin altitude and indicator are shown red. The cabin altitude limit during climb and descend depends on the airport altitude for take-off (or landing). This limit is between 9550 ft. (2910.78 m) and 14350 ft. (4373.79 m).

1.18.7 Preventive Cleaning / Replacement of the Temperature Control Thermostat Filter

To improve the reliability of the engine air bleed system, the aircraft manufacturer AIRBUS released Service Information Letter, SIL 36-055, and June 28, 2004. The revision 01 dated November 15, 2006, referred to appendix 8. The Description on this SIL is quoted as follows,

In the frame of a preventive maintenance action, we would recommend operators to perform a cleaning or replacement of the TCT / Th.C filter, with the following interval:

. For A320 family aircraft, every 6000 FH

. For A330 aircraft, every 6000 FH

. For A340 aircraft, every 12000 FH

Please note that each operator may customize the task interval from the above recommendation depending on the operating environment (highly polluted or sandy area), and their findings every above-mentioned interval. As an example for A330s operating in highly polluted or sandy area, it has been evidenced that this preventive task should be performed up to every 3000 FH.

Before the occurrence, Cathay Pacific Airways engineering conducted a review of the cleaning requirements for the filters. The Airbus Maintenance Planning Document (MPD) requires FAC-FAV filters to be cleaned every 6000FH. Referring to the (SIL) 36-055, CPA’s practice at the time was to replace, not clean, the FAV ThC filter as part of the 1C check accomplished every 15 months. The A330 daily utilization is 11 hours per day, therefore 3000FH is accumulated every 9 months. As a result, a program was introduced to remove and replace all FAV ThC filters that had accumulated more than 3000FH. A total of 38 ThC filters were identified and replaced by the end of July 2008.

The filter of B-HLH no.2 engine FAV-ThC was replaced under this program. The recent replacement was done on July 19, 2008. The maintenance record referred to 1.6.2.

After the occurrence, CPA engineer also performed a FAV ThC component reliability analysis showed that an interval of 3,100 flight cycles would provide a failure rate of less than 25%. This new flight cycle overhaul limit has been updated in the component tracking system.

1.18.8 Related Operations procedures and Regulations

The Operations procedures for aircraft emergency and communications are shown as Appendix 9.

The ATC procedures for aircraft emergency are shown on chapter 9 of Air Traffic Management Procedures (ATMP) as Appendix 10.

2 Analysis

2.1 Flight operations

The CX521 flight crew was certified and qualified in accordance with Hong Kong Civil Aviation Department (Hong Kong CAD) Regulations. The flight crew's duties and rest times was legal within 72 hours prior to the occurrence. No evidences showed consuming of alcohol or usage of drugs of the crews. The weight and balance was within limits. Based on the weather information contained in Section 1.7, the weather condition was poor due to circumfluent air flow from Typhoon "Sinlaku" at the time of the occurrence; the flight encountered with a moderate turbulence and shower rain.

The crew action in handling the dual bleed loss and the emergency descent were in accordance with procedures in general , with the following exceptions stated as below.:

2.1.1 Inadvertent frequency change

The CX521 was under TACC control at 1855:56 from flight level 400. One bleed system had been closed as per MEL 36-11-02 prior to departure, and the remaining bleed also failed when passing flight level 380. Flight crews decided to increase descent rate when discovering the cabin altitude increased due to bleed fault. Based on the CVR, TACC called at 1856:42：「dynasty three two one contact Taipei Approach one two five decimal one」. The CM1 replied:「one two five one bye-bye」. From the transcript above, the CX521 flight crew switched to 125.1 mistakenly, which instruction was given to Dynasty 5321, other flight a similar call sign within the same control space.

The probable mistakes in switching to 125.1 could be:

● A similar call sign on the same frequency (i.e.: CI5321, CI5213 etc.), similar call sign might caused the flight crew or ATC controller misheard or received wrong message. This also could be shown from the fact that at 1854:21 when TACC gave CI5213 permission to direct to Grace but misheard by CX521 that was permitted to Drake. The mistake was corrected by TACC when the CM1 read back the instruction. AT 1856:42, TACC cleared Dynasty five three two one to TPE Approach, Cathay five two one responded and acknowledged the frequency change. A similar mistake happened again at 1858:13 and 1858:20 when TPE APP misidentified Cathay five three one as the aircraft transmitting the MAYDAY message.

●Distraction and increased workload：

The CVR data showed at 1056:05UTC, the flight crew identified number two engine bleed fault and the increasing cabin altitude, from CVR data 1056:00 to 1056:50 UTC (Ref. Appendix 1) identified that the flight crew was busy on dealing with the AIR ENG 1(2) BLEED FAULT message. The flight crew were focused on bleed fault, cabin pressure & rapid descend may have resulted in less attention to radio watch and believed the instruction of TACC for frequency change was given to them.

Based on the FDR and CVR data, CX521 altitude was 35,000 ft and the distance was 120 nautical miles from waypoint APU (AnBu) (Ref. 1.18.4) while making the frequency change to 125.1. The AIP indicates a normal transfer point from TACC to APP is at 40 nautical miles north of APU between 10,000 ft and 20,000 ft altitude. The flight crew of CX521 could have questioned the TACC frequency change instruction if they were not distracted by anomalies and aware of their current position was still within TACC control area.

●Not completely adhere to company communication procedures:

The Dynasty 5213 acknowledgement of the frequency change was coincidental and occurred at the same time when CX521 responding to TPE ATC, combine with the flight crew did not including the flight call sign at the end of the transmission. According to the communication procedures in CATHAY PACIFIC Operations Manual, flight crew shall read back the frequency change instructions followed by a full call sign of the flight; as well as on the new assigned frequency to establish communication at immediate manner. During the flight, the CX521 flight crew at 1854:22 mistakenly confirmed TACC clearance and followed by at 1856:42 flight crew incorrectly acknowledge and switched the frequency to 125.1.During those times, flight crew did not strictly adhere to the company communication procedures in which the CM2 did neither read back the flight call sign at the end of the transmission nor on the new frequency prior to their frequency change, CM1 also did not remind CM2 to do so.

Incomplete radio read back and calls out from the CX521 flight crew with other aircrafts stepped on during transmitting made both controller and pilot lost opportunity to correct the mistake.

2.1.2 Flight crew actions

The relevant flight crew actions regarding this occurrence are 「AIR ENG 1(2) BLEED FAULT」, 「AIR DUAL BLEED FAULT」,「CAB PR EXCESS CAB ALT」 and 「EMER DESCENT」(Ref. 1.9.2). Actions to be examined include before 「CAB PR EXCESS CAB ALT」 and after 「CAB PR EXCESS CAB ALT」warning occurred are list as below:

2.1.2.1 Before 「CAB PR EXCESS CAB ALT」

The CX521 was released with number one engine bleed valve inoperative as per

MEL36-11-02. The number one bleed valve must be secured and closed with the cross bleed opened resulted in the number two bleed valve became the only source for cabin pressure.

According to FDR and CVR data, at 1855:46 the flight was descending and passing 38,500 ft with 1,000 fpm descent rate, the FDR showed “Flow Control Valve Disagree”. At 1856:05 CM1 called 「AIR ENG 1(2) BLEED FAULT」. At 1856:06 CM2 called "ENGINE TWO BLEED FAULT ON YEAH.” The fault message indicated that the bleed system might have anomalies. The CM1 reset the number 2 engine bleed valve without success; the crew decided to apply the speed brakes to increase descent rate to a lower altitude (refer to CVR transcript 1056:05 to 1056:19). The momentary maximum descent rate of 8,000 fpm was recorded in FDR data.

Per MEL 36-11-02 「AIR DUAL BLEED FAULT」, in the event of 2 engine bleed air supply system failure or associated engine failure, the flight crew was required to follow ECAM procedure as documented in QRH 2.2.1 and calls for 「AIR DUAL BLEED FAULT」 procedure, descent to FL220 in ASAP manner. Flight crew should use full speed brake to descend if applicable. If engine bleed air was not recovered during descend, crew shall start the APU, turn off wing anti ice, switch on the APU bleed valve when reaching FL220 or below.

According to the CVR transcript, the flight crew did reset the system when the “AIR ENG 2 BLEED FAULT” message displayed, used full speed brakes during descent complied with QRH procedures. The crew did not select the APU during the descent. The crew initially responded to the AIR ENG 2 BLEED FAULT message by initiating the AIR DUAL BLEED FAULT checklist, which includes selecting the APU ON. However, the crew interrupted completion of the AIR DUAL BLEED FAULT checklist in order to respond to the CAB PR EXCESS CAB ALT message by initiating the EMERG DESCENT checklist, which does not include the APU. The crew did not select the APU during the descent. The crew initially responded to the AIR ENG 2 BLEED FAULT message by initiating the AIR DUAL BLEED FAULT checklist, which include selecting the APU on, however, the crew interrupted completion of the AIR DUAL BLEED FAULT checklist in order to respond to the CAB PR EXCESS ALT message by initiating the EMERG DESCENT checklist in order to responde to the CAB PR EXCESS CAB ALT message by initiating the EMERG DESCENT checklist, which does not include the APU.The Captain (PM) indicated having considered the use of the APU further during the descent but decided not to, given the flight’s proximity to destination TPE, the time available, and the crew workload in initially handling the bleed fault and then the emergency descent checklists, and in establishing contact with ATC for the emergency descent.

2.1.2.2 After「CAB PR EXCESS CAB ALT」

According to the CVR, FDR data and the interview record, the “CAB PR EXCESS CAB ALT” warning appeared at 1857:40 during CX521 was descending and passing through FL300. In this case, the flight crew shall conduct「The CAB PR EXCESS CAB ALT ECAM」 checklist, the checklist is very similar to the 「Emergency Descent」 procedure. The 「Emergency Descent」 procedure clearly defines the actions between the PF and the PM. The flight crew shall applied the Guard channel and placed the transponder to 7700 if unable to contact with ATC during emergency descent, however, selecting of 7700 is optional in the 「The CAB PR EXCESS CAB ALT ECAM」 checklist. In review of the CPA A330 checklists indicates that the CAB PR EXCESS CAB ALT and the EMER DESCENT checklists are not consistent with regard to the selection of 7700 transponder code. Selection of 7700 is mandatory in the EMER DESCENT checklist, but optional in the CAB PR EXCESS CAB ALT (i.e. select 7700 or broadcast on 121.5 Guard).

According to the「EMER DESCENT」procedure, the flight crew should put on the OXY mask, engage the autopilot, apply the maximum appropriate speed, full speed brakes, throttle idle, turn on the sign and notify the ATC. If the cabin pressure exceeds 14,000 ft, the flight crew shall manually drop the PAX OXY masks.

Emergency Descent is a memory item, QRH defines roles play for both PF and PM, the primary task for PM is to monitor the PF's action such as check the descent target altitude, speed and contact ATC. The recommended practice also states after level flight, the PM should run through either the ECAM or the emergency descent checklist again to making sure all actions were completed. This practice suggests that the crews should execute the EMER DESCENT QRH from memory and review to ensure all actions have been accomplished.

In review of both FDR and CVR data (ref. Appendix 1); a master warning "EXCEED CABIN ALTITUDE" was activated due to the cabin altitude 9,680 ft. The "CAB PR EXCESS CAB ALT" checklist appeared on ECAM automatically, the flight crew should follow the ECAM checklist to descend as the best practice recommended; since CX521 was already cleared by ATC to FL140, the flight crew decided to increase descent rate at 1857:45. CM2 called 「confirm I have control ECAM action」. The flight was 121 NM away from APU (AnBu) at that time. At 1901:08 on frequency 125.1 CM1 requested further descent and deviated from the track in accordance with the procedure. At 1904:28, 83 NM from APU (AnBu), both flight crews took off the masks; at 1904:31 the flight reached 10,000ft.

The diagram as figure 2.1-1 FDR data shown is CX521 flight crew conducting "EMER DESCENT" procedure during the emergency descent.

The A330 cabin masks are automatically deployed when the cabin altitude exceeds 14,000ft. The EMERG DESCENT checklist advises pilots to manually drop the cabin masks when the cabin altitude exceeds 14,000ft, and this action item is thus an additional step to ensure cabin masks deploy when the cabin altitude exceeds 14,000ft. The CVR data indicated that at 1906:02 PM, the flight crew manually activated the passenger oxygen masks, and further explained that the CM1 could not read the cabin altitude clearly. The FDR data indicated that the highest cabin altitude was 13,424 ft (Refer to figure 2.1-1) and never exceeded 14,000 ft. Given the cabin altitude never exceeded 14,000ft during the occurrence, there was no requirement for the crew to manually deploy the cabin masks.

According to CVR transcript, the flight crew did transmitted the emergency message via 121.5; however, according to the ATC video playback, the investigation group did not find evidence of the 7700 alarm triggered on the TPE TACC radar screens, no subsequent maintenance report of faulty transponder equipment recorded. No evidence indicated that the flight crew selected 7700 SSR on the transponder.

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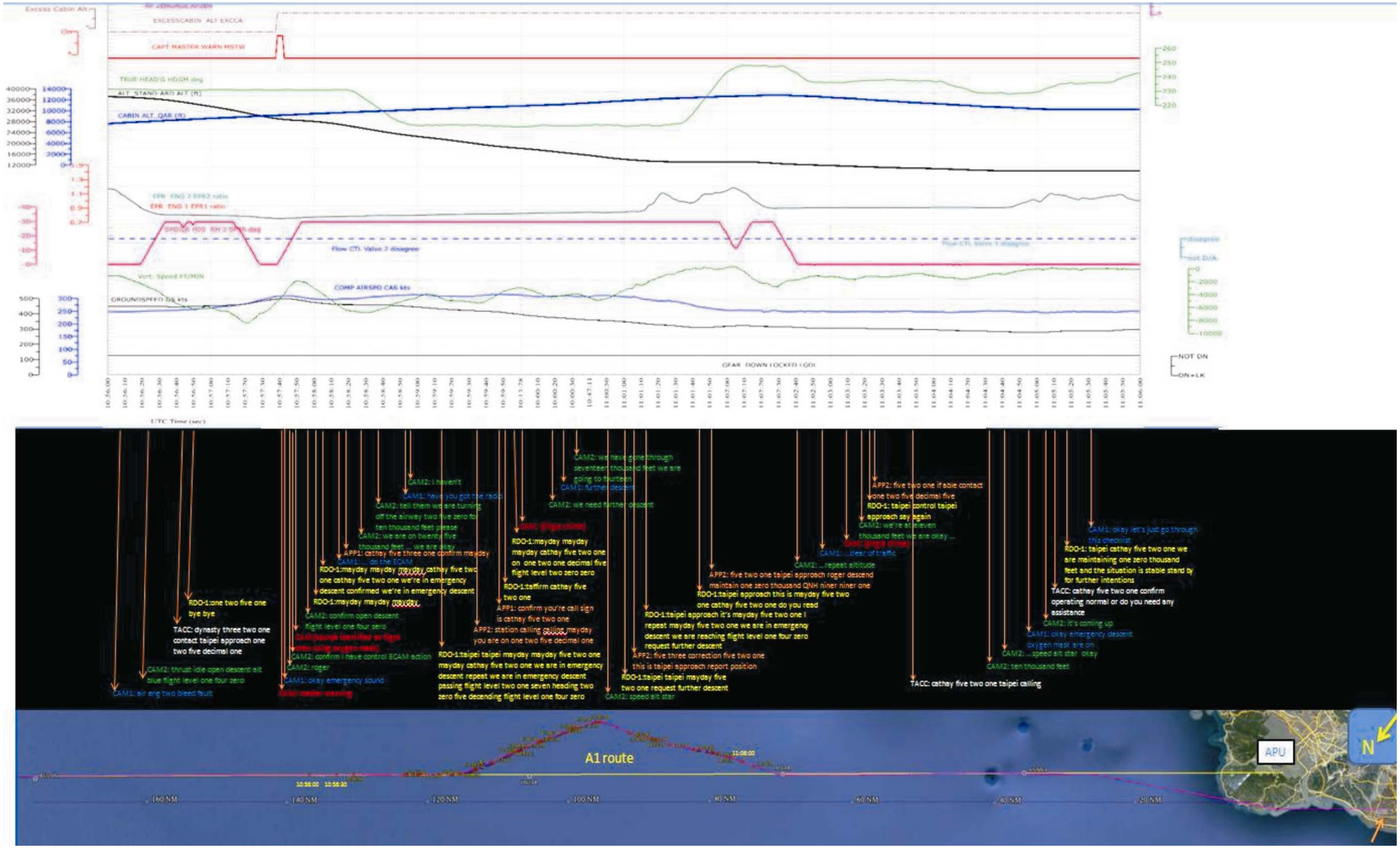

Figure 2.1-1 FDR data

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2.2 Pneumatic System and Emergency Descend

Refer to Section 1.18.5 A330 Bleed Air Supply System and 1.18.6 A330 Air Conditioning System/Cabin Pressurization, the A330 Pneumatics System provides compressed air for Air conditioning systems, wing and power plant nacelle anti-ice systems. In addition to adjusting the cockpit and cabin environmental temperature, the air conditioning systems are also the air sources of cabin pressurization. The B–HLH encountered the second engine bleed air system inoperative at pressure altitude 38,500 ft (UTC1055:46). The outside atmosphere pressure was about 2.9 psi. The cabin altitude was about 8,000 ft (cabin pressure was approximate 10.9 psi). With the maximum allowable leakage rate 1.1 psi/min (AMM 05-53-00), the estimated time to reach cabin altitude 15,000 ft (approx. 8.3 psi) is about 2 minutes and 22 seconds. This might have lead to cabin depressurization or even hypoxia if the flight crew did not take immediate action. The investigation team does not disagree with necessity the flight crew to perform the emergency descent to a safer altitude. It is however, in mitigation of the risk of cabin depressurization resulted from aircraft with one engine bleed system inoperative, the operator should dispatch aircraft with caution.

2.3 Cabin Pressurization and Passenger Emergency Oxygen System

Refer to the section 1.11.2 flight data records (including FDR data and QAR data), the cabin altitude was less than 8,000 ft under normal operation, the highest cabin altitude was 13,424 ft, at UTC 1102:28 the second engine bleed air system was inoperative and the outside pressure altitude was 13,500 ft. Refer to Code of Federal Regulations, Title 14: Aeronautics and Space, PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES, *25.841 Pressure Cabins, (a) Pressurized cabins and compartments to be occupied must be equipped to provide a cabin pressure altitude of not more than 8,000 feet at the maximum operating altitude* *of the airplane under normal operating conditions. (1) If certification for operation above 25,000 feet is requested, the airplane must be designed so that occupants will not be exposed to cabin pressure altitudes in excess of 15,000 feet after any probable failure condition in the pressurization system.*

In summary, the highest cabin altitude the aircraft experienced was within the airworthiness standard during the emergency descent.

According to Aircraft Maintenance Manual 05-53-00 TASK 05-53-00-780-803 Pressurization Retest and Leakage Rate Measurement, the maximum allowable leakage rate of A330 is 1.1 psi/min. Refer to the section 1.16.1 Leak Rate Test, the leakage rate of B-HLH was 0.8 psi/min. The test confirmed that the leakage rate of B-HLH was within the Aircraft Maintenance Manual specification.

The passenger emergency oxygen system could also be released manually from cockpit control panel. According to the interview notes, the passenger emergency oxygen was manually released by the flight crew. According to the description of Aircraft Maintenance Manual 35-20-00 Passenger Emergency Oxygen System, the oxygen masks will release automatically when cabin altitude reaching 14,000(+250,-750) ft. The highest cabin altitude that the B-HLH experienced was 13,424 ft, considering the fact that automatic release might occur at any altitude from 13,250 ft to 14,250 ft, it was possible that the cabin masks could have deployed automatically after the cabin altitude reaching 13,250 ft and prior to reaching 13,424 ft.

2.4 The redundancy air supply system and MEL

The main air supply source comes from the engines during flight operation, most transport category aircraft systems are designed with redundancy mechanism to provide higher reliability of system functions. The air supply of the pneumatic system could be from no.1 engine bleed air, engine no.2 bleed air or APU (Auxiliary Power Unit) bleed air. Aircraft engines are the primary source of compressed air in flight; APU is the primary compressed air source on ground, the APU operational altitude is limited to altitude 22,000 ft. APU takes at least 60 seconds acceleration time to reach the normal operation speed.

According to the FDR data, the B-HLH lost the second engine bleed air at altitude 38,500 feet, the APU was unable to provide compressed air even started. According to the prescription of the MEL, there is no requirement to start APU for standby purpose when dispatching aircraft with MEL 36-11-02., however, had the APU been started prior to reaching FL270 and teen selected at FL220, the bleed air would have restored cabin pressure and prevented the cabin altitude from climbing to the 13,424ft altitude achieved during the occurrence.

To reduce the risk of depressurization, The Aviation Safety Council suggests the operator consider evaluating the MEL or reviewing other procedures in order to recover the cabin pressurization capability with APU on in a timely manner under the condition that the second engine bleed air system also failed.

The aircraft dispatch is allowed one engine bleed system inoperative under A330 MEL 36-11-02 (refer to appendix 2). The maintenance action requirement is to secure the associated bleed air valve in the close position. In addition, the defect shall be rectified within 10 days (calendar day) and is allowed for one ETOPS flight only.

According to the section 1.6.2 Maintenance Records, the B-HLH no.1 engine pressure relieve valve (PRV) was inoperative and secured at close position at Inchon International Airport on September 13, 2008. The defect was carried onto the occurrence flight, therefore, the only compressed air source was the no.2 engine bleed air when CX521 was departing from Narita International Airport. Refer to 1.6.2

Maintenance Records on September 13 2008, the no.1 bleed air valve was secured at close position. Further checking the aircraft maintenance log book, the B-HLH's BLOCK OUT time was 0136UTC on September 13, 2008 and BLOCK IN time was 1139UTC on September 14, 2008, the accumulated time was 35 hours. The B-HLH had operated CX2411, CX919, CX918, CX905, CX904, CX520 and CX521 flight respectively. Reviewing the aircraft maintenance logbook, none of the flights were ETOPS.

The investigation group reviewed maintenance records in accordance with MEL 36-11-02 including PRV secured & closed, repair time and ETOPS restriction which and complied with MEL.

2.5 Causes of Engine Bleed Air System Failure

Refer to 1.1 history of flight, the B-HLH descent from FL400 at 1854:14, the no.2 engine bleed air system failed at 1855:46 with the ECAM message and associated cautions displayed. 1.18.1 CM1 interview notes shown that after completing the emergency procedure, the CM1 tried to reset the no.2 engine bleed air system but without success. After the aircraft descending and passing through 8,000ft, PM made a second attempt to reset no.2 engine bleed air system and successfully recovered the system.

Refer to 1.16.2 component test; the no.1 engine bleed air valve, no.2 fan air valve and the thermostat were sent to the manufacturer for testing and tearing down inspection. The no.1 engine bleed air valve test result found the closing time was slightly beyond the CMM specification, since the valve was secured at closed position before departure, it did not directly affect the no.2 engine bleed air system failure. The no.2 engine fan air valve test result found exterior contamination. The pneumatic test result was normal; the only defective was the inoperative closed indication. Aircraft manufacturer considered this defect may only affect the system operation when bleed air temperature was too low. The defect did not relate to the no.2 engine bleed air system failure caused by overheat condition. The no.2 thermostat did not pass the GO/NO GO test, further tear down inspection found the inlet filter was clean with normal function, but the grid filter was apparently contaminated. The test team pierced the filter to check the performance of the filter, the muscle air pressure immediately increased to normal operation range. After piercing the filter, the manufacturer found that the no.2 engine bleed air system failure was caused by ThC grid filter contamination which result in muscle air pressure was too low to operate FAV properly.

Reviewing the no.2 engine bleed air system operated normally during take-off, climbing and cruising phases, the problem did not occurred until initial descent. As previously mentioned, the primary cause of the system failure was the grid filter contamination with the following factors which may also be part of the failure chains.

When aircraft began to descend at FL400 (time 1854:15), the no.2 engine EPR[9] was about 1.41. The EPR decreased during descent with the lower thrust level and EPR went down to 1.17. According to the system description of engine bleed air supply system, at low engine speed, especially with engines at idle position, the air is automatically bled from high pressure on the 14th stage through the HP bleed valve[10]. The 14th stage provided the compressed air with higher pressure, the higher temperature would require more cooling air to regulate the temperature of the downstream air and require more opening of the fan air valve. As mentioned above, the contaminated grid filter blocked the muscle air pressure and caused the fan air valve

[9] EPR: Engine Pressure Ratio indicates the power of engine.
[10] Refer to the flight data, the no.2 engine HPV opened at 1054:23 while the EPR was about 1.23.

could not operate properly. The insufficient cooling air to the pre-cooler caused over temperature in PRV downstream air, activated the protection function and closed the HPV and PRV[11].

2.6 Corrective actions of DBL

Refer to 1.6.3, the operator provided previous A330 event reports of dual bleed failure. In addition to the CX521 occurrence, there were three events occurred from April 2008 to June 2008. Total of 4 dual bleed failures within the last 6 months; the faulty components related to these failures are listed as table 2.6-1.

Table 2.6-1 Dual bleed fault components

Item	Failure symptom	Component	Fault confirmed
1	Low pressure	No.1 OPV	Failed
2	Overtemp	No.2 ThC	Failed
3	Overtemp	No.1 ThC	Failed
4	Low pressure	No.2 PRV	Failed
5	Overtemp	No.1 FAV	Failed
6	Overtemp	Sense line leak	Leaking
7	Close indication error	No.1 PRV	Not confirmed
8	Overtemp	No.2 ThC	Failed

Reviewing the above bleed failures, five failures caused by overheat, among those; three were caused by the ThC malfunction.

According to a Service Information Letter, SIL 36-055, R01, dated 15 Nov. 2006, Subject: PREVENTIVE CLEANING / REPLACEMENT OF THE TEMPERATURE

[11] Refer to the flight data, the no.2 engine HPV closed at 1855:35; the PRV closed at 1855:37. Eventually the no.2 engine bleed air system stop to provide compressed air.

CONTROL THERMOSTAT FILTER, issued by the aircraft manufacturer. The purpose of this SIL was to inform operators to implement a preventive maintenance task of the Temperature Control Thermostat filter to improve the reliability of the engine air bleed system. Refer to 1.18.17, according to this SIL, the operator set up a maintenance program to replace the inlet filter every 3000 flight hours. The action mentioned in the SIL is to clean or to replace the inlet filter rather than the grid (outlet) filter. Refer to section 1.6.2 maintenance records, the inlet filter of no.2 ThC was replaced on July 19, 2008. Refer to 1.16.2 component test, the inlet filter of ThC was clean and functioning normally, but the grid filters was not satisfactory. The SIL 36-055 may have reduced the ThC malfunction caused by inlet filter contamination, not the grid filter. According to the AMM (36-11-43), the inlet filter is a line replaceable unit, but the grid filter is not. The grid filter should send to shop with the ThC assembly. According to the ThC tear down inspection findings, the contamination onto the grid filter came from a normal operation environment, the contamination on each ThC might be different depending upon airport and/or the flight routes flown.

The SIL 36-055 did not effectively reduce ThC malfunction due to contaminated grid filter; the air pollution is also unavoidable so far. The Aviation Safety Council suggests to modify or to redesign the grid filter so as to reducing the flight risk in bleed failure. The manufacturer and/or operator should consider evaluating the current maintenance program for Thc shop-in service or overhaul interval until any changes comes to effect.

The investigation team called for a 2nd CX521 technical review meeting on Feb.02, 2010. The meeting was to discuss for a concern regarding the solution for the A330 bleed issues released in September 25, 2009 (Liebherr VSB 342-36-04) which is similar to that of the A320 released in May 2008 including the replacement of the thermostat outlet grid filter with a protective cap.

CPA considered that the Air & Bleed Working Group for A320 was limited to A320 family only, and excluded A330 which share same design. CPA believes that the manufacturer was lack of effectiveness in fault reviewing processes particularly in response to service difficulty issues that requires an in-time corrective solution development.

The investigation team reviewed the manufacturer process in solving the in-service event of DBL both A320 and A330 Task Force. The initial considerations of A320 Air & Bleed Working Group to solve the dual bleed loss (DBL) issues (VSB342-36-08) was limited to A320 family and was exclusive of A330 fleet; the time line of A330 DBL Task Force as follows:

According to the document provided by Airbus, Airbus uses "Product Safety Process" to handle the in-service events. The process applies to all fleets type and uses same steps as screening, analysis, corrective actions, at each step, the consideration addressed to all possible impacts on other aircraft families before a single or multi-fleet treatment decision was made. The above process was approved and audited by the EASA periodically. As part of an aircraft certification process, failure condition classification and associated analysis is also reviewed, ATA 36 ranks risk classification in the SSA (System Safety Assessment12) from Major13 to Hazardous. The DBL failure condition was approved as "Major", means no unsafe conditions14 related.

The A320 Air and Bleed Working Group was initiated by 2007 A320 Technical Symposium. The Working Group was aiming at sharing a set of technical solutions (widely covering ATA21 and ATA36) with operators, considering expected reliability

[12] Requirement to be met: JAR 25.0903 b & JAR 25.1309 b,c,d
[13] Failure conditions include ranks, No safety effect, Minor, Major, Hazardous, Catastrophic.
[14] The Hazardous and Catastrophic failure conditions are defined as "Unsafe Conditions".

& economic impacts. The working scope was discussed and agreed by all participants (Airbus, Liebherr and interested operators) without A330. At 2007 year end when the A320 Air and Bleed Working Group aiming at technical solutions to solve the DBL events, according to the data provided by Airbus, the A330 DBL occurrence was not significant in trend, the major contributors of A330 DBL were ThC inlet filters contamination, ThC ageing, FAV leaking and ageing. Airbus referred CX521 occurrence was the first time to identify the mesh/grid filter contamination to be the root cause for A330 DBL event.

Airbus SB A320-36-1061 (released May 30, 2008) was published to advise all operators of A320 family aircraft of the issue of LIEBHERR Service Bulletin No. 342-36-08, which describes the modification that changes TCT from PN 342B040000 to PN 342B050000. This TCT component upgrade includes effectively the grid/mesh filter modification. This Service bulleting also recommends the simultaneous improvement of the FAV by Liebherr VSB 6730-36-03 (or 6730F-36-03 depending on the PN of the FAV) and of the TLT by Liebherr VSB 341-36-06. Airbus TFU 36.11.00.059 refers. Airbus indicated that a VSB (Vender Service Bulletin) issuing belongs to the supplier. As for any aircraft modification, a VSB needs the airworthiness authority’s approval.

CPA A330 fleet encountered several DBL events between April and June 2008. The CX521 occurrence happened in September 2008 and the root cause was confirmed in October 2008. A Task Force (TF) was set after the CX521 occurrence in April, 2009 to develop technical solutions specific to the A330 DBL events. Members of the Task Force from Airbus and Liebherr were the same as the members of A320 Air and Bleed Working Group. A technical update from the TF showed 50% of the second bleed loss was due to overtemp, mainly at cruise or TOD (66%), and mainly on RR application. The main root causes were drift of the ThC pressure (low pressure sent to FAV), environment pollution or contamination, FAV leakage/ageing. The other 50% of the second bleed loss was due to overpressure or low pressure, mainly at T/O or climb (66%), and mainly on GE/PW application. The main root causes of this group were drifted of the OPV setting, pressure transducer failure, or quick engine thrust ramp-up at take- off which increases pressure ramp-up. The solution (VSB 342-36-04) for A330 DBL was released in September 2009.

The time span from A320 Air & Bleed Working Group in November 2007 to the release of service bulletin (SB A320-36-1061) in May 2008 was 7 months. The CX521 DBL related components were tested and the root cause was confirmed in October 2008. The A330 DBL Task Force was set in April 2009. The solution (VSB 342-36-04) for A330 DBL was released in September 2009. It took about 12 months from internal investigation to final solution. According to Airbus, for those events not related to “unsafe conditions”, all means are put in place to optimize the answer time under the industrial constraints and assigned priorities. For the category “major failure condition”, a standard lead-time is approximately 12 months from investigation to VSB if applicable.

Aviation Safety Council (ASC) concludes that the decision by Air & Bleed Working Group launching for A320 DBL exclusive of the A330 was to follow the Airbus Product Safety Process, the A330 DBL rate was insufficient to drop correlation of the two therein. It is however, to take the increase of A330 DBL regional in-service fleet events and A320 problem solving experiences into Airbus’ Product Safety Process account, an A330 DBL task force should be formed in earlier and the A330 DBL VSB might have been released shorter than 12 months. The ASC also considered in view of DBL is classified as “Major” failure condition which is not related to unsafe conditions, the above solution might not come in time to prevent the CX521 from occurrence. This is also true to operators to do the internal assessment when a increase of regional DBL occurrences become obvious to adjust inspection and maintenance action in house; especially dispatched under MEL condition, as proactive risk mitigation measure.

2.7 Repeated Defects of Engine Bleed Air and Usage of MEL

The maintenance records revealed that the operator complied with all procedures required by the MEL 36-11-02, however, the Aviation Safety Council has following discussions which might go beyond the average standards to pursue for highest flight safety.

The operator rectified the PRV defect within MEL prescribed 10 days. As mentioned at section 1.6.3, dual bleed air system failure occurred many times in recent half year. The system failure fact revealed the unstable condition of the A330 engine bleed air system and required special attention. Within the MEL prescribed 10 days period, the B-HLH stopped over 2 times at Hong Kong Airport and conducted transit checks were conducted. The transit stops short time available prevented the operator from proactive actions to repair the system in an earlier stage prior to the occurrence.

Refer to 1.6.2 maintenance record; the repeated defect of no.1 PRV revealed those defects were much likely an indication problem. Most of those events occurred during engine shut down, few of them occurred at engine start phase and no event occurred during normal engine operation speed. This valve position indication problem occurred at duct pressure very low stage. Refer to the tear down inspection of the no.1 PRV; the shop finding also could not confirm the indication problem.

The Safety Council believes the numerous dual system failure events prior to the occurrence and the repeated defects reveal the deficiency of the system' reliability and potential operation risk. The Safety Council suggests the operator consider evaluating the MEL to restrict aircraft being dispatched from home base with an inoperative system and suffered the system reliability.

2.8 ATC

According to TACC radar control play back, no evidence showed that the flight crew selected 7700 on transponder; ASC reviewed the TACC radar system and performed an emergency transponder test after the occurrence, both tests with no anomaly. The CVR revealed temporary communication difficulties, poor radio signal quality and poor readability between CX521 and TPE ATC during the 1903 to 1907 period. The interviewed with the station manager and by reviewing both stations intercom log book, no malfunction records been found both receiving and sending. No evidence shows the TACC VHF system had anomaly at the time of the occurrence, the most probable cause for the temporary malfunction might be the altitude coverage of the VHF, however, this could not be confirmed by the CAA due to no update data provided.

The ATC related factors to the occurrence include: communication procedure of similar sounding call signs, handling procedure of distress aircraft and guard frequency and radio communication test.

2.8.1 ATC related sequence of event

CX521 departed Japan Narita International Airport for Taiwan Taoyuan International Airport at cruising altitude FL400. CX521 entered Taipei FIR via A1 route, transponder code 3766 and under TACC radar control with 125.5 MHz frequency.

The following table 2.8-1 and figure 2.8-1 are the sequence of event based on the CVR, FDR, radar, ATC radio and hot line recording records.

Table 2.8-1 ATC sequence of event

Time	TACC/APP controller	CX521Flight crew	Remarks
1847:42	TACC cleared CX521 to AUGUR via AN2B RNAV		CX521 en route A1 with cruising altitude at FL400
1852:25	TACC cleared CX521 descend to FL140		
1854:22	TACC cleared CI5213 direct to Grace	CX521 mistakenly confirmed TACC clearance to direct to Drake then controller corrected CX521' mistake	
1856:18		Flight crew notice 2 engines bleed valve inoperative, cabin altitude begun to rise and decided to increase the descend rate	
1856:42	TACC cleared CI5321 change frequency to 125.1	CX521incorrectly acknowledged and switched the frequency to 125.1	CX521 was 129 nm from ANBU VOR, altitude about 28,700ft.
1857:48		Flight crew donned their oxygen masks	
1858:03		CM1 made Mayday call and announcing emergency descent at APP channel of 125.1	APP South Taoyuan Sector was communicating with other aircraft at that time
1858:14	APP controller was busying with CX531 final approach on RWY 24 Tao-Yuan International Airport when he heard the Mayday call. The controller confirmed with CX531 Mayday call and gave landing clearance		CX521 was 119 nm from ANBU VOR, altitude about 28,000ft.

	afterward.		
1859:13		CM1declear mayday and emergency descent passing through FL217 at 125.1MHz	
1859:34	APP controller verified with CX521 of call sign and frequency use		
1859:55		CM1use guard frequency called「Mayday、FL200」	
1859:56	APP called TACC via hotline to check whether CX521 call Mayday and declared emergency. TACC North Sector responded CX521 was under their control but unaware of the emergency call		TACC North Sector contacted CX521 twice at 125.5
	Some other aircrafts were alerted by CX521 Mayday call at Guard frequency and relayed the distress message to TACC during 1859:55 to 1905:21		
1900:07	SQ879informed TPE TACC West Sector of the Mayday call heard on121.5MHz		
1900:52	TACC all station could heard other aircraft transmitting on guard frequency		
1900:59		CM1requested further descend on 125.1MHz	CX521 was100NMfrom ANBU, altitude 15,000ft
1901:50	APP coordinate TACC to give 10,000ft further descend clearance to CX521		
1901:15	CLX843heard Mayday call on121.5guard frequency and checked with TACC East Sector		
1902:32	NAHA Control called TACC and checked the status of CX521, TACC North Sector data controller replied they did not hear CX521 emergency call on 121.5 and unable to contact with CX521. NAHA control advised other aircraft overheard CX521 calling Mayday		
1903:03	TACC instructed CX521to contact TPE Control North Sector		
1903:13	APP instructed CX521contacted TACC 125.5MHz		

1903:48	TACC contacted CX521	CM1reported the emergency descent to 10,000 ft and heading 230	CX521 was 86NM from ANBU VOR
1904:28		Flight crew took off oxygen masks	CX521 descent to FL10,00ft.
1905:10	TACC questioned CX521 whether the operation was normal or need any assistance	CM1replied condition stable and asked TACC to wait for further notice	
1906:03	TACC informed APP of early control transfer, APP informed to take over with 124.2MHz		TACC informed APP of CX521 abnormal calling and recommended APP to take immediate actions
1907:03		CM1called TPE TACC and requested for landing permission and priority landing	
1907:26	TACC and APP 124.2controller made radar hand over		CX521 was 69NM from ANBU VOR
1907:39	TACC instructed CX521made frequency change again to 125.1 MHz due to unclear receiving	CM1read back and changed frequency to 125.1 MHz	TACC instructed CX521changed frequency to 124.2MHz while CX521 already made 125.1 frequency change
1908:06		CM1 contacted APP South Taoyuan Sector by channel 125.1 and reported the situation and requested priority approach	
1908:29	APP South Taoyuan Sector questioning CX521 current position from ANBU	CM1reported 56NM from ANBU VOR 053	APP South Taoyuan Sector unaware of the radar hand over been done
1910:10	APP South Taoyuan Sector cleared CX521continue	CM1 asked APP if established Radar	

	descending to 8,000ft, heading 225	Contact	
1910:24	APP South Taoyuan Sector asked CX521 to hold and confirm the emergency details	CM1confirmed emergency descent, leaving 10,000ft to 8,000ft and 52NM from ANBU VOR	
1910:41	APP South Taoyuan Sector informed CX521 established Radar Contact and their RWY preferences(RWY23 or RWY 24)	CM1replied RWY 24	
1911:14	APP South Taoyuan Sector asked CX521chenged to 124.2 frequency		
1912:41	APP 124.2 controller contact flight crew to confirm their RWY use and emergency status	CM1report they had to make a rapid descent to a safe altitude due to depressurization problem	
1913:48	APP124.2controller cleared CX521to continue descend to 7,000ft.		
1914:17	APP 124.2controllerasked CX521 if they needed ground service after landing	CM1repliedwill taxi off the RWY but like ground service stand by	
1914:35	APP 124.2 controller verified with CX521of their intention to stay on the RWY for a couple minutes	CM1re-affirmed will taxi off from RWY 24andrequested emergency equipment to stand by	
1914:55	APP 124.2 cleared CX521further descend to 6,000ft		
1916:00		CM1requested direct to FLASH	
1916:05	APP124.2controller agreed with restricted speed 220 Kt.	CM1rejected and clarified for priority landing request,	

		controller agreed	
1916:32	APP 124.2controllercleared CX521 for RWY24ILS/DME APP		
1917:07	Another APP controller confirmed after landing to remain on runway and waiting for tow car	CM1replied will vacate the runway and I have asked for emergency services to stand by	
1923:02	APP 124.2 controller instructed CX521 changed frequency to tower		
1924:22	Tower controller contact CX521, provide landing info and permission to land		
1929:17			CX521landedsafely

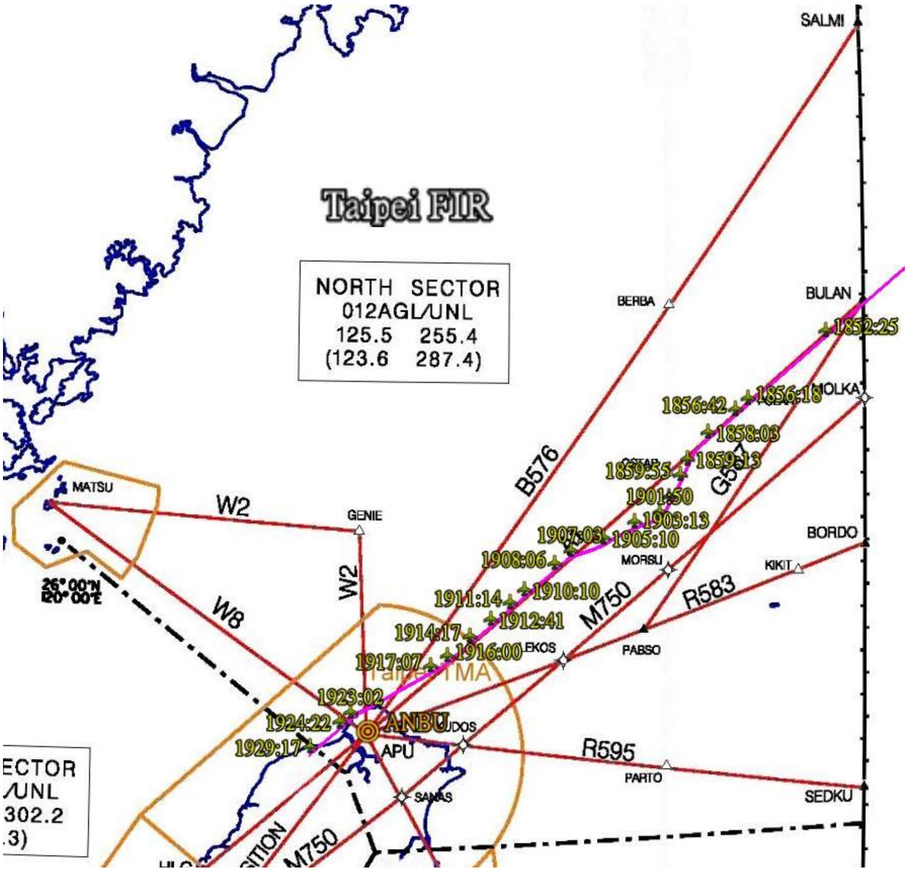

Figure 2.8-1 Diagram of the track of CX521 and the area of TACC North Sector and Taipei Approach

2.8.2 Communication procedure for similar call sign

According to the CVR data and ATC transcript, at 1854:22 TACC instructed CI5213 (call sign dynasty five two one tree) direct to Grace, this message was mistakenly acknowledged by CX521 but rejected by TACC.AT1856:42; TPE TACC instructed CI5321 (call sign dynasty five tree two one) changed frequency to TPE APP 125.1, the instruction was incorrectly acknowledged by CM1without checking. The crew did not followed the company communication procedure and include the flight call sign at the end of the transmission and replied “one two five one bye bye” and changed frequency to 125.1. The simultaneously replied of CI5321 “one two five one dynasty five tree two one good day” left the mistake un-discovered and corrected accordingly by the controller. At the time, CX521 was 129NM from ANBU with altitude 35,700ft.

Several aircrafts with similar call sign (CX521, CI5213, and CI5321) were within the region and under TACC’s control. According to the ATMP (Air Traffic Management Procedures) regulation 2-4-15 regarding emphasize and verify : to emphasize appropriate digits, letters, or similar sounding words to aid in distinguishing between similar sounding aircraft identifications, and notify each pilot concerned. TACC controller should aware of the existing similar call sign situation when CX521 initially incorrectly acknowledging CI5213 frequency changed instruction, the controller should use CATHAY FIVE TWO ONE CATHAY or DYNASTY FIVE TWO ONE THREE DYNASTY for pilot’ distinguishing.

There is an in consist description between the Chinese version and the English version of the ATMP (Air Traffic Management Procedures) regulation 2-4-15. Referring to the ATMP Chinese version 1-2-1 word meaning that contain shall, or an action verb in the imperative sense: should, may, will, the controllers shall follow these action verbs while doing their job. Refer to ATMP English version of 2-4-15, it emphasizes appropriate digits, letters, or similar sounding words to aid in distinguishing between similar sounding aircraft identifications……..is mandatory (identical with FAA order JO 7110.65S Air Traffic Control); refer to the Chinese version which uses a word not list in word meaning. The controller may be confused by the informal word using hence misunderstood the mandatory procedure is only recommended.

2.8.3 Handling of distress aircraft

2.8.3.1 Handling of Information of emergency condition

AT 1858:03, APP South Taoyuan Sector was communicating with other aircraft on125.1MHz, a Mayday call was made by CX521, the controller was busy in handling other aircrafts on 125.1MHz; on hand aircraft include the similar call sign CX531 which was making final app on Tao-Yuan International Airport RWY24. The controller confirmed with CX531 of the Mayday message and re-issued the clearance to CX531 afterward. At the time CX521 was 120NM from ANBU and 28,700 altitudes.

According to Standard of Aeronautical Telecommunication of CAA, the station addressed by aircraft in distress shall: a) immediately acknowledge the distress message; b) take control of the communications or specifically and clearly transfer that responsibility, advising the aircraft if a transfer is made; c) take immediate action to ensure that all necessary information is made available, as soon as possible, to the ATS unit concerned.

Albeit CX521 mistakenly made an early frequency change, APP controllers considered the initial Mayday call was made by CX531 and considered it might be the cross talk and not acknowledged the distress message immediately till they received the second one one minute latter. NAHA ATC confirmed with ATC of the distress message immediately after receiving the same message.

The situation awareness, the emergency handling and the provision of timely assistance to distress aircraft of TPE APP controller may need further improvement.

2.8.3.2 Coordination and services of ATC

According to ATMP 9-2-1, it requires controller to start assistance as soon as enough information has been obtained upon which to act. Minimum required information for in-flight emergencies include: aircraft identification and type, nature of the emergency and pilot’s intention. According to ATC recording data, the time starting from CX521 called Mayday at 1058:03 till controller established contact with CX521 at 10,000 ft was about 7 minutes, it is not until 1113:03 that APP 124.2 controller verify with the flight crew and obtained the information. The controller' time frame of assisting in-flight emergencies needs further improvement.

CX521 encountered cabin altitude arising and decided to make emergency descent; the flight crew’s mayday called will also increased their workload. The regulation required ATC to assist and minimize interference to the distress aircraft. By reviewing the factual data, TACC or APP controllers instructed flight crew to change frequency several times, the congestion of frequency 125.1 and interrupted communication did not comply with the principles. The numerous frequency changes might have increased flight crew’s workload despite controller’s good intention. The investigation group considered that the controller should have instructed other aircrafts to change to another frequency in order to focus on the distress aircraft.

ATMP requests controller to provide maximum assistance and first priority to distress aircraft. The controllers’ frequent frequency changed and instructed distress aircraft to follow speed restriction were not in accordance with ATMP. The controller didn't consider workload and human factor during their radio communication with the flight crew. ATC APP and tower controllers verified with flight crew regarding the ground service several times after landing also showed lack of coordination and information exchange internally.

In summary, the radio communication procedure, emergency handling, priority of the distress aircraft, flight crew workload consideration, ATC communication human factors issues and training, checking and emergency response handling should be enhenced.

2.8.3.3 The situated location of the radio stations for Guard Channel

A "Mayday" call was made by the CX521 at 1859:56 on 121.5 Frequency. A few other flights in air transfer the CX521 emergency call. Naha Control of Japan called TACC at 1902:38 to ensure Mayday was received but all TACC controllers on seat failed to receive the emergency call for their reasons until 1900:52.

The location of the two radio stations for Guard Channel include one situated at Mekong, an off shore island from Taiwan, the other on Taipei Datum Mt. According to the TACC tapes reviewed by ASC, the two radio stations have different coverage. Radio station on Datum Mt covers mainly the North and East spaces of Taiwan and Mekong covers the West and South spaces of Taiwan.

By reviewing the tapes, the investigation group confirmed that the Approach controllers were on frequency of Datum Mt and the TACC controllers were using Mekong; no single controller received the emergency call made by CX521 on the guard frequency.

The TACC north station frequency 125.5 stations include Datum Mt, Sandiaojiao and Nangan radio station; Guard frequency 121.5 stations include Datum Mt and Mekong. The controller could choose freely by selecting one or both stations as their Guard frequency's station.

At the time of the occurrence, the TACC north station controller choose Mekong station as the Guard frequency channel, however, the above station would not cover all route space of CX521 and failed to receive the Mayday call by CX521 from Guard frequency, in addition, the two systems are unable to back up for each other due to the 140NM distance and the geographic difference. The coverage and installation of both the TACC north station guard frequency back up mechanism as well as other stations should be reviewed.

2.8.4 Radio communication tests

In accordance with the ATMP 2-4-2, controllers are obligated to monitor interphones and their assigned radio frequencies continuously. Every morning, all duty controllers of TACC are required to test radio communication in their control area to the most far reaching waypoints predefined in the test sheet, log in before signing by supervisor, the test sheet then deliver to the maintenance for follow up actions when necessary.

According to the TACC North Sector test sheets three locations shall be tested include ±0.5 NM of Matsu at west, ±20 NM of SALMI at north, and ±20 NM of SEDKU at east, however, no guard frequency test made on SALMI which is the occurrence neighbor area. The missing test point may also result in TACC controllers missing Mayday call from CX521. A revision to TACC radio test inclusive of guard frequency at SALMI would have an earlier identification of radio gap of Mekong station.

2.9 Survival Factors

According to investigation, cabin crew members had qualified cabin emergency training regarding loss of cabin pressure and test. Cabin crew actions and communication with the flight deck were conducted in accordance with procedures in general.Cabin crew actions and communication with the flight crew were conducted in accordance with the procedures in general.Some deficiencies were noted with regard to the failure of three of the cabin crew masks to deploy, and some of the cabin crew awaress of the operation of the cabin masks and knowledge of the secondary effets from the chemical oxygen generators on the A330 aircraft. Base on the aircraft’s design, when the cabin altitude excesses 14,000 ft, the oxygen masks will automatically deploy accompany with the no smoking sign and seatbelt signs, automatic pre-recorded announcement will also be activated. The announcement will announce no smoking, wear oxygen mask and fasten seat belt in English, Japanese and Cantonese language, the auto announcement will activate when flight crew manually releasing the oxygen system. To generate the oxygen flow, the user must pull down to start the chemical reaction and release the pin from the cap before donning the oxygen masks. If cabin oxygen masks did not drop automatically, cabin crew may open the cover panel by tools to drop down oxygen mask. The Cathy Pacific's Operation Manual Chapter 5「CABIN CREW SAFETY AND EMERGENCY PROCEDURES MANUAL」section 4.2 illustrates 「On the Airbus and B777 the masks must be pulled down to initiate oxygen flow. On the B747-400, oxygen flows as soon as the masks deploy.」.

Refer to section 1.15.3, three passengers were found not initiating their oxygen masks. It revealed that some passengers either not fully understand the instructions from the automatic announcement or they did not follow the instructions.

Refer to table 1.15-1; three of cabin crew members’ oxygen masks did not deploy properly owing to their access panel being stocked and not serviceable at door L1 and R1. According to CX internal interview, none of those three cabin crew members tried to open their access panels and therefore did not have access to their masks or using portable oxygen bottle around their seats.

Refer to table 1.15-1, of the eight cabin crew members whose mask did deploy, two cabin crew members did not use the masks because they considered it was unnecessary and four cabin crew members did not pull down the masks to trigger oxygen bottle. As revealed from company internal interview and the masks serviceability, some cabin crew members considered the masks were unserviceable because of the bags were not inflating, some cabin crew members whose oxygen bottle were not triggered but still considered functioning normally. This suggests that those cabin crews were not fully aware of the normal operation of the cabin masks.

The Cathy Pacific's Operation Manual Chapter 5 section 7 illustrates if aircraft maintained continually in 38000 feet depressurized, human being in this aircraft will became unconsciousness within 30 seconds.

FLIGHT ALTITUDE	TIME OF USEFUL CONSCIOUSNESS
25,000 FT	2 MIN
30,000 FT	1 MIN
38,000 FT	30 SEC
40,000 FT	15 SEC

The above information sugges that some cabin crew members may not be familiar with the cabin masks design features and operation with regard to pulling down on the cord to activate oxygen flow. Those cabin crew members who were not to or not able to use their oxygen masks may not be affected and remained conscious as the cabin altitude never exceeded 14,000ft throughout this occurrence. However, by not wearing their masks, the cabin crew could have misled passengers into thinking that wearing the mask was not required.

Refer to section 1.15, the direct communication between the flight crew and cabin crew regarding cabin fire include that the cabin crew reported the burning smell and heat to ISM, ISM reported to the flight crew and received their instructions to standby complied with the company's procedure, however, some cabin crew members were not aware of the additional heat and burning smells were generated from the activation of the chemical oxygen system. These side effects of the chemical oxygen generators did not list in any cabin related manual and training course. This may have increased the injury risk if cabin crews unfastened their seat belt and tried to find out the suspected fire source.

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3 Conclusion

In this Chapter, the Safety Council presents the findings derived from the factual information gathered during the investigation and the analysis of the CX521 accident. The findings are presented in three major categories: findings related to probable causes, findings related to risk, and other findings.

The findings related to probable causes identify elements that have been shown to have operated in the accident, or almost certainly operated in the accident. These findings are associated with unsafe acts, unsafe conditions, or safety deficiencies associated with safety significant events that played a major role in the circumstances leading to the accident.

The findings related to risk identify elements of risk that have the potential to degrade aviation safety. Some of the findings in this category identify unsafe acts, unsafe conditions, and safety deficiencies, including organizational and systemic risks that made this accident more likely; however, they cannot be clearly shown to have operated in the accident alone. Further, some of the findings in this category identify risks that are unrelated to this accident, but nonetheless were safety deficiencies that may warrant future safety actions.

Other findings identify elements that have the potential to enhance aviation safety, resolve an issue of controversy, or clarify an issue of unresolved ambiguity. Some of these findings are of general interests that are often included in the ICAO format accident reports for informational, safety awareness, education, and improvement purposes.

3.1 Findings related to probable causes

1. Giving the de-activated of the No.1 engine bleed air valve per MEL 36-11-02, the

no.2 engine bleed air was the only one compressed air source for the two air conditioning systems. The no.2 engine bleed air valve operated in a high demand status. During aircraft descent, the compressed air automatically bled from high pressure stage which provided the compressed air with higher pressure and higher temperature. This led the pre-cooler downstream temperature air getting higher. Due to the THC's grid filter contaminated from which to reduce the muscle air pressure to control fan air valve that resulted in the fan air valve could not open properly to provide sufficient cooling air to pre-cooler. The no.2 engine bleed air valve was shut down automatically due to bleed air overheat. Both air conditioning systems lost the compressed air source and thereby aircraft lost its pressurization capability. (2.5)

3.2 Findings related to risk

1. The repeated defects of the numerous dual bleed air system and number one engine bleed air defects prior to the occurrence revealed the deficiency of the bleed air system' reliability and potential operation risk. (2.6)

2. The flight crew might have confused the similar call signs on the same control frequency. The crew were distracted by the system failure when they did not adhere to company communication procedures by inadvertently omitting the CX521 flight number at the end of one of the transmissions, which contributed to the premature change of frequency. (2.1.1)

3. The flight crew omission of the CX521 flight number the fact that the transmission was stepped on resulted in a lost opportunity for the pilot and the controller to correct the mistake and prevent the premature change of frequency. (2.1.1)

4. Approach controller should be aware the existing similar call sign situation and follow the ATMP regulation for pilot' distinguishing when the CX521 acknowledged

instruction and read back frequency change incorrectly for other aircraft. (2.1.1, 2.8.2)

5. The ATMP English version and Chinese version 2-4-15 regarding emphasizing to aid in distinguishing between similar sounding aircraft are inconsistent: English version is mandatory while the Chinese version is not. (2.782)

6. Approach controller did not acknowledge the CX521 distress message immediately on Guard frequency until the second one one minute latter. (2.8.3.1)

7. The ATMP request controllers to provide maximum assistance and first priority to distress aircraft; consider pilot workload and human factor of radio communication. The late information handling, frequent frequency change instructions and instructed distress aircraft to follow speed restriction were not in accordance with ATMP. (2.8.3.2)

8. Duplicated questions asking regarding ground assistance showed lack of coordination and information exchange internally from both the TPE Tower and the Approach controllers. (2.8.3.2)

9. All TACC controllers selected Mekong radio station which resulted in TACC controllers failed to receive the CX521 "Mayday" call at 1859:56 on 121.5 Frequency until 1900:52. (2.8.3.3)

10. Guard frequency 121.5 stations situated at Datum Mt and Mekong. The two frequencies unable to cover each other due to the 140NM distance and geographic influence. (2.8.3.3)

11. TACC North Sector guard frequency test omitted the occurrence neighbor area waypoint SALMI. The omitted way point test may have resulted in TACC controllers missing Mayday call from CX521. (2.8.4)

12. Some cabin crew members whose oxygen mask did not drop down, did not try to open their access panels or using portable oxygen bottle around their seats. (2.9)

13. Some cabin crew members may not be familiar with the cabin masks design features and operation with regard to pulling down on the cord to activate oxygen flow and not be fully aware of the normal operation of the cabin masks. (2.9)

14. Some cabin crew members who were not to or not able to use their oxygen masks may have misled passengers into thinking that wearing the mask was not required. (2.9)

15. These side effects of the chemical oxygen generators did not list in any cabin related manual and training course. This may have increased the injury risk if cabin crews unfastened their seat belt and tried to find out the suspected fire source. (2.9)

3.3 Other findings

1. Both flight crew members were certified and qualified in accordance with Hong Kong Civil Aviation Regulations. (2.1)

2. There was neither evidence indicate the crew have any physical or psychological problems, nor usage of alcohol or drugs. (2.1)

3. The crew did not select the APU after interrupting the AIR DUAL BLEED FAULT checklist to initiate the EMERG DESCENT checklist in response to the CAB PR EXCESS CAB ALT message. (2.1.2.1)

4. The FDR data indicated that the cabin altitude never exceeded 14,000ft during the occurrence, there was no requirement for the crew to manually deploy the cabin masks. (2.1.2.2)

5. The “CAB PR EXCESS CAB ALT” and “EMER DESCENT” procedures were

inconsistent regarding the selection of 7700. (2.1.2.2)

6. According to ATC radar control video play back, there was no evidence indicating that the flight crew had selected 7700 SSR on the transponder. (2.1.2, 2.7)

7. It was deem necessary that the flight crew took the immediate action and performed the emergency descent to a safer altitude when dual bleed system fail. (2.2)

8. The highest cabin altitude aircraft experienced was within the airworthiness standard during the emergency descent operation. (2.3)

9. The leakage rate of B-HLH was within the Aircraft Maintenance Manual specification. (2.3)

10. The Operator complied with the MEL 36-11-02 prescriptions. (2.4)

11. Refer to the tear down inspection result of the no.1 PRV; the shop findings also could not confirm the indication problem. (2.6)

12. The CVR revealed there were temporary communication, poor radio signal quality, poor readability and difficulties during the 1903 to 1907 period. No evidence showed the TACC VHF system had anomaly at the time of occurrence. (2.7)

13. Some passengers were not wearing their oxygen masks revealed that some passengers either not fully understand the instructions from the automatic announcement or they did not follow the instructions. (2.9)

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4 Safety Recommendations

4.1 Recommendations

To Hong Kong CAD

1. Require Cathay Pacific Airways consider evaluating or revising the MEL procedure to reduce the depressurization risk under one engine bleed air fail, and recover the cabin pressurization capability with APU in a timely manner when the second engine bleed air system also failed. (ASC-ASR-10-08-004)

2. Require Cathay Pacific Airways consider evaluating the maintenance program for ThC shop-in service or overhaul interval before the new grid filter design or modification come to effect. (ASC-ASR-10-08-005)

3. Require Cathay Pacific Airways consider evaluating the MEL restriction regarding aircraft been dispatched from home base with an inoperative system to lower the dual bleed system failure risk. (ASC-ASR-10-08-006)

4. Require Cathay Pacific Airways to review air dual bleed fault and emergency descent procedures and revise related inconsistent procedures accordingly. (ASC-ASR-10-08-007)

5. Require Cathay Pacific Airways cabin crew members to review cabin depressurization related procedures including: provide oxygen bottle side effect information, manually opening the oxygen cover panel to initiate oxygen flow; enhance cabin crew depressurization training. (ASC-ASR-10-08-008)

To the DGAC France

1. Require manufacturer to modify or redesign the ThC grid filter to reduce the risk of

A330 dual bleed system failure. The manufacturer should evaluate the maintenance program for ThC shop-in service or overhaul interval before the new design or modification come to effect. (ASC-ASR-10-08-009)

2. Require manufacturer to review air dual bleed fault and emergency descent procedures and revise related inconsistent procedures accordingly. (ASC-ASR-10-08-010)

3. Require manufacturer considering to take the in-service fleet events and family fleet problem solving experiences into Product Safety Process account and form the problem solving task force in an earlier time as proactive risk mitigation measure. (ASC-ASR-10-08-011)

To Cathay Pacific Airways

1. Consider evaluating the MEL dispatch or reviews other procedures under one engine bleed air fail to recover the cabin pressurization capability with APU in a timely manner in case of the second engine bleed air system failed to reduce the depressurization risk. (ASC-ASR-10-08-012)

2. Consider evaluating the maintenance program for ThC shop-in service or overhaul interval before the new grid filter design or modification come to effect. (ASC-ASR-10-08-013)

3. Consider evaluating the MEL of restrict aircraft being dispatched from home base with an inoperative system and suffered the system's reliability. (ASC-ASR-10-08-014)

4. Review air dual bleed fault and emergency descent procedures and revise related inconsistent procedures accordingly. (ASC-ASR-10-08-015)

5. Require cabin crew members to review cabin depressurization related procedures including: provide oxygen bottle side effect information, manually opening the oxygen cover panel to initiate oxygen flow; enhance cabin crew depressurization training. (ASC-ASR-10-08-016)

<u>To CAA Taiwan</u>

1. Require controller followed ATMP procedures, emphasize similar flight numbers or call sign and informed the flight crew for distinguishing. (ASC-ASR-10-08-017)

2. Review and revise the ATMP Chinese version 2-4-15 word meaning in accordance with the English version 1-2-1. (ASC-ASR-10-08-018)

3. Enhance controller emergency response and situation awareness when handling the distress aircraft in accordance with the ATMP procedure. Assuring the controller handled the nature of emergency and pilot expectation in a timely and efficiency manner, provide the utmost assistance, highest priority and considered the pilots' workload and human factor of radio communication. (ASC-ASR-10-08-019)

4. Review the ATMP procedure regarding the frequency change instruction for distress aircraft that might increased flight crew workload. (ASC-ASR-10-08-020)

5. Enhance ATC internal coordination, communication during emergency situation includes the training, checking and handling of distress aircraft. (ASC-ASR-10-08-021)

6. Carefully selected appropriate radio communication stations as backup system to avoid communication performance degrade. (ASC-ASR-10-08-022)

7. Revise the TACC Guard frequency radio test inclusive at SALMI waypoint. (ASC-ASR-10-08-023)

4.2 Safety action already taken

Safety Action already taken by CAA

TACC conducted recurrent training on Nov. 10th,2008 for the station controllers and reiterated the procedures regarding the Handling of the distress aircraft Station check list for the distress aircraft on Jan. 8th, 2009 notice to all controller on Dec. 1st, 2009. Daily equipment test now include B576 SALMI point.

Safety Action already taken by Cathay Pacific Airways

- *Thermostat (ThC) Reliability Recovery Plan:*

  Initial action - remove all ThCs with TSI > 15000 FH.

  Current ThC overhaul programme.

  Weibull analysis shows an interval of 3100 FC will provide a failure rate of (less than) 25%.

  ThC will be removed and sent to Liebherr for overhaul when they have accumulated 3100 FC.

  High time ThC replacement is ongoing (Spare provision & workshop TAT driving program).

  AMS task already raised to remove ThC based on 3100 FC life limit.

- *New procedure in April 2009 rev of TSM to confirm if further troubleshooting is required when an a/c experiences PRV not closed fault.*

- *Temporary Restrictions imposed in CPA A330 MEL from Sep 2008. No dispatch out of Hong Kong for ; ATA 36-11-01, 36-11-02, 36-11-03, 36-11-04, 36-11-05, 36-11-06, 36-11-07.*

- *Additional restrictions imposed on CPA A330 operations from Jan 2009. CMS Fault message: THRM/FAN AIR-V/SENSE LINE must be investigated as per TSM 36-11-81-810-850[861] prior to next HKG departure.*

- *A new MEL revision has been developed by CX Airbus Fleet Office and Engineering, and is still awaiting final approval from Airbus before being made permanent. This new MEL revision reintroduces an operational procedure whereby the APU is started in case of a subsequent bleed failure in flight.*

- *Mandarin language has been added to the cabin auto-announcements (ref. Cabin Crew Manual Vol5, p.1.9.1 and p.2.8.1, and cabin crew induction, conversion and refresher training).*

- *Cabin crew manuals (Vol. 5p. 1.9.1 and p. 2.8.1) and cabin crew induction, conversion and refresher training have since been amended to emphasize the need to pull on the cabin mask cord to initiate oxygen flow on the A330 and B777 aircraft, and to clarify that the bag does not inflate during normal operation of the cabin masks. In addition, the CPA cabin safety video has also been amended to show that the cabin mask bag does not inflate when used.*

Safety Actions already taken by Airbus

- Airbus performed a review of dual bleed loss events that occurred on A330 aircraft, as done previously for the A320 family aircraft.

  This review highlighted that, among the bleed loss events due to over-temperature, 90% were due to THC clapper and grid filter pollution, as it was the case for CPA A330 MSN 121.

- To address these over-temperature events, Airbus launched the following actions:

1) THC improvement:

- The THC filter grid has been modified. The THC modification consists in replacing mesh filter by a pollution cover. This modification is covered by VSB 398-36-04.

- This modification will be applied in production with the following ranks of embodiment at component level:

  PN 398B050000 SN 1830 (PW4168 & GE/CF6-80 Applications)
  PN 398E020000 SN 1826 (RR-Trent700 Application)

- For in-service A/C, the VSB is available since week 41 2009.

  Please find attached VSB 398-36-04.

  SIL 36-051 (ENGINE BLEED AIR SYSTEM COMPONENTS EVOLUTION & INTERCHANGEABILITY) will be updated in the aim to reflect these new improvements.

  Please find attached SIL 36-051 (not updated yet) for Engine Air bleed system overview

2) MPD update:

- MPD task ref 361143-01-1 asks for THC cleaning every 6000 FH. Today, this task is not mandatory and only refers to SIL 36-055 (refer to attached document).

- It is planned to render this task mandatory by MPD revision. However, since the MRB process is lengthy, the MPD revision is not expected before 1Q 2011.

- Pending the MPD update, Airbus provides advance information through SIL 36-055.
- This SIL also recommends to customize the cleaning interval depending on the operating environment.

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Appendix 1 CVR data (1056:00 to 1106:00)

hh	mm	ss	Source	Context
10	56	00.3	CAM-1	okay let's just pull for open descent
10	56	05.3	CAM-1	air eng two bleed fault
10	56	06.4	CAM-2	eng two bleed fault oh yeah
10	56	10.0	CAM-1	so
10	56	10.3	CAM-2	just see the cabin here
10	56	14.5	CAM-2	eight fifty
10	56	16.7	CAM-1	it is rising
10	56	17.8	CAM-2	let's go down quicker
10	56	19.1	CAM-1	get down
10	56	19.7	CAM-2	yep
10	56	22.4	CAM-2	thrust idle open descent alt blue flight level one four zero
10	56	26.8	CAM-1	cabin crew please be seated for landing
10	56	30.3	CAM-2	eight hundred feet per minute
10	56	32.0	CAM-1	okay let's have…
10	56	32.5	CAM-2	we can't go to taipei with wing anti ice unavailable those bleed fault don't aren't the same right
10	56	41.8	CAM-1	okay …
10	56	42.2	TACC	dynasty three two one contact taipei approach one two five decimal one
10	56	48.0	RDO-1	one two five one bye bye
10	56	49.2	CAM-2	it's still holding seven point three p s i seven point two
10	56	52.9	CAM-1	let's just get down there
10	56	53.7	CAM-2	yep
10	56	54.7	CAM-1	first
10	57	01.9	CAM-1	okay with air eng bleed two fault we've got an advisory
10	57	05.6	CAM-2	yep
10	57	12.7	CAM-1	okay we've got pressure
10	57	16.7	CAM-1	we need one bleed on
10	57	16.8	CAM-2	look how fast it's going down …
10	57	19.5	CAM-1	okay reduce the rate of our descent it's not going to be able to keep up
10	57	32.7	CAM-1	air eng one config eng one bleed off it is off
10	57	33.6	CAM-2	yes

hh	mm	ss	Source	Context
10	57	36.9	CAM-1	bleed not recovered and I can’t …
10	57	40.1	CAM	(sounds identified as master warning)
10	57	42.1	CAM-1	okay emergency sounds
10	57	43.9	CAM-2	roger
10	57	45.9	CAM-2	confirmed I have control ECAM action
10	57	47.9	CAM	(sounds identified as flight crew using oxygen mask)
10	57	52.6	CAM-1	I have control
10	57	53.4	CAM-2	you have control
10	57	55.6	CAM-2	confirm open descent flight level one four zero
10	58	00.6	RDO-1	mayday mayday mayday
10	58	03.2	RDO-1	mayday mayday mayday cathay five two one cathay five two one we’re in emergency descent confirmed we’re in emergency descent
10	58	13.8	APP1	cathay five three one confirm mayday
10	58	18.3	CAM-1	… do the ECAM
10	58	20.6	APP1	cathay five three one …
10	58	21.3	CAM-2	I have control I have control
10	58	23.1	CAM-1	sorry okay
10	58	25.2	CAM-2	roger
10	58	27.7	CAM-2	we are on twenty five thousand feet … we are okay
10	58	33.5	CAM-1	okay
10	58	35.4	CAM-2	we are okay
10	58	36.6	CAM-2	tell them we are turning off the airway two five zero for ten thousand feet please
10	58	51.0	RDO-1	taipei
10	58	51.6	CAM-1	have you got the radio
10	58	53.5	CAM-2	I haven’t
10	59	02.6	CAM-2	… we are okay
10	59	04.7	CAM-?	…
10	59	13.3	RDO-1	taipei taipei mayday mayday five two one mayday cathay five two one we are in emergency descent repeat we are in emergency descent passing flight level two one seven heading two zero five decending flight level one four zero
10	59	34.1	APP2	station calling calling mayday you are on one two five decimal one

hh	mm	ss	Source	Context
10	59	41.1	RDO-1	confirming cathay five two one
10	59	47.0	APP1	confirm you're call sign is cathay five two one
10	59	50.9	RDO-1	affirm cathay five two one
10	59	54.7	RDO-1	mayday mayday mayday cathay five two one on one two one decimal five flight level two zero zero
11	00	16.0	CAM	(single chime)
11	00	18.1	CAM-2	we need further descent
11	00	22.8	CAM-1	further descent
11	00	24.2	CAM-2	okay
11	00	31.0	CAM-2	we have gone through seventeen thousand feet we are going to fourteen
11	00	35.6	CAM-1	okay
11	00	40.9	CAM-2	require … flight level fourteen request lower
11	00	49.5	CAM-2	speed alt star
11	00	59.0	RDO-1	taipei taipei mayday five two one request further descent
11	01	04.5	APP2	five three correction five two one this is taipei approach report position
11	01	11.8	RDO-1	taipei approach it's mayday five two one I repeat mayday five two one we are in emergency descent we are reaching flight level one four zero request further descent
11	01	26.6	RDO-1	we are heading two one zero get back on course
11	01	43.1	RDO-1	taipei approach this is mayday five two one cathay five two one do you read
11	01	49.8	APP2	five two one taipei approach roger descend maintain one zero thousand QNH niner niner one
11	01	54.2	CAM	(single chime)
11	01	58.0	RDO-1	descend one two thousand correction one zero zero thousand QNH niner niner one mayday five two one
11	02	19.6	CAM-1	do we …
11	02	23.3	CAM-2	…i repeat sir
11	02	24.6	CAM-1	we
11	02	27.3	CAM-1	okay …
11	02	39.9	CAM-2	…repeat altitude
11	02	43.8	CAM-1	…
11	02	55.0	CAM-1	…clear of traffic

hh	mm	ss	Source	Context
11	03	09.0	CAM	(single chime)
11	03	12.8	APP2	cathay five two one … if able contact taipei control one two five decimal five
11	03	18.0	CAM-2	we're at eleven thousand feet we are okay …
11	03	21.6	RDO-1	taipei control taipei approach say again
11	03	25.0	APP2	five two one if able contact one two five decimal five
11	03	30.6	RDO-1	one two five five
11	03	33.4	CAM-2	tell them we've one to go
11	03	35.1	CAM-1	check
11	03	48.0	TACC	cathay five two one taipei calling
11	03	51.0	RDO-1	taipei cathay five two one we are descending one zero thousand
11	03	57.2	CAM-2	roger two three zero
11	03	59.3	RDO-1	we are heading two three zero we have commenced an emergency descent stand by
11	04	17.3	OTH	five two one …go ahead your mayday I'll relay it to taipei for you
11	04	24.4	RDO-1	taipei control have me
11	04	26.3	OTH	say again
11	04	28.4	CAM-2	okay speakers to headset
11	04	29.0	RDO-1	five two eight thanks
11	04	31.9	CAM-2	ten thousand feet
11	04	41.0	CAM-2	…speed alt star okay
11	04	44.6	CAM-1	okay
11	04	45.5	CAM-2	heading two three zero we are high enough to be above anything
11	04	51.0	CAM-1	yep
11	04	52.1	CAM-2	oh
11	04	55.7	CAM-1	okay emergency descent oxygen mask are on
11	04	58.8	CAM-2	alt
11	04	59.6	CAM-1	okay the altitude and heading we are good with speed we are happy with thrust is good
11	05	04.8	CAM-2	it's coming up
11	05	09.5	TACC	cathay five two one confirm operating normal or do you need any assistance

hh	mm	ss	Source	Context
11	05	14.0	CAM-2	we are ok
11	05	16.6	RDO-1	taipei cathay five two one we are maintaining one zero thousand feet and the situation is stable stand by for further intentions
11	05	30.4	CAM-2	okay
11	05	31.3	CAM-1	okay let’s just go through this checklist
11	05	31.8	CAM-2	check
11	05	33.1	CAM-1	we’ve got autothrust on we’re maintaining speed speed brake is in emergency descent were done two fifty is the max appropriate we’re good with that we’re at one zero zero
11	05	45.0	CAM-2	um hum
11	05	46.6	CAM-1	um
11	05	49.0	CAM-1	signs we have on ignition still and we have on ATC know that
11	05	53.9	CAM-2	no
11	05	54.2	CAM-1	save oxygen okay
11	05	57.1	CAM-2	set the diluter to the n position
11	06	00.2	CAM-2	we’re fine we are at ten thousand feet
11	06	02.1	CAM-1	I dropped the um oxygen masks
11	06	05.0	CAM-2	the masks okay
11	06	07.3	CAM-1	I was looking I could not read initially
11	06	08.7	CAM-2	yes no no it was violent it was eight thousand feet per minute yep they might not be getting oxygen though
11	06	12.1	CAM	(sounds identified as cabin call)
11	06	12.9	CAM-2	so … we should do the announcement now
11	06	16.8	CAM-1	okay
11	06	19.9	INT-1	hello
11	06	21.1	INT-3	this is f p … from doors four we had a very strong smell of burning we like to …
11	06	30.0	INT-1	okay stand by
11	06	31.3	INT-3	okay thanks bye
11	06	32.2	CAM-1	okay let’s go to taipei
11	06	33.7	CAM-2	yep we need direct to taipei
11	06	40.6	CAM-2	probably the chemical generator from the oxygen masks
11	06	42.3	CAM-1	yep

hh	mm	ss	Source	Context
11	06	42.7	CAM-2	yep
11	06	51.5	CAM-2	okay so I’m going to speed up
11	06	53.7	CAM-1	yep okay
11	06	55.3	CAM-2	to three hundred knots if that’s okay with you
11	06	57.0	CAM-1	yep yep
11	06	59.9	RDO-1	taipei it’s cathay five two one

Appendix 2 Defects Records from Aircraft Maintenance Log

From/To Block Off/On	Defect/Action
From Block OFF	Defect
SIN 2008/7/29 02:52	PRIOR TO START ENG 1 BLEED PRESSURE SHOWING 22 PSI WITH ENG 2 INDICATING 40 PSI DURING START ENG 1 BLEED SHOWED 16 PSI HOWEVER ENG START / ROTATION / EGT ALL NORMAL SUSPECT SENSOR PROBLEM
HKG 2008/7/29 08:40	ENG 1 BLEED FOR INFO= REF LP 44 ITEM 1 DURING ENGINE 1 START(WITH GROUND PNEUMATIC AIR), ENGINE 1 BLEED INDICATED 18 PSI ENGINE START AND ALL OTHER PARAMETERS NORMAL.
ICN 2008/7/29 12:18	PREV HISTORY REVIEWED AND CREW CONSULTED NO RELATED CM2R NOTED, AND BMC 1&2 POWER CYCLED AND SYSTEM TEST OK ENG DRY MOTORING C/OUT BY APU BLEED NO1 ENG 28PSI,NO2 ENG 32PSI NOTED.ENG DUCT PX IND NORMAL WHEN DRY MOTORING . PLS OBS FURTHER.
ICN 2008/7/30 01:30	ENG 1 BLEED FOR INFO RE LP 45 ITEM 1 DURING ENG 1 START ENG 1 BLEED INDICATED 28 PSI
BKK 2008/8/1 02:45	REF LP44 AND FOLLOWING REPORTS ENG 1 BLEED INDICATED 10PSI DURING ENG START. ENG START PARAMETERS AND PERFORMANCE NORMAL
HKG 2008/8/4 09:27	DURING EXTERNAL START AND CROSS BLEED START NBR 1 ENG BLEED PRESSURE INDICATING LOW BETWEEN 12 AQND 18 PSI BUT START APPEARS NORMAL
HKG 2008/8/4 09:27	DURING EXTERNAL START AND CROSS BLEED START NBR 1 ENG BLEED PRESSURE INDICATING LOW BETWEEN 12 AQND 18 PSI BUT START APPEARS NORMAL
MNL 2008/8/5 10:05	A597 NO.1 ENG BLEED PX INDICATING LOW
CTS 2008/8/6 10:53	DURING ENG #1 START BOTH SECTORS BLEED PSI WAS ONLY INDICATING 14-18 PSI HOWEVER ENG #1 STARTED NORMALLY
HKG 2008/8/7 11:25	ADD 597 #1 ENG BLEED PRESSURE IND LOW BTW 12-20 PSI BUT START APPEAR NML
SGN	REF ADD 597 NO.1 ENG BLEED PX IND LOW.

2008/8/14 11:58	
SGN 2008/8/14 11:58	REF ADD 597 PLS CHK FOR WATE RCONTAMINATION ON SENSE LINE AND CARRY OUT FUNCTIONAL TEST OF BLEED REGUIDED PRESS XDCR.
HKG 2008/8/14 14:41	NO.1 ENG BLEED PRESS SDCR 8HA 1 SENSE LINE CHKD NIL WATER CONTAMINATION FUNCTIONAL TEST OF PRESS SDUCER C/OUT IAW AMM 36-11-16 720-801 SATIS PRESS INDICATION AGREES WITH TEST SET PRESS HOWEVER, USING APU AIR INDICAITON STILL LOW ADD REMAINS.
SGN 2008/8/14 11:58	REF ADD 597 NO.1 ENG START BLEED PRESSURE INDICATES LOW.
HKG 2008/8/17 06:00	G2 BEV MAKER CUATER SUPPLY LINE AIR BLEEDING CARRIED OUT & CHKED SATIS
DEL 2008/8/19 21:54	AIR ENG 1 BLEED NOT CLOSED DURING ENG SHUTDOWN
HKG 2008/8/20 03:52	NIL RELATED ON CM2R ENG 1 BLEED SW CYCLED BMC 1 SYS TEST AND GND RPT OK
HKG 2008/8/21 12:19	AMM TASK 36-11-15-720-801 C/OUT FUNCTIONAL TEST AT BLEED TRANSFERRED PRESS TRANSDUCER PASS ADD REMAINS
DEL 2008/8/23 13:32	AIR ENG 1 BLEED NOT CLOSED DURING CROSS BLEED START OF ENG NO.1, NO.1 BLEED HAD ALREADY BEEN SELECTED OFF AS PER CROSS BLEED START PROCEDURE. SELF CLEARED
HKG 2008/8/23 19:20	TSM 36-11-81-810-833 CONSULTED NO.1 ENG BLEED VALVE INDICATION CONFIRMED FULL CLOSED AT 'OFF' POSN AS PER TSM NO FURTHER ACTION REQD
DEL 2008/8/24 08:57	REF ADD 597 ENG 1 BLEED PRESS IND UNDER READ
HKG 2008/8/24 14:42	HISTORY REVIEWED AND WIRING I/R CHK C/OUT AS PER ASM 36-11/08 CHK OK ENG 1 REG PRESS TRANSDUCER (8HAI) SENSING LINE DISCONNECTED AND FOUND THE AIR FLOW FROM APU BLEED SOURCE IS WEEK TEST PRESSURE FROM BLEED VLV TESTER CONNECTED TO THE TRANSDUCER (8 HAI) SENSING PORT DIRECTLY FOR TROUBLE SHOOTING. FOUND THE ACMS ALPHA CALL RADING AND BLEED PRESS IND ON ECAM BLEED PAGE ARE CONSISTANCE WITH THE TESTER SETTING EG.

	TESTER SETTING ACM READING ECAM IND 1.0BAR 13.5PSI 13PSI 1.5BAR 25.0PSI 25PSI 2.0BAR 31.0PSI 31PSI SUSPECT THE BLOCKAGE OR LEAK FROM THE SENSING LINE. PLS FURTHER T/SHOOTING.
HKG 2008/8/24 14:42	BLEED REG PX XDCR REINSTALLED REF ITEM 7
DEL 2008/8/24 08:57	DURING ENG START AND CROSS BLFED START NO.1 ENG BLEED PX INDICATING LOW.
HKG 2008/8/24 14:42	FOUND LINE BETW PNEU DUCT AND BLEED REG PX XDCR SHEARED. LINE REPLACED. ENG START WITH CROSS BLEED, PX SHOWED 28 PSI
HKG 2008/8/26 08:29	AIR ENG 1 BLEED NOT CLSD AFTER LANDING
ICN 2008/8/26 11:55	BMC #1 SYSTEM TESTS C/OUT PASSED. ENG 1 BLEED VLV OPS TEST OK. PLS OBS FURTHER
SUB 2008/8/29 01:21	ENG 1 BLEED FAULT / ON FOR 1 SECOND IN CRUISE
CGK 2008/8/31 01:40	ENG 1 BLEED NOT CLOSED OCCURRED AFTER SHUTDOWN VALVE OPEN AMBER ON BLD PAGE THEN SELF CLEARED AFTER TWO MINS
HKG 2008/8/31 06:24	NO FAULT MSG CAPTURE. ENGING 1 GROUND RUN CARRIED OUT BLEED VALVE OPERATION NORMAL. AMM 71-00-00
HKG 2008/9/1 08:20	INBD CREW VERBAL REPORT. ENG 1 BLEED STS FAULT IN CRZ.
HKG 2008/9/3 16:09	AIR ENG 1 BLEED NOT CLSD AFTER ENG SHUTDOWN.
HKG 2008/9/12 21:03	AIR ENG 1 BLEED NOT CLOSED. WHIST TAXI-ING IN AFTER LANDING.
ICN 2008/9/13 00:40	361152 PRESS REG-V/SOV CLASS 1 NOTED, #1 BLEED VLV EXERCISED & ECAM ERASED.
ICN 2008/9/13 01:36	AIR ENG BLEED NOT CLOSED THIS TIME OCCURING DURING ENGINE WIND DOWN AFTER ENG MASTER SX'D OFF.
HKG 2008/9/13 05:04	NO 1 ENG BLEED VALVE SECURED. CLOSED A/C DISPATCHED PER MEL. ON BLEED PAGE NO 1 ENG BLEED INDICATION SHOWING OPEN ALL THE TIME.

NRT 2008/9/14 07:54	AIR ENG 2 BLEED FAULT @APPROX 36000 INITAL RESET UNSUCESSFUL ,2ND O.K SEE ASR.
NRT 2008/9/14 07:54	SADD 617 "AIR ENG 1 BLEED NOT CLOSED"ECAM MSG
TPE 2008/9/14 11:39	ENG 1 BLEED VALVE (4001HA)REPLACED PER AMM 36-11-52 LEAK CHK C/OUT SATIS REF TO ITEM 11
NRT 2008/9/14 07:54	PLS C/OUT BOTH ENG BLEED AIR VALVE OPS CHK WITH ENG RUN
TPE 2008/9/14 11:39	ENG IDLE RUN C/OUT ON BOTH ENG ,BOTH BLEED AIR VLVS OPS CHK SATIS
NRT 2008/9/14 07:54	ETOPS DOWNGRADES BOTH ENG BLEED AIR SYS HAVE BEEN DISTURBED
HKG 2008/9/14 23:15	NO.1 ENG BLEED VLV AND SENSING LINE N1 OPS CHK C/OUT WITH TEST SET C/OUT AS PER TSM OPS AND LEAK CHK SATIS NIL FAULT NOTED REF CARD NLH01149
TPE 2008/9/14 21:45	AS PER WORKREQUEST 39703 ITEM 02 C/OUT TSM TASK 36-11-81-810-913 ON NO.2 ENG
HKG 2008/9/14 23:15	NO.2 ENG BLEED VLV AND SENSING LINE N1 OPS CHK C/OUT WITH TEST SET IAW TSM OPS AND LEAK CHK SATIS NIL FAULT NOTED REF CRD NLH01149
TPE 2008/9/14 21:45	AS PER WORK REQUEST 39703 ITEM 03 C/OUT TSM TASK 36-11-81-810-850 ON NO.1 ENG
HKG 2008/9/14 23:15	NO.1 ENG FAV AND SENSING LINE N2 OPS CHK C/OUT WIT TEST SET AS PER TSM OPS AND LEAK CHK SATIS NIL FAULT NOTED REF CARD NLH01149
TPE 2008/9/14 21:45	AS PER WORKREQUEST 39703 ITEM 04 C/OUT TSM TASK 36-11-81-810-861 ON NO.2 ENG
HKG 2008/9/14 23:15	NO.2 ENG FAV AND SENSING LINE N2 OPS CHK C/OUT WITH TEST SET AS PER TSM OPS AND LEAK CHK SATIS NIL FAULT NOTED REF CARD NLH01149
TPE 2008/9/14 21:45	AS PER WORK REQUEST 39703 ITEM 05 BMC 1 + 2 DATA PRINT OUT
HKG 2008/9/14 23:15	BMC 1 + 2 DATA PRINT OUT AND FAX TO IOC IAW AMM 36-11-00-710-811 REF CARD NLH01149
TPE 2008/9/14 21:45	AS PER WORK REQUEST 39703 ITEM 06 BOTH ENG BLEED SYSTEM OPS CHK

HKG 2008/9/14 23:15	BOTH ENG BLEED SYSTEM OPS CHK C/OUT IAW AMM 36-11-00-710-813 NO.1 ENG BLEED 38 PSI AND BLEED TEMP 150C AT IDEL NO.2 ENG BLEED PX 39 PSI AND BLEED TEMP 140C AT IDLE ALL VLV INDICATION NML NO.1 ENG BLEED PX 40 PSI AND BLEED TEMP 150C NO.2 ENG BLEED PX 40 PSI AND BLEED TEMP 148C WHEN BOTH ENG N1 AT 35% ALL VLV INDICATION NML NO.1 ENG BLEED PX 48PSI AND BLEED TEMP 145C NO.2 ENG BLEED PX 48PSI AND BLEED TEMP 140C WHEN BOTH ENG AT 65% N1 ALL VLV INDICATION NML REF CARD NLH01149
TPE 2008/9/14 21:45	AS PER WORKREQUEST 39703 ITEM 07 FUNCTIONAL TEST OF BLEED VLV
HKG 2008/9/14 23:15	BOTH ENG BLEED VLV FUNCTIONAL TEST C/OUT IAW AMM 36-11-52-720-809 SATIS REF CARD NLH01149
TPE 2008/9/14 21:45	AS PER WORK REQUEST 39703 ITEM 08 FUNCTIONAL TEST OF HP BLEED VLV
HKG 2008/9/14 23:15	BOTH ENG HP BLEED VLV FUNCTIONAL TEST C/OUT IAW AMM 36-11-51-720-810 SATIS REF CARD NLH01149
TPE 2008/9/14 21:45	AS PER WORK REQUEST 39703 ITEM 09 CPC 1 AND 2 OPS CHK
HKG 2008/9/14 23:15	CPC 1 + 2 OPS CHK C/OUT IAW AMM 21-31-00-710-801 TEST OK REF CARD NLH01149
HKG 2008/9/14 23:15	TEST C/OUT IAW AMM 05-53-00-780-803-01 TEST SATIS A/L LEAK RATE APPROX 0.8 PSI/MM

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Appendix 3 MEL 36-11

CATHAY PACIFIC AIRWAYS

A330 MEL	**MINIMUM EQUIPMENT LIST**	01-36
	PNEUMATIC	TS7996/TM/cl/ TR 229 (4 JUN 08)

FILING INSTRUCTIONS: Remove and destroy Temporary Revision 218, insert and record Temporary Revision 229 facing 01-36 P 1.

ITEM	1.	2. RECTIFICATION INTERVAL	3. NUMBER INSTALLED	4. NUMBER REQUIRED FOR DISPATCH	5. REMARKS OR EXCEPTIONS
36-11 ENGINE BLEED AIR SUPPLY SYSTEM					
11-01 Bleed Air Supply System	[ ]	[ ]	[ ]	[ ]	[ ]
	C	2	1	*(o) [P] [E]	One may be inoperative provided: 1) The associated ENG BLEED pb sw is selected OFF, and 2) The crossbleed valve is selected OPEN, and [ ] [3) The APU and APU bleed air supply system is serviceable, and 4) The speedbrake control system is serviceable.] [ ] [*Note* : *In case of depressurization at altitudes higher than 37,400 FT (11,400 M), PSU oxygen masks may drop during the descent.* Consider 27-92-01 (SPLR), and Consider 36-12-01 (APU BLEED)] [ ] ***— ETOPS —*** ***For ETOPS operations.*** ***Dispatch with one Bleed Air supply system inoperative is allowed for One flight only.***
11-02 Bleed Valve	C	2	1	(m) [P]	One may be inoperative provided: 1) It is secured closed, and 2) The associated engine bleed air supply system is considered inoperative. Apply 36-11-01 [E] (ENG BLEED)

CATHAY PACIFIC AIRWAYS

A330 MEL	**OPERATIONAL PROCEDURES**	02-36
	PNEUMATIC	TS7996/TM/cl/ TR 230 (4 JUN 08)

FILING INSTRUCTIONS: Insert and record Temporary Revision 230 facing 02-36 P 1.

36-11 ENGINE BLEED AIR SUPPLY SYSTEM

11-01 Bleed Air Supply System

During cockpit preparation:

- Refer to FCOM 3.02.36 (AIR ABNORM BLEED CONFIG procedure).
- Consider the severity of forecast icing conditions, if any (the wing anti-ice will be lost if the remaining engine bleed air supply system becomes inoperative).

[ ]

In-flight failure:

In the event of remaining engine bleed air supply system failure, or associated engine failure:

[– Apply the associated ECAM procedure, then
– Apply QRH procedure (AIR DUAL BLEED FAULT)]
[ ]

11-06 IP Check Valve

b)
- After start, during taxi:
  Crossbleed Sel ....OPEN
  Associated ENG 1(2) BLEED pb SW ....OFF
- Just before take-off:
  Associated ENG 1(2) BLEED pb SW ....ON
  Crossbleed Sel ....AUTO
- Before initiating descent and until landing:
  Crossbleed Sel ....OPEN
  Associated ENG 1(2) BLEED pb SW ....OFF
- Just before engine shutdown:
  Associated ENG 1(2) BLEED pb SW ....ON
  Crossbleed Sel ....AUTO

Appendix 4 Deferred defects list

Raise Date	Defect
29/Aug/08	ON WAC NO.2 ENG NOSE COWL BOTTOM PORTION FND CHIPPED OFF PAINT AT 6 O/C POSN
29/Aug/08	NO.2 ENG COMMON NOZZLE ASSY LOWRE HALF EXTERNAL SURFACE TOP COATING CRACK N PEELING OFF 3 PIECES OF COATING (ABOUT 1"X1" EACH).
8/Sep/08	AFT CGO 33L, 32P, 41L, 42R PDU ROLLER W.T.L.
12/Sep/08	DECAL / PLACARD DISCHARGE OXY MISSING AT RH FUSELAGE FWD
8/Sep/08	L1,R2,R3 ATTENDANT SEAT COVER DIRTY
8/Sep/08	41L, 34R PDU U/S.
11/Sep/08	LH WING NBR 1 SLAT I/B END BLADE SEAL TORN
14/Sep/08	CAPT MASTER CAUTION SW INOP LT DOES NOT EXTINGUISH WHEN PUSHED TO CANCEL
8/Sep/08	TWO SMALL DENTS NOTED ON LOWER BELLY FAIRING PANEL 191AB ADJACENT TO THE FWD DRAIN MAST.
8/Sep/08	FWD CGO 12R, 12L, 11P, 11L, 24R, 25R, 24L PDUROLLER W.T.L.
13/Sep/08	AIR ENG BLEED NOT CLOSED THIS TIME OCCURING DURING ENGINE WIND DOWN AFTER ENG MASTER SX'D OFF.

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Appendix 5 Maintenance Current Flight Report

A/C IDENT ..B-HLH MAINTENANCE DATE 14SEP08

FLT NBR CPA521 CURRENT FLIGHT REPORT UTC 1116

FROM/TO RJAA/RCTP LEG 00

START/END 0800/CFR1 DB/N 11L

```
--------------------------------------------------------------
   06 COCKPIT   |   UTC    |              08 FAULTS
    EFFECTS     | PHASE    |
--------------------------------------------------------------
ATA 3600        |   0801   |ATA 362216            SOURCE *BMC2
                |          |CLASS 2
                | ENGINE   |HARD
MAINTENANCE     |  START   |L WING LOOP A
STATUS BMC 2    |    02    |
--------------------------------------------------------------
ATA 4900        |   0801   |ATA 494138            SOURCE *ECB
                |          |CLASS 2
                | ENGINE   |HARD
MAINTENANCE     |  START   |IGNITION PLUG (59KA31)/
STATUS APU      |    02    |IGNITION EXCITER(59KA10)
--------------------------------------------------------------
                |   0801   |ATA 383154            SOURCE *VSC
                |          |CLASS 2
                | ENGINE   |HARD
```

```
                  |   START |WASTE DRAIN VLV NOT CLSD
                  |     02    |L (135MG)
------------------------------------------------------------------
                  |   0801   |ATA 493151                    SOURCE *ECB
                  |              |CLASS 2
                  | ENGINE |HARD
                  |   START |FLOW DIVDR
                  |     02    |ASSY(59KF25)/DATA MEMORY
                  |              |MDUL(59KV20)
------------------------------------------------------------------
                  |   0814   |ATA 228334                    SOURCE ILS2
                  |              |CLASS 1                        IDENTIFIERS
                  |              |HARD                               ILS1
                  | CRUISE |FMGEC2(1CA2)/RMP2(1RG2)/
                  |     06    |ILS2(1RT2)
------------------------------------------------------------------
ATA 3831          |   0815   |
                  |              |
                  |              |
MAINTENANCE      | CRUISE |
STATUS TOILET |     06      |
------------------------------------------------------------------
                  |   0821   |ATA 275134                    SOURCE EIVMU2
                  |              |CLASS 1                        IDENTIFIERS
                  |              |HARD                               EIVMU1
                  | CRUISE |SFCC1 (21CV)/SFCC2
                  |     06    |(22CV)/EIVMU2 (1KS2)
```

```
---------------------------------------------------------------
                    |   0851   |ATA 307000                      SOURCE CIDS1
                    |          |CLASS 1
                    |          |HARD
                    | CRUISE |HEATR 129/ WIPCU AFT
                    |    06    |(200DW)
---------------------------------------------------------------
ATA 3621            |   1055   |ATA 361143                      SOURCE BMC2
                    |          |CLASS 1
                    |          |HARD
AIR ENG 2           | CRUISE |THRM (5HA2)/ FAN AIR-V
BLEED FAULT         |    06    |(12HA2) /SENSE LINE
---------------------------------------------------------------
ATA 2131            |   1056   |
                    |          |
                    |          |
ADVISORY CABIN| CRUISE |
ALTITUDE            |    06    |
---------------------------------------------------------------
ATA 2131            |   1057   |
                    |          |
                    |          |
CAB PR EXCESS | CRUISE |
CAB ALT             |    06    |
---------------------------------------------------------------
```

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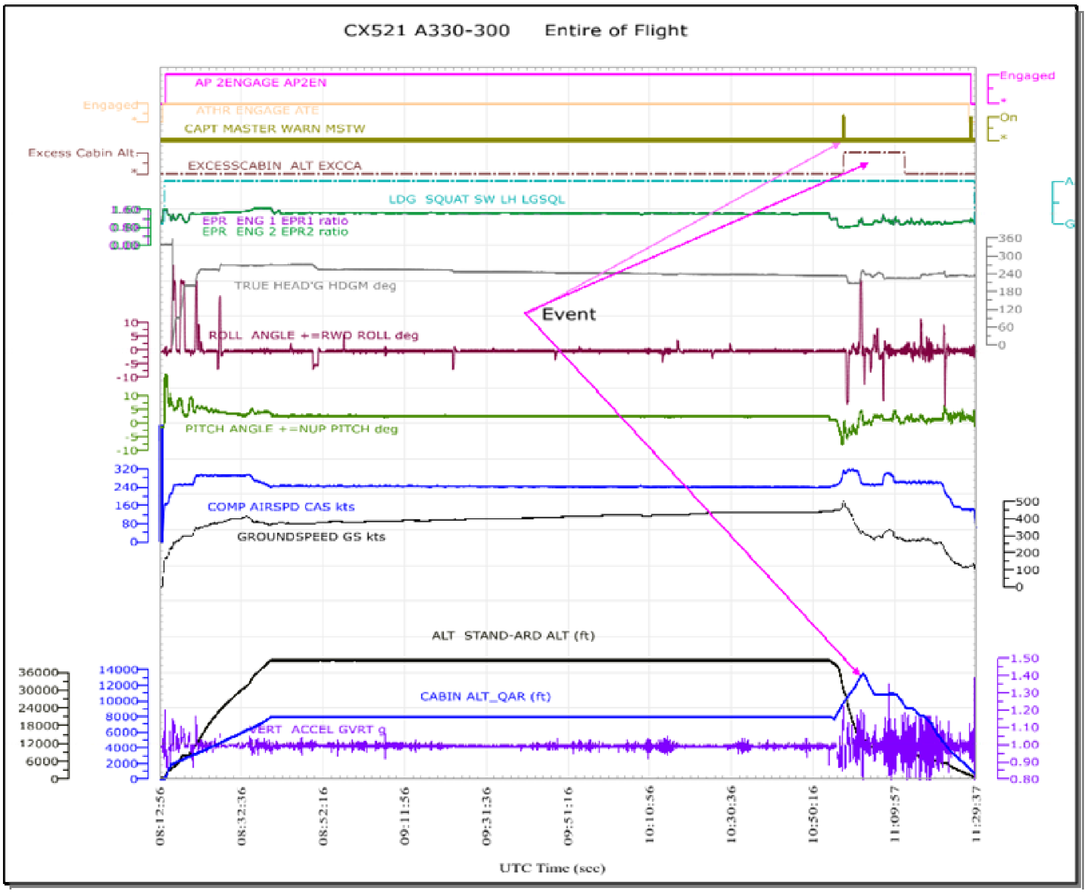
Appendix 6 SSFDR data plots

6-1 SSFDR related parameters plot (1)

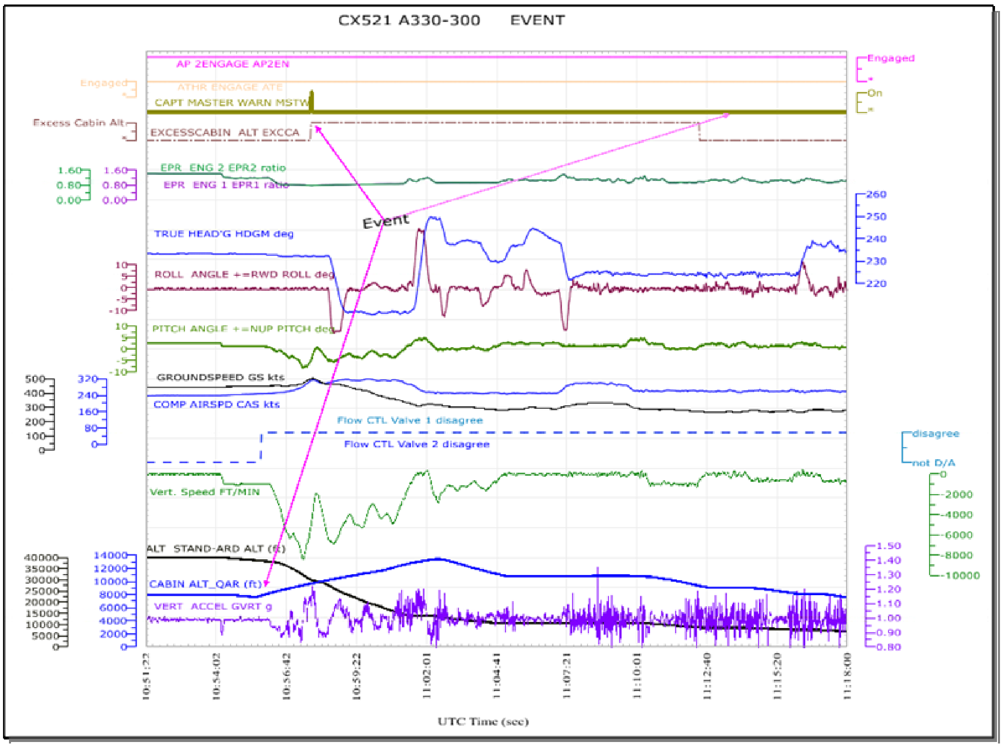
6-2 SSFDR related parameters plot (2)

6-3 SSFDR related parameters plot (3)

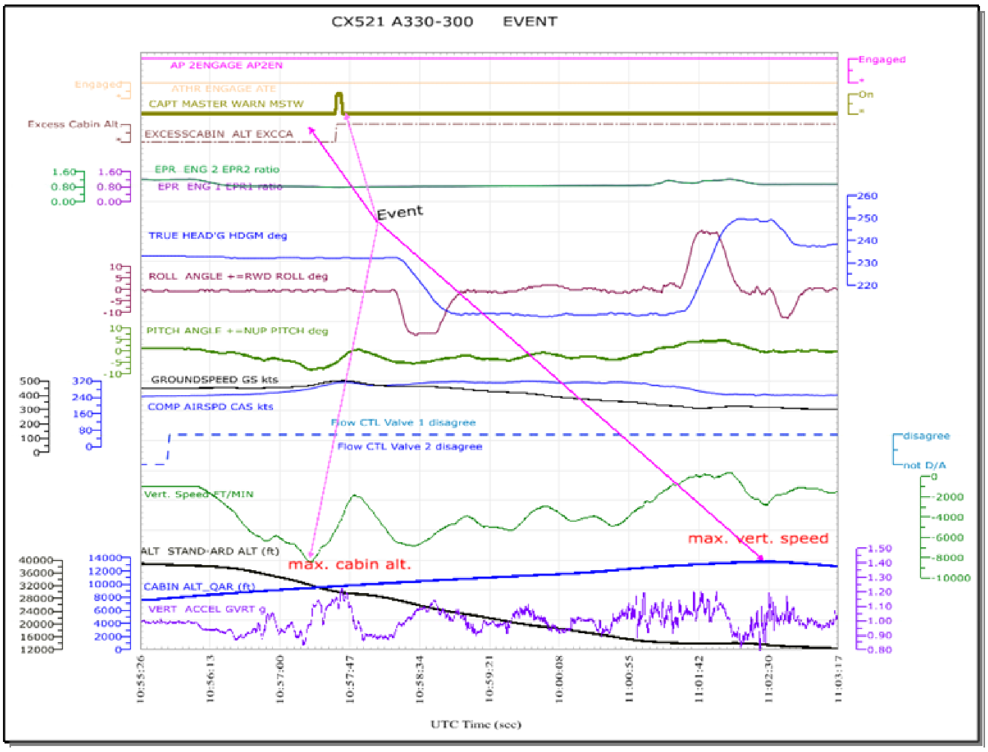
6-4 Superposition of flight path and satellite Map.



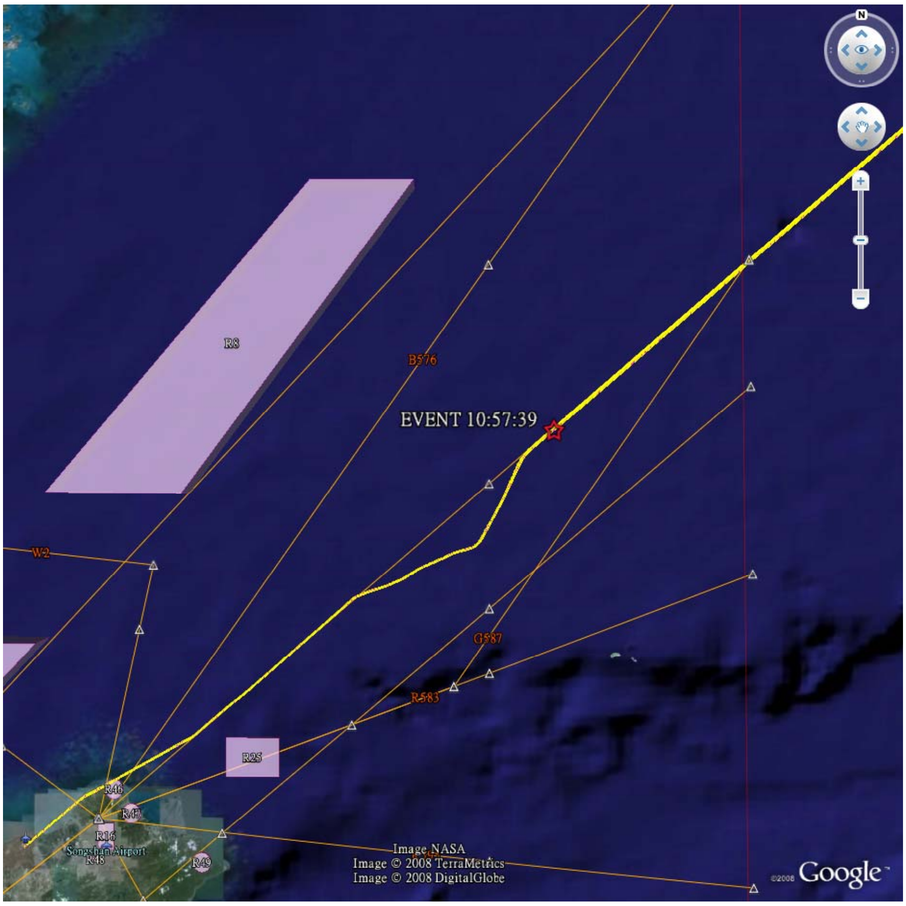
6-1 SSFDR related parameters plot: entire of flight (1)



6-2 SSFDR related parameters plot: Event (2)



6-3 SSFDR related parameters plot: Event (3)



6-4 Superposition of flight path and satellite Map

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Appendix 7 COMPTE RENDU D'EXPERTISE / INVESTIGATION REPORT

LIEBHERR-AEROSPACE TOULOUSE S.A.

B.P. 2010 - 408 av.des Etats-Unis	REFERENCE	: SC/ST/08-1219
F-31016 Toulouse Cedex - France	Indice/ Issue	: /
	Date de l'expertise	: 22/10/2008
	Lieu	: LTS
	Page	: 1/10

COMPTE RENDU D'EXPERTISE / INVESTIGATION REPORT

EMETTEUR / SENDER	Rédigé par / Issued by	Approuvé par / Approved by
Nom / Name	[redacted]	
Département	Technical Support	
Téléphone / Phone	05-61-35-22-41	
Fax	05-61-35-29-29	
Date	22/10/2008	
Visa		

PARTICIPANTS / MEMBERS		DIFFUSION / ISSUING	
[redacted]	BEA CPA	Participants + : P Graves	AI : SEE
[redacted]	AI :EYVT AI :SEE	Mathieu CALLENAERE	AI : LR Prog
[redacted]	LTS : Enginering LTS : Enginering LTS : Enginering LTS : Methods LTS : Methods LTS : Laboratory Material	Lloyd Tracy Guillaume Gard Michel Eglem Francis Carla Dominique Loret Philippe Tardieu Claude Rossignol	LTS : Technical Support LTS : Technical Support LTS : Enginering LTS : Enginering LTS : Quality Assurance LTS : Quality Assurance LTS : Laboratory Material

OBJET DE L'EXPERTISE / SUBJECT

Description	Thermostat (THC)	Fan Air valve (FAV)
Part Number	398E020000	6733A030000
Sérial Number	00163	00156
Operator	CPA	CPA
Aircraft	B-HLH # 1	B-HLH # 1
Assembly Date	05/94	10/94
Flight hours	TSI 10145 FH TSN 31547 FH	TSI 17305 FH TSN 25203 FH
Removal Date	14/09/2008	14/09/2008

MOTIF DE L'EXPERTISE / PROBLEM DESCRIPTION

Removal reason : **Dual bleed loss, with masks deployed on B-HLH (MSN 121) 13th Sep 2008**

- engine 2 : Air eng bleed not closed this time occurring during engine wind down after eng master SX'D OFF. Then NO 1 eng bleed valve secured. Closed A/C dispatched per MEL. On bleed page No 1 eng bleed indication showing open all the time.
- engine 1 : Engine bleed fault due to overtemp condition

matrice/0992crex

LIEBHERR-AEROSPACE TOULOUSE S.A.

B.P. 2010 - 408 av.des Etats-Unis
F-31016 Toulouse Cedex - France

REFERENCE	:	
Indice/ Issue	:	/
Date de l'expertise	:	22/10/2008
Lieu	:	LTS
Page	:	2/10

❖ THC 398E020000 SN 0163 :

➢ _ Visual inspection

Nothing unusual observed

➢ _ Investigation

A complete hot GO NOGO test has been performed as per CMM 36-11-35 requirements : see hereunder copy of the Test results appendix 1.
This test has revealed a lower reduced pressure (muscle pressure to the FAV) than required in the primary nominal testing condition :

- T= 205°C with a supplied pressure = 3 Bar
  Reduced pressure = 266 mbar vs of 300 +/- 20 mbar as per CMM

Additional hot testing at 250°C (not included in th e CMM requirements) have been also performed :

- T= 250°C with a supplied pressure = 3 Bar
  Reduced pressure = 473 mbar

Removal of the filter(CMM item 01-550) to check the contamination level:
Filter permeability check = 20 mbar for 100 mbar maximum. ➔Filter is clean.

Note : this clean filter has possibly been changed on wing by Operator since last shop visit per recommended AI SIL 36 055

Then a visual inspection allowed to note contamination on the grid filter(see figure hereunder for location).
It has been decided to pierce the grid filter in order to measure the performance.

Testing with the grid filter pierced:

- T= 250°C with a supplied pressure = 3 Bar
  Reduced pressure = 634 mbar

With grid filter pierced the testing results at T=250 °C have shown a significant rise of the reduced pressure level :
- with the contaminated grid filter the slope of the curve Reduced pressure = f(T°C) is equal to 4,6 mbar/°C (low slope)
- with the pierced grid filter the slope of the curve Reduced pressure = f(T°C) is >7 mbar/°C

The THC has re-found the normal behaviour vs Temperature with a pierced grid filter.

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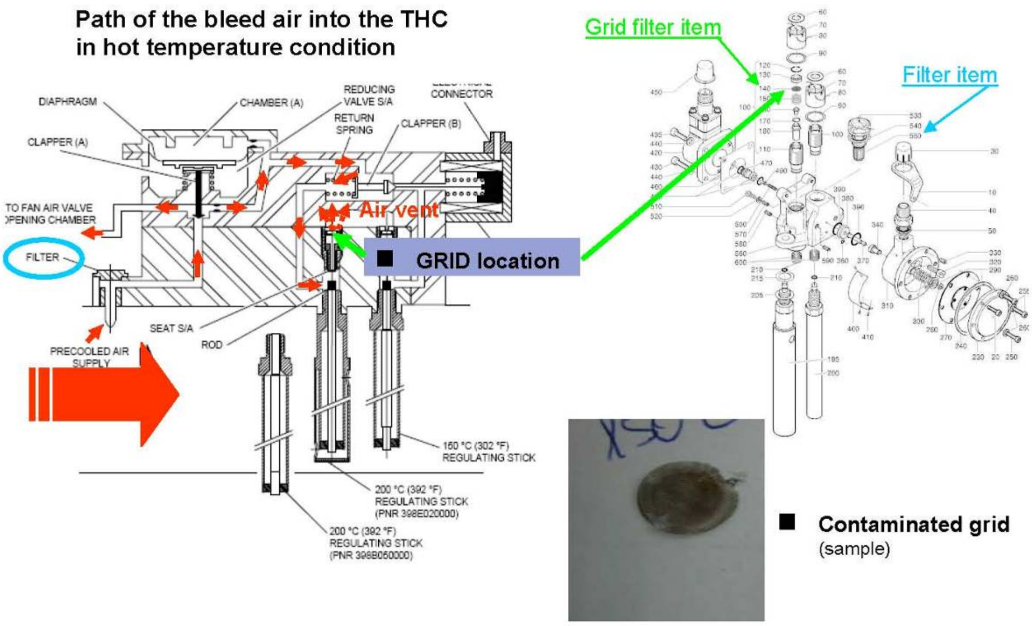
Final Testing with the grid filter pierced at nominal temperature condition as per CMM requirements has allowed to re-find the value within the tolerances:

-T= 205 ℃ and supplied pressure = 3 Bar
with the grid filter, the reduced pressure = 266 mbar for 300 mbar +/- 20 mbar
with the grid filter pierced, the reduced pressure = 317 mbar for 300 mbar +/- 20 mbar

At high temperature condition the reduced pressure normally vents through the grid filter thanks to the thermal expansion of the regulation stick (see figure hereunder for air bleed path into the THC)
The contamination of the grid has affected the flow of the reduced pressure (causing a pressure loss) coming from the bleed air through the THC .



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➢ **_ Conclusion.**

The removal of the THC is confirmed due to level of contamination at the grid filter location.
The contamination level of the grid filter has caused a drift of the reduced pressure (muscle pressure) below the nominal tolerance to the FAV which could lead to prevent a correct full opening of the FAV and causing an overtemperature condition on the bleed system of the engine 1.

The contamination of the grid filter is coming from "expected" atmospheric pollution going through the THC past the primary filter (see flow path diagram above).
Note : The air path inlet filter is 45 µm, and is intended for dust/sand/FOD/contamination protection with minimum pressure loss.
LTS action : quantitative investigation of the grid filter contamination by LTS Laboratory
➔target date : Mid of November

Background of the THC S/N 163 (as requested by BEA representative)
During the THC Bleed Improvement Program modification (July 2002) to P/N 398E020000 at TSN = 15810 FH the grid filter was replaced.
This grid filter was cleaned at the previous repair (May 2004) TSN= not reported / Cycle ? at LSI Shop as per the CMM Cleaning chapter procedure.
Since June 2007 a Technical note issued by LTS to all Liebherr repair shops recommends to systematically replace the grid filter during a repair in Shop.

Complementary note:
BEA has requested the removal of the opposite THC (engine 2) for investigation and check of the contamination level.

On October 10 2008 the THC SN 644 from MSN B-HLH was removed due to "# 1 ENG BLEED FAULT" msg: See attached copy of the SFR and preliminary and standard CMM testing
Note: on the attached documents of the THC from CPA, THC was noted removed from Engine # 1. Could CPA clarify ?

Shop finding report summary (see hereunder LSI SFR and incoming and outgoing testing in the Appendix 3):

Low reduced pressure than the CMM requirements:
-T= 205 °C and supplied pressure = 3 Bar
with the grid filter, the reduced pressure = 248 mbar for 300 mbar +/- 20 mbar

Filter permeability check = 110 mbar for 100 mbar maximum as per CMM. ➔Filter was slightly contaminated but the measured pressure loss level is not enough to affect the performance of the THC.
Note : The grid filter was replaced during a repair in Shop.

The removal is confirmed due to the drift of the reduced pressure (muscle pressure) below the nominal tolerance to the FAV which could lead to prevent a correct full opening of the FAV and causing an overtemperature condition on the bleed system (drift at low side).

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❖ FAV 6733A030000 SN 0156 :

➢ _ Visual inspection

High level of external pollution

➢ _ Investigation

A complete GO NOGO test has been performed as per CMM 36-11-24 requirements : see attached copy of the Test results appendix 2.

The valve passed the pneumatic test:

- minimum opening pressure = 400 mbar for > 300 mbar
- full opening pressure = 452 mbar for < 550 mbar

This test has also revealed a no indication of the FAV closing position due to wear between the switch lever and the lever causing a drift of the initial switch setting.

Complementary note:
At bleed system level AIRBUS said the missing closing indication would have an impact in case of bleed low temp only.

Mechanical wear

Switch lever wear

lever wear

matrice/

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➢ _ **Conclusion**

The removal of the FAV is not confirmed/ justified due to the Overtemperature condition of the engine 1 bleed system.
Due to the high level of pollution a complete disassembly will be carry out for cleaning plus an overall repair.

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APPENDIX 1: THC testing

Banc Therm

title/titre:	TCT					
reference:	GO-NOGO 398E020000					
RO S/N:	RO:	194376		S/N:	163	
mesure	unité	min	max	mesure	résultat	
measurement	unit	min	max	value	result	
1 N° du banc						
Banc	n°	1	6	6	V	
2 Etanchéité canne / Siège						
T = 20°C P.amont = 3 ± 0.1 bar SS=0VDC Mesure de Pd	mbar	0	150	163	F	
T = 20°C P.amont = 3 ± 0.1 bar SS=17VDC Mesure de Pd	mbar	0	150	136	V	
3 Contrôle de la pression détendue						
T =161 °C P.amont = 3 bar SS=17VDC Mesure de Pd (1)	mbar	280	320	314	V	
HP → T =205 °C P.amont = 3 bar SS=0VDC Mesure de Pd (2)	mbar	280	320	266	F	
T =205 °C P.amont = 4 bar SS=0VDC Mesure de Pd (3)	mbar	325	355	298	F	
T =205 °C P.amont = 2 bar SS=0VDC Mesure de Pd (4)	mbar	255	275	244	F	
T =205 °C P.amont = 3 bar SS=0VDC Mesure de Pd (5)	mbar	280	320	279	F	
T =161 °C P.amont = 3 bar SS=17VDC Mesure de Pd (6)	mbar	286	318	341	F	
T =205 °C P.amont = 3 bar SS=0VDC Mesure de Pd (7)	mbar	280	320	265	F	
T =161 °C P.amont = 3 bar SS=17VDC Mesure de Pd (8)	mbar	280	320	369	F	
T =20 °C P.amont = 3 bar SS=0VDC Mesure de Pd (9)	mbar	0	150	150	V	
T =20 °C P.amont = 3 bar SS=17VDC Mesure de Pd (10)	mbar	0	150	130	V	
5 Validation du déverminage						
Validation	.	V	V	F	F	

P/N:398E020000 Date:22/10/2008 Signature:

2,7 = 455 mbar
sous 3 bar - | 250°C = 473 mbar

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APPENDIX 2 : FAV testing

LIEBHERR AEROSPACE SAS — Trouble shooting Data sheet / Fiche de codification de panne

ref RO : 194338 P/N : 6733A030000 S/N : 00156	CMM : 36-11-24 Client / Airline : LSZ Date : Monteur / Operator :	Contrôle final / Final control :

NFF- No fault found / NFF- Pas de pannes trouvées	1000	

Designation of test	Condition	Nominal value	LIROM code	Value	confirmation
Visual inspection					
	Check visual inspection		10__		
Insulation resistance test					
Apply 50VDC	Check insulation resistance	R ≥ 100 MΩ	20__	70000	
Continuity test					
	Mesure continuity between bonding points	R ≤ 20 mΩ	20__	5 mΩ	
Air functionnal test on table					
Mini. Opening pressure test					
Valve closed	Check Closed indicator light	ON	30__	OFF	←
	Check Not Closed indicator light	OFF	30__	ON	←
Close valve, gradually increase P1	Check value when the valve start to open	P1 > 300 mbar (4.35 psig)	35__	400	
	Check Closed indicator light	OFF	30__	OFF	
	Check Not Closed indicator light	ON	30__	ON	
	Check Not Open indicator light	ON	30__	ON	
Increase P1	Check value when the valve is full open	P1 ≤ 550 mbar rel (7.98 psig)	35__	452	
	Check Not open indicator light	OFF	30__	OFF	
	Check Open indicator light	ON	30__	ON	
Operation through ground test union					
Valve closed, gradually increase P1	Check when the valve is full open	0.7 ≤ P1 ≤ 1.3 bar rel	70__	0,980	
	Not open indicator light	OFF	30__	OFF	
	Check Open indicator light	ON	30__	ON	
Valve locking in closed position					
Remove special screw. Apply P1 (0.7 ≤ P1 ≤ 1.3 bar rel.) (10.15 to 18.15 psig).	Check Closed indicator light	ON	75__	ON	
	Check Not Closed indicator light	OFF	30__	OFF	
Leakage test					
Internal leakage valve body					
Apply P1 = 800 to 900 mbar rel (11.6 to 13.05 psig)	Check value of Q leakage rate	Q1 ≤ 110 Nl/min	80__	98	
External leakage					
Apply P1 = 800 to 900 mbar rel (11.6 to 13.05 psig)	Check value of Q1 flowmeter	Q2 ≤ 30 Nl/min	83__	15,5	
External leakage of the actuator					
Apply P1 = 800 to 900 mbar rel (11.6 to 13.05 psig)	Check value of Q3 flowmeter	Q3 ≤ 12 Nl/min	82__	12,8	

Constats non codifiés / Findings not codified

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Appendix 3 THC SN 644 SFR and testing

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Liebherr Aerospace Singapore
8 Pandan Avenue
Singapore 609384

CATHAY PACIFIC AIRWAYS LTD
PBH, MAT.PLANNING & SUPPLY
7/F SOUTH TOWER,CATHAY PAC.
CITY, 8 SCENIC RD.LANTAU
HONGKONG
001

Your contact : Name : [redacted]
Tel : 65 64247225
Fax : 65 62652657
E-mail : [redacted]

SHOP FINDING REPORT
INVESTIGATION REPORT

Repair Order : 317014
Sales Order : 317014
Sheet : 1 of 2 Issue : 0
Date : 29/10/2008

CUSTOMER DATA

Operator	: cathay pacific airways pbh
Customer Order	: RO1868853
Aircraft	: A330BIP
Aircraft Reg N°	: B-HLH
Date of removal	: 10/10/2008
Date of receipt	: 15/10/2008
Work requested	: repair
Warranty requested	: No
Approved data	: CMM 36-11-35 Rev3

UNIT RECEIVED DATA

Part N°	: 398E020000
Amendments	: -
Description	: thermostat
Serial N°	: 00644
Quantity	: 1
Manufacture date	: 10/00
TSI	: 10163.54
TSO	: 10163.54
TSN	: 17584.36
HRS,LDGS,CYCLES	: HRS

UNIT TO BE DELIVERED / UNIT DELIVERED

Part N°	: 398E020000
Amendments	: -
Customer ref.	:
Serial N°	: 00644
Concession	:
Work performed	: repair
Warranty applied	: Out of Warranty

Comments : nil

LIEBHERR

SHOP FINDING REPORT
INVESTIGATION REPORT

Repair Order : 317014
Sales Order : 317014
Sheet : 2 of 2 Issue : 0
Date : 29/10/2008

REASON FOR RETURN :
#1 ENG BLEED FAULT MSG
G01A3

VISUAL CHECK :

Unit received in dirty condition.

FINDINGS AND ANALYSIS :
reduced press (hot air) on 150°c stick out of tol
reduced press (hot air) on 200°c stick out of tol
In-coming filter pressure drop test found: 110 mbar (nom:< 100 mbar)
Disassembly defects found:
Diaphragm 342-0250 aged.
Poppet 398-24 worn.
Spring S100-673, S100-687 & S100-909 tension weak.
M/F: Reduced pressure drift.(low side)

ORIGIN OF DEFECT :

Reported defects was due to the faulty pressure reducing s/a.(drift at low side)

WORK PERFORMED : AS PER MANUAL
contact 150°c stick / seat cleaned and lapped
packing s602-2-2x1-6 on 150°c stick replaced
setting 150°c stick / seat adjusted (hot air)
contact 200°c stick / seat cleaned and lapped
packing s602-2-2x1-6 on 200°c stick replaced
setting 200°c stick / seat adjusted (hot air)
diaphragm replaced
Replaced parts as shown on Replaced Parts List.

Out-going filter (after cleaned) pressure drop test found: 25 mbar (nom:< 100 mbar)

Unit was inspected, repaired and tested in accordance with CMM 36-11-35, Rev.03.

REMARKS :

nil

Return justified ? : Yes
Reason for return confirmed ? : Yes

Name : ____________

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LIEBHERR
Aerospace
COMPONENT MAINTENANCE MANUAL
398B050000 & 398E020000
THERMOSTAT

TASK 36-11-35-700-801-A01
1. Acceptance Test Repair Data Sheet (ATRDS)
A. Test Procedure
NOTE: "ACTUAL VALUE A": Write this value before the repairs.
"ACTUAL VALUE B": Write this value before the installation on the aircraft.

APPLICABLE PAGES: Page 1 of 1	FILE No: 317014
PNR: 398E020000	S/N: 00644
TESTED BY [redacted]	DATE: 22OCT08
FINAL INSPECTION APPROVAL BY: [redacted]	DATE: 22 OCT 2008

POSITION IN THE CMM.	MEASUREMENT	NOMINAL VALUE TOLERANCE	ACTUAL VALUE A	ACTUAL VALUE B
Para. 1.D.2a	**Insulation resistance test** Apply a 50 VDC voltage between interconnected contact pins (1) & (2) (coil) and contact pin (3) (ground) of electrical connector (02-150)	> 100 MΩ	NA	>100 MΩ
Para. 1.D.2b	**Electrical continuity test** Measure electrical continuity between contact pin(3)(ground) of electrical connector (02-150) and any point of unit.	≤ 20 mΩ		17 mΩ
Para. 1.D.2.c	**Coil resistance test** Measure the coil resistance between the pins (1) and (2)	76 to 84 Ω		80 Ω
Para. 1.D.3a	**Cold operation test** **200°C regulating stick** P1=3 bar rel. ± 0.1 bar rel. P2 value=	≤150 mbar rel.		129 mbar
Para. 1.D.3b	**150 °C regulating stick** energize the solenoid with 17 VDC P1=3 bar rel. ± 0.1 bar rel. P2 value=	≤150 mbar rel.		127 mbar
Para. 1.D.4.g	Hot air test **Adjustment of 150°C regulating stick.** T1= 161± 2°C, P1=3 ± 0.1 bar rel. **P2 value =**	300 ± 20 mbar		298 mbar
Para. 1.D.4.h	**Adjustment of 200°C regulating stick.** T1= 205 ± 2°C, P1=3 ± 0.1 bar rel., **P2 value =**	300 ± 20 mbar		301 mbar
Para. 1.D.4.i	Temperature control T1= 205± 2°C, P1=4 ± 0.1 bar rel. **P2 value =** P1=2 bar rel. **P2 value =** P1=3 bar rel. **P2 value =** Decrease T1= 161°C **P2 value =**	340 ± 15 mbar 265 ± 10 mbar 303 ± 9 mbar 302 ± 16 mbar		334 mbar 263 mbar 300 mbar 298 mbar

LASI/TD/226 Rev.'1',Dated 09 Sep. 2008 CMM 36-11-35, Rev. 3

LIEBHERR
Aerospace
COMPONENT MAINTENANCE MANUAL
398B050000 & 398E020000
THERMOSTAT

TASK 36-11-35-700-801-A01
1. Acceptance Test Repair Data Sheet (ATRDS)
A. Test Procedure
NOTE: "ACTUAL VALUE A": Write this value before the repairs.
"ACTUAL VALUE B": Write this value before the installation on the aircraft.

APPLICABLE PAGES: Page 1 of 1	FILE No: 317014
PNR: 398E020000	S/N: 00644
TESTED BY Lim Kian Aik	DATE: 20 OCT08
FINAL INSPECTION APPROVAL BY: Sungip Mohamed	DATE: 20 OCT 2008

POSITION IN THE CMM.	MEASUREMENT	NOMINAL VALUE TOLERANCE	ACTUAL VALUE A	ACTUAL VALUE B
Para. 1.D.2a	**Insulation resistance test** Apply a 50 VDC voltage between interconnected contact pins (1) & (2) (coil) and contact pin (3) (ground) of electrical connector (02-150)	> 100 MΩ	>100 MΩ	NA
Para. 1.D.2b	**Electrical continuity test** Measure electrical continuity between contact pin(3)(ground) of electrical connector (02-150) and any point of unit.	≤ 20 mΩ	18 mΩ	
Para. 1.D.2.c	**Coil resistance test** Measure the coil resistance between the pins (1) and (2)	76 to 84 Ω	80 Ω	
Para. 1.D.3a	**Cold operation test** **200°C regulating stick** P1=3 bar rel. ± 0.1 bar rel. P2 value=	≤150 mbar rel.	149 mbar	
Para. 1.D.3b	**150 °C regulating stick** energize the solenoid with 17 VDC P1=3 bar rel. ± 0.1 bar rel. P2 value=	≤150 mbar rel.	147 mbar	
Para. 1.D.4.g	Hot air test **Adjustment of 150°C regulating stick.** T1= 161± 2°C, P1=3 ± 0.1 bar rel. **P2 value =**	300 ± 20 mbar	256 mbar	
Para. 1.D.4.h	**Adjustment of 200°C regulating stick.** T1= 205 ± 2°C, P1=3 ± 0.1 bar rel., **P2 value =**	300 ± 20 mbar	248 mbar	
Para. 1.D.4.i	Temperature control T1= 205± 2°C, P1=4 ± 0.1 bar rel. **P2 value =** P1=2 bar rel. **P2 value =** P1=3 bar rel. **P2 value =** Decrease T1= 161°C **P2 value =**	340 ± 15 mbar 265 ± 10 mbar 303 ± 9 mbar 302 ± 16 mbar	200 mbar 280 mbar 242 mbar 250 mbar	

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COMPTE RENDU D'EXPERTISE / INVESTIGATION REPORT

EMETTEUR / SENDER	Rédigé par / Issued by	Approuvé par / Approved by
Nom / Name	[redacted]	
Département	Technical Support	
Téléphone / Phone	05-61-35-22-41	
Fax	05-61-35-29-29	
Date	22/10/2008	
Visa		

PARTICIPANTS / MEMBERS

[redacted]	BEA CPA
[redacted]	AI :EYVT AI :SEE
[redacted]	LTS : Enginering LTS : Enginering LTS : Enginering LTS : Methods LTS : Methods LTS : Laboratory Material

DIFFUSION / ISSUING

Participants + :

P Graves	AI : SEE
Mathieu CALLENAERE	AI : LR Prog
Lloyd Tracy	LTS : Technical Support
Guillaume Gard	LTS : Technical Support
Michel Eglem	LTS : Enginering
Francis Carla	LTS : Enginering
Dominique Loret	LTS : Quality Assurance
Philippe Tardieu	LTS : Quality Assurance
Claude Rossignol	LTS : Laboratory Material

OBJET DE L'EXPERTISE / SUBJECT

Description	PRV
Part Number	6764B040000 Amdt A
Sérial Number	00573
Operator	CPA
Aircraft	B-HLH # 2
Assembly Date	12/99
Flight hours	TSI 7895 FH
Removal Date	14/09/2008

MOTIF DE L'EXPERTISE / PROBLEM DESCRIPTION

Removal reason : **Dual bleed loss, with masks deployed on B-HLH (MSN 121) 13th Sep 2008**

- engine 2 : Air eng bleed not closed this time occurring during engine wind down after eng master SX'D OFF. Then NO 1 eng bleed valve secured. Closed A/C dispatched per MEL. On bleed page No 1 eng bleed indication showing open all the time.
- engine 1 : Engine bleed fault due to overtemp condition

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❖ PRV 6764B040000 SN 00573 :

➢ _ Visual inspection

Nothing unusual observed

➢ _ Investigation

A complete hot dynamic testing has been performed as per CMM 36-11-35 requirements (see hereunder copy of the Test results appendix 1):

This test has revealed some minor drifts of the closing indication time and the level of the regulated pressure.

- Closing indication time at low supplied pressure (2 bar): 3.1 s for 3 s maximum per CMM
- Regulated pressure level : 3.626 bar for 3.6 bar maximum

Note: LTS would consider this level of drift from CMM tolerance as minor

<u>Closing indication issue</u>:
Complementary static test has been performed and has revealed a minor drift of the initial switch setting which could affect the PRV closing time (see hereunder copy of the Test results appendix 2):
- switch setting 5,5 ° for 8 ° +/- 1 °

Complementary note:
At bleed system level AIRBUS said the confirmation time to trigger the "bleed not closed "msg is 10 s.

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Regulated pressure issue:
Complementary static tests have been performed and have revealed an external leakage and an actuator piston leakage out of the CMM tolerances:
- external leakages : 170 l/mn for 100 l/mn maximum
- actuator piston leakage : 26 l/mn for 22 l/mn maximum.

Both above findings are due to carbon seal wear which would have an impact on the PRV regulation level.

Disassembly:
Moreover some traces of corrosion have been noted in the piston which could lead to degrade the actuator piston seal too. This corrosion could be explained by humidity environment in Asia area.

During the investigation of the PRV the electrical connector of the has been also checked without any finding.

➢ _ **Conclusion.**

The removal of the PRV is not confirmed/ justified due to "BLEED NOT CLOSED" msg and in PRV MEL configuration indicated open at cockpit

Complementary note:
AIRBUS said that the PRV position indication change in cockpit when PRV in MEL configuration could be due to electrical issue with the harness installation.
Airbus advises CPA to check the harness connection on engine 2.

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Appendix 1

LIEBHERR-AEROSPACE TOULOUSE SA
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FICHIER D'ATR

P/N : 6764B040000 Amdt A CMM
S/N : RO 194359 SN 00573

BAES 5 - Site 1
Titre / title : A330/ PRV
Référence : ATRDS 36-11- 23 Rev :4

Mesure Measurement	Unité Unit	Min Min	Max Max	Mesure Value	Résultat Result
3.D Air functional test /Essais fonctionnel					
Voyant élec. non fermé 1 allumé	.	V	V	V	V
3.D.(2) Closing test / Essai de fermeture					
Mesure de T1	°C	380	420	414	V
...Closing at low pressure / Fermeture à basse pression					
P1 = 2 bar rel.					
Voyant élec. non fermé 1 allumé	.	V	V	V	V
Temps de manoeuvre sur Fermeture 1	sec	0.0	3.0	3.1	F
Voyant élec. fermé 1 allumé	.	V	V	V	V
...Closing at high pressure / Fermeture à haute pression					
P1 = 6 bar rel.					
Voyant élec. non fermé 1 allumé	.	V	V	V	V
Temps de manoeuvre sur Fermeture 1	sec	0.0	2.0	1.4	V
Voyant élec. fermé 1 allumé	.	V	V	V	V
3.D.(3) Pressure regulation test / Test de régulation de pression					
Mesure de P2	bar	3.000	3.600	3.498	V
Mesure de P2	bar	3.000	3.600	3.626	F
Voyant élec. non fermé 1 allumé	.	V	V	V	V
Voyant élec. fermé 1 éteint	.	V	V	V	V
Mesure de P2	bar	3.000	3.600	3.382	V
3.D.(4) Pressure limitation test / Essai de limitation de pression					
Mesure de P2	bar	0.960	1.550	1.676	F
Mesure de P2	bar	0.960	1.550	1.743	F
Mesure de P2	bar	0.960	1.550	1.480	V
3.D.(5) Closing test with no pressure / Essai de fermeture sans pression					
Voyant élec. fermé 1 allumé	.	V	V	V	V
Fin de l'essai					

matrice/0992crex ind 1

LIEBHERR-AEROSPACE TOULOUSE S.A.

B.P. 2010 - 408 av.des Etats-Unis	**REFERENCE**	**: SC/ST/08-1222**
F-31016 Toulouse Cedex - France	**Indice/ Issue**	**: /**
	Date de l'expertise	**: 22/10/2008**
	Lieu	**: LTS**
	Page	**:** 5/5

Appendix 2

LIEBHERR AEROSPACE SAS Fiche d

ref RO : 194359 P/N : 6764B040000 S/N : 00573.	CMM : 36-11-23 Client / Airline : CATHAY. Date : Monteur / Operator :	Contrôle final / Final control :

NFF- No fault Found / NFF- Pas de pannes trouvées	1000	

Designation of test	Condition	Nominal value Tolerance	LIROM code	Value	Confirmation
Visual inspection					
	Check visual inspection		10__		
Check of butterfly clearance					
	Check value butterfly clearance	1.5 ≤ H-H' ≤ 2.5 mm (0.039 to 0.12 in)	70__	1,29.	
	Check value butterfly YX clearance	Y-X = - 0.1 to 0.15 mm	75__	Y = 70 X = 60.	
Insulation resistance test					
Apply 50VDC	Check insulation resistance	R ≥ 100 MΩ	20__	7000.	
Continuity test					
	Mesure continuity between bonding points	R ≤ 20 mΩ	20__	4,21.	
Position indication test					
place butterfly valve in the open position	Check Not Closed indicator	ON	30__	ON	
	Check Closed indicator	OFF	30	OFF.	
Additionnal microswitch test					
Open and close valve	Check switch setting	8 ± 1°	35 16	5,5	
	Check switch hysteresis	≤ 13°	35__	10.	
Air functionnal test on table					
Mini. Opening pressure test					
Close valve, gradually apply P1 until valve is fully open	Check value of P1	P1 < 550 mbar (7.97 psig)	40__	520	
	Check Not Closed indicator	ON	30	ON.	
Closing opening test					
Valve open . Apply P1= 1.5 ± 0.1 bar rel (21.75 ± 1.45 psig)	Close valve by air venting and check time to close	tc ≤ 4s	45__	3.	
	Open valve by obturating vent and check time to open	to ≤ 4s	45 45	4,4.	
Test of downstream clapper					
Apply P2= 1 bar rel (14.5 psig)	Verify opening of downstream clapper	open	50__	open.	
Pressure regulation test					
Modulates P1 from 4 to 12 bar rel (58 to 174 psig) and from 12 to 4 bar rel (174 to 58 psig, P2= 3.2 bar (46.4 psig)	verify reduced pressure to 4 bar rel	2.15 ≤ P3 ≤ 2.40 bar rel 31.17 ≤ P3 ≤ 34.80 psig	60 23	2,46.	
	verify reduced pressure to 12 bar rel	2.15 ≤ P3 ≤ 2.40 bar rel 31.17 ≤ P3 ≤ 34.80 psig	60 23	2,52	
	verify reduced pressure to 4 bar rel	2.15 ≤ P3 ≤ 2.40 bar rel 31.17 ≤ P3 ≤ 34.80 psig	60__	1,33.	
Pressure limitation test					
Modulates P1 from 4 to 12 bar rel (58 to 174 psig) and from 12 to 4 bar rel (174 to 58 psig, F2= 1.5 bar (21.75 psig)	verify reduced pressure to 4 bar rel	1 ≤ P3 ≤ 1.15 bar rel 14.5 ≤ P3 ≤ 16.67 psig	65__	1,14.	
	verify reduced pressure to 12 bar rel	1 ≤ P3 ≤ 1.15 bar rel 14.5 ≤ P3 ≤ 16.67 psig	65 31	1,30.	
	verify reduced pressure to 4 bar rel	1 ≤ P3 ≤ 1.15 bar rel 14.5 ≤ P3 ≤ 16.67 psig	65__	1,14.	
	Verify coupling pressure	≥ 330 mbar rel	65__	500.	
Leakage fuse thermical					
Apply P4=3 ± 0,1 bar rel (42.06 to 44.96 psig)	Check value of leakage	Q1 ≤ 10 l/h	81__	<6.	
Internal leakage					
Apply P1=11.3 ± 0.2 bar rel (161 to 166.8 psig) P2 = 3 ± 0.1 bar rel (42 to 45 psig)	Check value of Q1 leakage rate	Q1 ≤ 750 Nl/min	80 61	850 l/min => 740 Nl/min.	
External leakage					
Apply P1= 3 ± 0.1 bar rel (42 to 45 psig)	Check value of Q2 flowmeter	Q5 ≤ 100 Nl/min	83 65	170.	
Trouble shooting performed in hot air condition					
In this case fill in result of trouble shooting using code 85__			85__		

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Appendix 8 Service Information Letter

CUSTOMER SERVICES DIRECTORATE
1 ROND POINT MAURICE BELLONTE
31707 BLAGNAC CEDEX FRANCE
TELEPHONE + 33 (0)5 61 93 33 33
TELEX AIRBU 530526F

AIRBUS

SERVICE INFORMATION LETTER

SUBJECT: PREVENTIVE CLEANING / REPLACEMENT OF THE TEMPERATURE CONTROL THERMOSTAT FILTER

ATA CHAPTER: 36

AIRCRAFT TYPE:
.A320 family (including A318)
.A330
.A340-200/-300 (not applicable to A340-500/-600)

APPLICABILITY: This task is applicable to A/C equipped with the following TCT / Th.C standards and subsequent ones:

.For A320 family	: PN 342B030000, mod 27723
	: PN 342D030000, mod 27723
.For A330	: PN 398E010000, mod 47281 / SB 36-3016
	: PN 398B040000, mod 47280 / SB 36-3016
.For A340	: PN 388D010000, mod 45625 / SB 36-4025

REFERENCES:
. IPC 36.11.06.06, Thermostats TCT / ThC
. For AMM task reference, refer to annex #1
. Liebherr SIL LS398-36-02

1. **PURPOSE:**

The purpose of subject SIL is to inform operators of the set-up of a preventive maintenance task for the filter of the Temperature Control Thermostat. This preventive action is to improve the reliability of the engine air bleed system.

Revision 01 of this SIL is to update the intervals for the task (Flight Hours instead of Calendar), and to update documentation references.

SIL NUMBER:	36-055
PAGE:	1 of 4
DATE:	Jun. 28/2004
REVISION:	01 - 15 Nov. 2006

AIRBUS

SERVICE INFORMATION LETTER

2. **BACKGROUND:**

Some operators have reported occurrences of TCT / Th.C filters found clogged. The clogging of this filter can actually cause abnormal operation of the bleed air temperature regulation system, since the pressure drop through the filter affects the command of the Fan Air Valve (FAV).

In the case the filter is polluted, the FAV would not open properly, leading to a slight temperature increase of the engine bleed air at precooler outlet level. If the filter is clogged, the bleed temperature might reach over-temperature conditions, leading to the ECAM warning 'ENGi BLEED FAULT' and to the automatic closure of the corresponding bleed system.

3. **DESCRIPTION:**

In the frame of a preventive maintenance action, we would recommend operators to perform a cleaning or replacement of the TCT / Th.C filter, with the following interval:

. For A320 family aircraft, every 6000 FH
. For A330 aircraft, every 6000 FH
. For A340 aircraft, every 12000 FH

Please note that each operator may customize the task interval from the above recommendation depending on the operating environment (highly polluted or sandy area), and their findings every above-mentioned interval. As an example for A330s operating in highly polluted or sandy area, it has been evidenced that this preventive task should be performed up to every 3000 FH.

4. **INVESTIGATION:**

A sampling based on the TCT / Th.C returned to LTS during 6 months has been performed, for A320 family, A330 and A340 thermostats. This sampling permitted to evaluate the pressure drop vs the number of FH. Furthermore, it has been evidenced that the level of pollution highly depends on the environment of the aircraft operations: after 5.000FH, the pressure drop could be measured from 0.3 up to 2 bars.

This preventive maintenance action has been included in the MPD 2005 revisions as an advisory item: rev. 28 for A320 family, rev. 14 for A330, rev. 15 for A340.

Additional investigations have confirmed that this preventive task has a significant positive impact on the reliability of the temperature regulation system, especially for A320 Family. In order to re-enforce further the application of this task, specifically for this fleet, subject task will be a MRB item in A320 Family MPD, from the revision 30 scheduled for first quarter 2007.

Besides, please note that for A330's, attention should be paid to the standard of the filter installed on the Th.C's (Annex 2. refers).

AIRBUS

SERVICE INFORMATION LETTER

5. MODIFICATION INFORMATION:

Not applicable.

6. MATERIAL:

Please refer to the associated AMM tasks.

7. PROCUREMENT:

Not Applicable

. **Annex 1, AMM Task reference:**

	Filter removal	Filter cleaning	Filter installation
A320 family	36-11-43-000-003	36-11-43-100-001	36-11-43-400-003
A330, GE engine	36-11-43-000-806	36-11-43-100-801	36-11-43-400-806
A330, PW engine	36-11-43-000-807	36-11-43-100-801	36-11-43-400-807
A330, RR engine	36-11-43-000-808	36-11-43-100-801	36-11-43-400-808
A340	36-11-43-000-805	36-11-43-100-801	36-11-43-400-805

. **Annex 2, A330 maintenance task:**

We would like to highlight that two types of filter are currently installed on A330 Th.Cs, with a different head size (1/2 inch or 11/16 inch). In the case the filter is an 11/16 inch head type, we recommend not to replace the filter on-wing, due to accessibility constraints and potential damages of the parts. Please note that this recommendation has been included in the A330 AMM from Oct/04 revision.

Furthermore as per Liebherr SIL ref LS398-36-02 repair stations are recommended to replace systematically a 11/16 inch filter by a ½ inch filter so as to permit the replacement of the Th.C filter on-wing.

SIL NUMBER: 36-055
PAGE: 3 of 4
DATE: Jun. 28/2004
REVISION: 01 - 15 Nov. 2006

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Appendix 9 Related Operation procedures

The related emergency procedures are shown as following:

- AIR ABNORM BLEED CONFIG:

3.02.36 P1~P3, REV 16, 6 Jun 2005, A330 Flight Crew Operations Manual (FCOM) 3, CATHAY PACIFIC AIRWAYS.

CATHAY PACIFIC AIRWAYS

A330 FCOM 3	ABNORMAL AND EMERGENCY	3.02.36 P 1
	PNEUMATIC	TS5861/FTO/j/CR/ REV 16 (6 Jun 2005)

AIR ENG 1(2) BLEED FAULT

This caution appears in case of overheat, overpressure or low pressure.
In case of faults on engine 1 or 2 bleeds, one reset may be attempted by switching the affected ENG BLEED pushbutton OFF then ON, provided there is no AIR ENG BLEED LEAK caution displayed.

— ENG BLEED affected (if not automatically closed) . . . . OFF
The ENG BLEED is not automatically closed in case of LO PR.
The FAULT lt extinguishes when the failure disappears (overheat or overpressure).
PACK FLOW is limited to 80 %.

STATUS
INOP SYS
ENG 1 (2) BLEED

AIR ABNORM BLEED CONFIG

Refer to associated procedure.

AIR ENG 1(2) BLEED NOT CLSD

This caution appears if engine bleed valve is unduly open during engine start or when APU BLEED is selected on.

— ENG BLEED (affected) . . . . OFF

- **When engine start is completed or APU BLEED is deselected (automatic recall):**
  — ENG BLEED (affected) . . . . ON

CATHAY PACIFIC AIRWAYS

A330 FCOM 3	ABNORMAL AND EMERGENCY	3.02.36 P 2
	PNEUMATIC	TS5861/FTO/jt/CR/ REV 16 (6 Jun 2005)

AIR ABNORM BLEED CONFIG

At least one BLEED system is faulty, off or not supplied.

- **If BLEED abnormally selected off:**
  ENG 1(2) BLEED OFF
- **IF BLEED NOT RECOVERED**
  — X BLEED .... CLOSE or OPEN
  CLOSE if:
  – LEAK or
  – ENG FIRE (detected, or FIRE pushbutton pressed), or
  or
  – Engine start valve failed open
  – Overpressure with bleed valve failed open
  OPEN in all other cases

■ **X BLEED OPEN**

- **If WING A. ICE off and no engine failed:**
  — PACK FLOW .... LO
  Pack flow is automatically limited to 80 %
  — FWD CRG COOLING ◁ .... OFF
- **If WING A. ICE on or one engine failed:**
  — PACK (affected side if opposite pack healthy) .... OFF

CATHAY PACIFIC AIRWAYS

A330 FCOM 3	ABNORMAL AND EMERGENCY	3.02.36 P 3
	PNEUMATIC	TS5861/FTO/jt/CR/ REV 16 (6 Jun 2005)

AIR ABNORM BLEED CONFIG (CONT'D)

Note : If the pack is switched off following an engine shut down it may be recovered provided performance permit and wing anti-ice is selected off.

STATUS

ONE PACK ONLY IF WAI ON

INOP SYS
ENG 1 (2) BLEED
PACK 1 (2)
(if selected off)

■ **X BLEED CLOSE**

— WING A. ICE .... OFF
AVOID ICING CONDITIONS
Note : APU BLEED must not be used for wing anti ice purpose or after ENG 1 FIRE.

STATUS

- **IF ICE ACCRETION:**
  — APPR SPD .... VLS + 10 KT
  — LDG DIST PROC .... APPLY
  Refer to QRH Part 2.

INOP SYS
WING A. ICE
ENG 1 (2) BLEED
PACK 1(2)

- CAB PR EXCESS CAB ALT:

3.02.21 P6~P7, REV 16, 6 Jun 2005, A330 FCOM 3, CATHAY PACIFIC AIRWAYS.

CAB PR EXCESS CAB ALT

— CREW OXY MASK (if above FL 100) . . . . ON

It is recommended to descend with autopilot engaged:

- Turn ALT selector knob and pull
- Turn HDG selector knob and pull
- Set target SPD/MACH.

CATHAY PACIFIC AIRWAYS

A330 FCOM 3	ABNORMAL AND EMERGENCY	3.02.21 P 7
	AIR COND / PRESS / VENT	TS6867/DCP/cw/ REV 23 (28 Sep 2006)

CAB PR EXCESS CAB ALT (CONT'D)

- **If above FL 100 and below FL 160:**
  — DESCENT (if above FL 100) . . . . INITIATE
- **If above FL 160, or IF RAPID DECOMPRESSION:**
  EMER DESCENT FL 100/MEA (or minimum obstacle clearance altitude)
  — THR LEVERS (if A/THR not engaged) . . . . IDLE
  — SPD BRK . . . . FULL
  — SPD . . . . MAX/APPROPRIATE
  Descent at maximum appropriate speed or, if structural damage is suspected use the flight controls with care and reduce speed as appropriate.
  Landing gear may be extended below 21 000 feet; speed must be reduced to 250 knots.

— SIGNS . . . . ON

— ENG START SEL . . . . IGN

— ATC . . . . NOTIFY

Notify ATC of the nature of the emergency and state 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 oxygen diluter selector to N position.
With oxygen diluter selector set to 100 %, oxygen quantity may not be sufficient to cover the entire descent profile.
Ensure that the crew can communicate wearing oxygen masks.
Avoid the continuous use of interphone position to minimize the interference from oxygen mask breathing noise.

- **IF CAB ALT > 14 000 FT:**
  — PAX OXY MASKS . . . . MAN ON

Note : *When descent is established and if time permits check that the OUTFLOW VALVES are closed on the CAB PRESS ECAM page. If they are not closed and ΔP is positive, select manual control and the V/S CTL toggle switch to full down.*
Notify cabin crew when safe flight level has been reached and oxygen mask use can be stopped.

- Emergency Descent:

  1.28, REV 45, 25 APR. 2007, EMERGENCY PROCEDURES, Quick Reference Handbook (QRH), CATHAY PACIFIC AIRWAYS.

CATHAY PACIFIC AIRWAYS

A330	EMERGENCY PROCEDURES MISCELLANEOUS	T56780/TM cwREV 45 CR C (25 APR 07)	1.28

EMER DESCENT

– CREW OXY MASKS .... ON

PF IMMEDIATE ACTIONS

The recommendation is to descend with the autopilot engaged:
- *Turn ALT selector knob and pull*
- *Turn HDG selector knob and pull*
- *Set target SPD/MACH*

– THRUST .... IDLE
- *If A/THR engaged, check IDLE on UPPER ECAM.*
- *If not engaged, retard thrust levers.*

– SPD BRK .... FULL

- **WHEN DESCENT ESTABLISHED**

– EMER DESCENT .... FL 100 (or minimum allowable altitude)
– SPEED .... MAX / APPROPRIATE

CAUTION
Descend at maximum appropriate speed. If structural damage is suspected use the flight controls with care and fly a speed that maintains structural integrity.

Landing gear may be extended below 21,000 FT. Speed must be reduced to 250 KTS/0.55 M.

PNF IMMEDIATE ACTIONS

– SIGNS .... ON
– ENG START SEL .... IGN
– ATC .... NOTIFY
- *Notify ATC of the nature of the emergency and state the intentions. "MAYDAY" can be downgraded when appropriate.*
- *If not in contact with ATC transmit a distress message on (VHF) 121.5 MHZ and (HF) 2182 KHZ or 8364 KHZ.*

– TRANSPONDER A7700

Notes:
1. *To save oxygen set diluter selector to N position.*
2. *With the diluter selector left at 100% the oxygen quantity may not be sufficient to cover the entire emergency descent profile.*
3. *Ensure crew communication is established with oxygen masks on. Avoid the continuous use of the interphone to minimize interference from oxygen masks breathing noise.*

- **IF CAB ALT >14,000 FT:**
  – PAX OXY MASKS .... MAN ON
  - *Confirm passenger oxygen masks released.*
  - *If intermediate "level off" is necessary passengers should be advised if required to remain on oxygen.*
  - *Notify cabin crew and passengers when a safe flight level has been reached and oxygen use can be terminated.*

- AIR DUAL BLEED FAULT:

  2.21, REV 45, 25 APR. 2007, ABNORMAL PROCEDURES, CATHAY PACIFIC AIRWAYS.

CATHAY PACIFIC AIRWAYS

A330	ABNORMAL PROCEDURES / PNEUMATIC	T56700/TM REV 45 C (25 APR 07)	2.21

AIR DUAL BLEED FAULT

- <u>If ENG 1 BLEED was lost due to a:</u>
  LEAK on side 1
  ENG 1 FIRE
  Start Air Valve 1 failed open.
  [APU BLEED LEAK FED BY ENGINE]
  – DESCENT TO FL 100/MEA .... INITIATE
  Descend rapidly to FL 100/MEA, (full speedbrakes) to prevent excessive cabin altitude
  AVOID ICING CONDITIONS

- <u>If ENG 2 BLEED was lost due to a:</u>
  LEAK on side 2
  ENG 2 FIRE
  Start Air Valve 2 failed open.
  – X BLEED .... CHECK CLOSED
  – DESCENT TO FL 220/MEA .... INITIATE
  [*Descend rapidly to FL 220, (full speedbrakes) to recover bleed supply from the APU.*]
  – APU .... START
  Start the APU during the descent.

  - AT, OR BELOW, FL 220:
    – WING A. ICE .... OFF
    APU BLEED must not be used for wing anti-ice.
    – APU BLEED .... ON
    MAX FL 220
    AVOID ICING CONDITIONS

- <u>In all other cases:</u>
  – DESCENT .... INITIATE
  Descend rapidly to FL 220, (full speedbrakes) so that the bleed supply may be supplied by the APU, if the bleed system recovery is not successful.

  - If both packs are available:
    If both packs are operative, it can be suspected that the second bleed system failed due to excessive demand. Recovery of the second failed engine bleed may be attempted.

    - <u>If ENG 1 BLEED is lost first:</u>
      – PACK 1 .... OFF
      – ENGINE 2 BLEED .... ON

    - <u>If ENG 2 BLEED is lost first:</u>
      – PACK 2 .... OFF
      – ENGINE 1 BLEED .... ON

  - If engine bleed recovery was not successful, or if one pack is inoperative:
    – X BLEED .... CHECK OPEN
    [– DESCENT TO FL 220/MEA .... CONTINUE]
    Descend rapidly to FL 220, (full speedbrakes) to recover bleed supply from the APU.
    – APU .... START
    Start the APU during the descent.

    - AT, OR BELOW, FL 220:
      []
      – WING A. ICE .... OFF
      APU BLEED must not be used for wing anti-ice.
      – APU BLEED .... ON
      MAX FL 220
      AVOID ICING CONDITIONS

- EMERGENCY COMMUNICATION PROCEDURES:
  3-3-7~3-3-10, REV 418, 14 AUG. 2008, OPERATIONS MANUAL, CATHAY PACIFIC AIRWAYS LTD.

10. RADIO WATCH

10.1 A continuous listening or SELCAL watch shall be maintained on the appropriate VHF or HF frequency. When changing HF frequency another SELCAL check shall be completed on the new frequency in use. The HF antenna shall always be retuned after a frequency change even when reception only is required. All flights shall continuously monitor the VHF Emergency frequency 121.50 MHz, except for those periods when simultaneous monitoring of two channels may be limited due to Flight Deck duties, equipment limitations or communications on other VHF channels.

If at any time a member of the Flight Crew is uncertain of any detail of an ATC R/T instruction on either VHF, HF or Satcom, the Crew shall request ATC to repeat the instruction. Care shall be taken not to repeat any part of the instruction when asking for confirmation. Such phrases as, "Confirm cleared FL 310", shall be avoided: ATC shall be requested to "say again cleared Altitude" or "confirm radar HDG".

10.2 Refer to In-flight Blind Broadcast Procedures (IFBP) or Traffic Information Broadcast by Aircraft (TIBA).

11. RADIO COMMUNICATION FAILURE

ICAO basic and country specific Radio Failure Procedures are detailed in the AERAD supplement – COM Section.

12. RADIO DISCIPLINE AND PHRASEOLOGY

12.1 A high standard of R/T discipline and the use of Standard Phraseology are critical flight safety factors. The increase in the volume of air traffic, adverse weather and communications with Air Traffic Controllers, whose primary language is not English, are factors which can potentially lead to frequency congestion. It is essential that correct and precise communication technique and standard phraseology is used at all times.

The PM is normally responsible for communicating with ATC. The Clearance readback and the acknowledgement are important links in the information message chain. The Flight Crew shall request ATC to clarify any Clearance that is ambiguous, incomplete or causes confusion. Non-standard situations may require the Flight Crew to modify or extend standard phraseology. However, care shall be taken to ensure there is no possibility of confusion or misunderstanding to the basic meaning of the intended message.

12.2 Readback Of ATC Instructions

The following ATC instructions shall be readback in full and confirmed (cross-checked) by both Pilot Crew members:

A. Airway and Route clearances;

B. Approach Clearance;

C. Level, Heading and Speed instructions;

D. Runway-in-Use;

E. Clearance to: Enter, Land, Take-off, Backtrack, Cross or Hold-Short of any Active Runway;

F. Altimeter Settings and Transition Levels;

G. SSR Codes and Operating instructions; and,

H. Frequency changes

Complex or lengthy ATC Clearances or Instructions shall be written down by the Flight Crew.

The full aircraft callsign shall be included at the END of all Clearance readbacks.

12.3 Standard Words And Phrases

[Much aviation-related communication takes place between non-native English speakers and so poor communication discipline is a potential safety threat.

Communication protocols defined in this section should be used whenever possible. At all times it is important to ensure clarity by avoiding colloquialisms, speaking slowly, and avoiding multiple instructions or requests. This discipline should apply whether communicating with ATC, ground personnel or other crew members. If doubt exists about what was heard or said, there is no doubt: clarification must be sought.

The following words and phrases shall be used in radiotelephony communications, as appropriate, and shall have the meaning given below:]

WORD / PHRASE	MEANING
ACKNOWLEDGE	Let me know that you have received and understood this message.
AFFIRM	Yes.
APPROVED	Permission for proposed action granted.
BREAK	Indicates the separation between messages.
CANCEL	Annul the previously transmitted clearance.
CHANGING TO	I intend to call ... (unit) on ... (frequency).
CHECK	Examine a system or procedure (no answer is normally expected).
CLEARED	Authorised to proceed under the conditions specified.
CLIMB	Climb and maintain.
CONFIRM	Have I correctly received the following .....? or Did you correctly receive this message?
CONTACT	Establish radio contact with ... (your details have been passed).
CORRECT	That is correct.
CORRECTION	An error has been made in this transmission (or message indicated). The correct version is ...
DESCEND	Descend and maintain.
DISREGARD	Consider that transmission as not sent.
GOING AROUND	I am executing a missed approach.
HOW DO YOU READ	What is the readability of my transmission.
I SAY AGAIN	I repeat for clarity or emphasis.
LEAVING	A positive movement of the altimeter has been observed as Descent/ Climb is initiated from existing Level to a new Level.
[MAINTAINING	Maintaining Flight Level / Altitude.]
MONITOR	Listen out on (frequency).

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TS7684/DMLO/cw

CATHAY PACIFIC
GENERAL OPERATIONAL

3-3-9
COMMUNICATIONS
REV 410 (22 NOV 07)

WORD / PHRASE	MEANING
NEGATIVE	No or Permission not granted or that is not correct.
OVER*	My transmission is ended and I expect a response from you.
OUT*	This exchange of transmissions is ended and no response is expected.
PASS YOUR MESSAGE	Proceed with your message.
PASSING	You are passing a Level in the Climb/Descent.
REACHING	You are within 200 FT of your assigned Level, following a Climb/Descent.
READ BACK	Repeat all, or the specified part, of this message back to me exactly as received.
REPORT	Pass requested information.
REQUEST	I should like to know ... or I wish to obtain ...
ROGER	I have received all your last transmission.
	NOTE: Under no circumstances to be used in reply to a question requiring a direct answer in the affirmative (AFFIRM) or negative (NEGATIVE).
SAY AGAIN	Repeat all, or the following part of your last transmission.
SPEAK SLOWER	Reduce your rate of speech.
STANDBY	Wait and I will call you.
	NOTE: No onward clearance to be assumed.
VERIFY	Check and confirm.
WILCO	I understand your message and will comply with it (abbreviation for will comply).
TCAS	
["TCAS RA"	I am climbing (descending) to comply with RA.
"CLEAR OF CONFLICT, RETURNING TO FL _______"	The response to a TCAS RA is completed and a return to the ATC clearance or instruction is initiated.
OR	
"CLEAR OF CONFLICT, FL _______ RESUMED"	The response to a TCAS RA is completed and the assigned ATC clearance or instruction has been resumed.
"UNABLE TCAS RA"	After an ATC clearance or instruction contradictory to the TCAS RA is received, the flight crew will follow the RA and inform ATC directly.]

MAYDAY/PAN/ DECLARATION OF AN EMERGENCY	Whilst the term "Mayday" is internationally recognized as a distress message, the term "PAN" may not be recognized by some countries as an urgency message. In cases where a "Mayday" call is not considered appropriate and "Pan" is not eliciting the correct response from ATC then the phrase "We are declaring an emergency" should be used. Emergency communication procedures are detailed on the back of the AERAD Flight Information Supplement.
RVSM AIRSPACE :	
AFFIRM RVSM	Aircraft is RVSM approved.
UNABLE RVSM DUE TURBULENCE	When aircraft unable to maintain RVSM level due moderate or severe turbulence.
READY TO RESUME RVSM	When clear of turbulence encounter and able to maintain RVSM level once again.
UNABLE RVSM DUE EQUIPMENT	When aircraft equipment failure results in aircraft being unable to accept an RVSM level.

* Not normally used in VHF Communications.

12.4 Prevention of misunderstandings between pilots and ATC.

A. Flight Level/Altitude Reports By Pilots

a. Except when turbulent conditions exist, the vertical separation standards applied by ATC stipulate that one aircraft may be assigned the level previously occupied by another, after the latter has reported leaving it. The word "Leaving" means that a positive movement has been observed on the altimeter. The call **must** not be made until descent has commenced. "Leaving" is not a statement of intent, it is a statement of action.

This call is not required when under Radar Control.

When reporting flight levels on the climb or descent, the term "passing flight level" should be used. Such phrases as "approaching", "coming up to" or "coming down to" are too vague, can be misleading and are to be avoided.

When within 200 FT of your assigned level, following a Climb/Descent, you should report "Reaching". This indicates to ATC that you are now within the prescribed Level tolerances.

This call is not required when under Radar Control.

b. The words "Flight Level" must precede the numbers when responding to a level change instruction, e.g. Descend Flight Level Two Eight Zero.

c. The words "to altitude" must precede the numbers when responding to an altitude change instruction. Furthermore, the numbers are to be stated in plain language as opposed to the repetition of individual numbers associated with a Flight Level. A typical response would be "Descend to altitude four thousand five hundred feet."

d. When you are first cleared to descend from a Flight Level to an Altitude, ATC should include the QNH in the transmission. If they omit to do so, then it is to be requested. It is not adequate to rely on the ATIS QNH.

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Appendix 10 ATC procedures for aircraft emergency

04/16/2008 Air Traffic Management Procedures - ATMP(CHG-1)

Chapter 9. EMERGENCIES

Section 1. GENERAL

9-1-1 EMERGENCY DETERMINATIONS

a. An emergency can be either a Distress or an Urgency condition.

b. A pilot who encounters a *Distress* condition should declare an emergency by beginning the initial communication with the word "Mayday," preferably repeated three times. For an *Urgency* condition, the word "Pan-Pan," should be used in the same manner.

c. If the words "Mayday" or "Pan-Pan" are not used and you are in doubt that a situation constitutes an emergency or potential emergency, handle it as though it were an emergency.

d. Because of the infinite variety of possible emergency situations, specific procedures cannot be prescribed. However, when you believe an emergency exists or is imminent, select and pursue a course of action which appears to be most appropriate under the circumstances and which most nearly conforms to the instructions in this manual.

9-1-2 OBTAINING INFORMATION

Obtain enough information to handle the emergency intelligently. Base your decision as to what type of assistance is needed on information and requests received from the pilot because he/she is authorized by "Rules of the Air" to determine a course of action.

9-1-3 PROVIDING ASSISTANCE

Provide maximum assistance to aircraft in distress. Enlist the services of available radar units and the military services, as well as their emergency services and units, when the pilot requests or when you deem necessary.

REFERENCE:
SPECIFIC PRIORITIES, Para 2-1-6.

9-1-4 RESPONSIBILITY

a. If you are in communication with an aircraft in distress, handle the emergency and coordinate and direct the activities of assisting units. Transfer this responsibility to another unit only when you feel better handling of the emergency will result.

b. When you receive information about an aircraft in distress, forward detailed data to ACC.

NOTE:

① The National SAR Plan assigns search and rescue responsibilities as follows:

(a) All facilities follow the National Rescue Command Center's instructions - Conducting physical search and rescue operations.

(b) To the CAA

(1) Providing emergency service to aircraft in distress.

(2) Assuring that SAR procedures will be initiated if an aircraft becomes overdue or unreported. This is accomplished through the ATC system for IFR aircraft and the flight plan system for VFR aircraft.

(3) Attempting to locate overdue or unreported aircraft by INREQ and Notification communications search.

(4) Making all possible facilities available for use by the searching agencies.

General 9.1.1

② *ACC serves as the central points for collecting information, for coordinating with NRCC, and for conducting a communications search by distributing any necessary Notifications concerning:*

(a). overdue or missing IFR aircraft

(b). IFR aircraft in an emergency situation occurring in their respective area.

(c). Aircraft on a combination VFR/IFR or an airfiled IFR flight plan and 30 minutes have passed since the pilot requested IFR clearance and neither communication nor radar contact can be established with it. For SAR purposes, these aircraft are treated the same as IFR aircraft.

(d). Overdue or missing aircraft which have been authorized to operate in accordance with Special VFR clearance.

③ *ACC serves as the central point for collecting information and coordinating with the NRCC on ELT signals.*

④ *Notifying ACC about a VFR aircraft emergency allows provision of IFR separation if considered necessary.*

REFERENCE:

EMERGENCY SITUATIONS, Para 9-2-5.

INFORMATION TO BE FORWARDED TO ACC, Para 9-3-2.

INFORMATION TO BE FORWARDED TO NRCC, Para 9-3-3.

c. If the aircraft involved is operated by a foreign air carrier, notify ACC serving the departure or destination point, when either point is within the TAIPEI FIR, for relay to the operator of the aircraft.

d. The ACC shall be responsible for receiving and relaying all pertinent ELT signal information to the appropriate authorities.

REFERENCE:
EMERGENCY LOCATOR TRANSMITTER (ELT) SIGNALS, Para 9-2-13.

e. When consideration is given to the need to escort an aircraft in distress, evaluate the close formation required by both aircraft. Special consideration should be given if the maneuver takes the aircraft through the clouds.

f. Before a determination is made to have an aircraft in distress be escorted by another aircraft, ask the pilots if they are familiar with and capable of formation flight.

1. Do not allow aircraft to join up in formation during emergency conditions, unless:

(a) The pilots involved are familiar with and capable of formation flight.

(b) They can communicate with one another, and have visual contact with each other.

2. If there is a need for aircraft that are not designated as search and rescue aircraft to get closer to one another than radar separation standards allow, the maneuver shall be accomplished, visually, by the aircraft involved.

9-1-5 COORDINATION

Coordinate efforts to the extent possible to assist any aircraft believed overdue, lost, or in emergency status.

9-1-6 AERODROME GROUND EMERGENCY

TERMINAL

a. When an aerodrome emergency occurs, give priority to emergency vehicles over all other surface movement traffic. If necessary, stop all surface movement traffic until the progress of the emergency vehicles will not be impeded. This also applies when routes within the aerodrome proper are required for movement of local emergency equipment going to or from an emergency which occurs outside the aerodrome proper.

NOTE:

Aircraft operated in proximity to accident or other emergency or disaster locations may cause hindrances to *airborne and surface rescue or relief operations. Congestion, distraction or other effects, such as wake turbulence from nearby airplanes and helicopters, could prevent or delay proper execution of these operations.*

b. Workload permitting monitor the progress of emergency vehicles responding to a situation. If necessary, provide available information to assist responders in finding the accident/incident scene.

9-1-7 IN-FLIGHT EMERGENCIES INVOLVING MILITARY FIGHTER-TYPE AIRCRAFT

a. The design and complexity of military fighter-type aircraft places an extremely high workload on the pilot during an in-flight emergency. The pilot's full attention is required to maintain control of the aircraft. Therefore, radio frequency and transponder code changes should be avoided and radio transmissions held to a minimum, especially when the aircraft experiencing the emergency is at low level.

b. Pilots of military fighter-type aircraft, normally single engine, experiencing or anticipating loss of engine power or control may execute a flameout pattern in an emergency situation. Circumstances may dictate that the pilot, depending on the position and nature of the emergency, modify the pattern based on actual emergency recovery requirements.

c. Military airfields with an assigned flying mission may conduct practice emergency approaches. Participating units maintain specific procedures for conducting these operations.

REFERENCE:

SIMULATED FLAMEOUT (SFO) APPORACHES/PRACTICE PRECAUTIONARY APPROACHES, Para 3-10-12.

Section 2. EMERGENCY ASSISTANCE

9-2-1 INFORMATION REQUIREMENTS

a. Start assistance as soon as enough information has been obtained upon which to act. Information requirements will vary, depending on the existing situation. Minimum required information for in-flight emergencies is:

NOTE:
In the event of an ELT signal see 9-2-13 Emergency Locator Transmitter (ELT) Signals.

1. Aircraft identification and type.
2. Nature of the emergency.
3. Pilot's desires.

b. After initiating action, obtain the following items or any other pertinent information from the pilot or aircraft operator, as necessary:

NOTE:
Normally, do not request this information from military fighter-type aircraft that are at low levels (ie on approach, immediately after departure, on a low level route etc.). However, request the position of an aircraft that is not visually sighted or displayed on radar if the location is not given by the pilot.

1. Aircraft level.
2. Fuel remaining in time.
3. Pilot reported weather.
4. Pilot capability for IFR flight
5. Time and place of last known position.
6. Heading since last known position.
7. Airspeed.
8. Navigation equipment capability.
9. NAVAID signals received.
10. Visible landmarks.
11. Aircraft color.
12. Number of people on board.
13. Point of departure and destination.
14. Emergency equipment on board.

9-2-2 FREQUENCY AND SSR CODE CHANGES

Changes of radio frequency and SSR code should be avoided if possible and should normally be made only when or if an improved service can be provided to the aircraft concerned. Manoeuvring instructions to an aircraft experiencing engine failure should be limited to a minimum. When appropriate, other aircraft operating in the vicinity of the aircraft in emergency should be advised of the circumstances.

9-2-3 AIRCRAFT ORIENTATION

Orientate an aircraft by the means most appropriate to the circumstance. Recognized methods include:

a. Radar.

b. NAVAIDS.

c. Pilotage.

d. Sighting by other aircraft.

9-2-4 LEVEL CHANGE FOR IMPROVED RECEPTION

When you consider it necessary and if weather and circumstances permit, recommend that the aircraft maintain or increase level to improve communications, radar or DF reception.

NOTE:

Aircraft with high-bypass turbofan engines (such as B747) encountering volcanic ash clouds have experienced total loss of power to all engines. Damage to engines due to volcanic ash ingestion increases as engine power is increased, therefore, climb while in the ash cloud is to be avoided where terrain permits.

9-2-5 EMERGENCY SITUATIONS

Consider that an aircraft emergency exists and inform the ACC for relay to the NRCC when:

a. An emergency is declared by either:

   1. The pilot.

   2. Unit personnel.

   3. Officials responsible for the operation of the aircraft.

b. There is unexpected loss of radar contact and radio communications with any IFR or VFR aircraft.

c. Reports indicate it has made a forced landing, is about to do so, or its operating efficiency is so impaired that a forced landing will be necessary.

d. Reports indicate the crew has abandoned the aircraft or is about to do so.

e. An emergency radar beacon response is received.

   NOTE:
   For ACC or TCC automation system, Code 7700 causes EMRG (or EM) to blink in the data block.

f. Intercept or escort aircraft services are required.

g. The need for ground rescue appears likely.

h. An Emergency Locator Transmitter (ELT) signal is heard or reported.

   REFERENCE:
   PROVIDING ASSISTANCE, Para 9-1-3.
   EMERGENCY LOCATOR TRANSMITTER (ELT) SIGNALS, Para 9-2-13.

9-2-6 HIJACKED AIRCRAFT

When you observe a Mode 3/A Code 7500, an unexplained loss of beacon code, change in direction of flight or level, and/or a loss of communications, notify supervisory personnel immediately. As it relates to observing a Code 7500, do the following:

NOTE:

① Military units will notify the ACC of any indication that an aircraft is being hijacked. They will also provided full cooperation with the civil agencies in the control of such aircraft,

② During ATCAS operations, Code 7500 causes HIJK (or HJ) to blink in the data block.

③ Only nondiscrete Code 7500 will be decoded as the hijack code.

a. Acknowledge and confirm receipt of Code 7500 by asking the pilot to verify it. If the aircraft is not being subjected to unlawful interference, the pilot should respond to the query by broadcasting in the clear that he is not being subjected to unlawful interference. If the reply is in the affirmative or if no reply is received, do not question the pilot further but be responsive to the aircraft requests.

PHRASEOLOGY:

(Aircraft Ident) (name of unit) CONFIRM SQUAWK 7500

NOTE:

Code 7500 is only assigned upon notification from the pilot that his aircraft is being subjected to unlawful interference. Therefore pilots have been requested to refuse the assignment of Code 7500 in any other situation and to inform the controller accordingly.

b. Transmit and continue to transmit, information pertinent to the safe conduct of flight, without expecting a reply from the aircraft.

c. Notify supervisory personnel who should in turn notify the operator or its representative, the appropriate NRCC in accordance with alerting procedures, and, the designated security authority.

d. Flight follow aircraft and use normal handoff procedures without requiring transmissions or responses by aircraft unless communications have been established by the aircraft.

e. If aircraft are dispatched to escort the hijacked aircraft, provide all possible assistance to the escort aircraft to aid in placing them in a position behind the hijacked aircraft.

REFERENCE:

CODE MONITOR, Para 5-2-11

9-2-7 AIRCRAFT BOMB THREATS

a. When information is received from any source that a bomb has been placed on, in, or near an aircraft for the purpose of damaging or destroying such aircraft, notify your supervisor or the unit air traffic manager. If the threat is general in nature, handle it as a "Suspicious Activity", when the threat is targeted against a specific aircraft and you are in contact with the suspect aircraft take the following actions as appropriate:

NOTE:

① Unit supervisors are expected to notify the appropriate office, agencies, operators/ air carriers according to applicable plans, directives, and military directives.

② A "specific" threat may be directed to an aircraft registry or tail number, the air carrier flight number, the name of an operator, crew member or passenger, the departure/ arrival point or times, or combinations thereof.

1. Advise the pilot of the threat.
2. Inform the pilot that technical assistance can be obtained from the unit concerned.
3. Ask the pilot if he desires to climb or descend to a level that would equalize or reduce the outside air pressure/ existing cabin air pressure differential. Issue or relay an appropriate clearance considering MEA, MRA, and weather.

   NOTE:

   Equalizing existing cabin air pressure with outside air pressure is a key step which the pilot may wish to take to minimize the damage potential of a bomb.

4. Handle the aircraft as an emergency and/or provide the most expeditious handling possible with respect to the safety of other aircraft, ground facilities, and personnel.

   NOTE:

   Emergency handling is discretionary and should be based on the situation. With certain types of threats, plans may call for a low-key action or response.

5. Issue or relay clearances to a new destination if requested.

6. When a pilot requests technical assistance or if it is apparent that a pilot may need such assistance, do NOT suggest what actions the pilot should take concerning a bomb, but obtain the following information and notify your supervisor:

NOTE:
This information is needed by the unit concerned so that he can assess the situation and make immediate recommendations to the pilot. The Aviation Explosives Expert may not be familiar with all military aircraft configurations but he can offer technical assistance which would be beneficial to the pilot.

(a) Type, series, and model of the aircraft.

(b) Precise location/ description of the bomb device if known.

(c) Other details which may be pertinent.

NOTE:
The following details may be of significance if known, but it is not intended that the pilot should disturb a suspected bomb/bomb container to ascertain the information; the level or time set for the bomb to explode, type of detonation action (barometric, time, anti-handling, remote radio transmitter), power source (battery, electrical, mechanical), type of initiator (blasting cap, flashing bulb, chemical) and the type of explosive/ incendiary charge (dynamite, black powder, chemical).

b. When a bomb threat involves an aircraft on the ground and you are in contact with the suspect aircraft take the following actions in addition to those discussed in the preceding paragraph which may be appropriate:

1. If the aircraft is at an airport where tower control service is not available, or if the pilot ignores the threat at any airport, recommend that takeoff be delayed until the pilot or aircraft operator establishes that a bomb is not aboard. If the pilot insists on taking off and in your opinion the operation will not adversely affect other traffic, issue or relay an ATC clearance.

2. Advise the aircraft to remain as far away from other aircraft and facilities as possible, to clear the runway, if appropriate, and to taxi to an isolated or designated search area. When it is impractical or if the pilot takes an alternative action; e.g. parking and off-loading immediately, advise other aircraft to remain clear of the suspect aircraft by at least 100 meters if able.

NOTE:
Passenger deplaning may be of paramount importance and must be considered before the aircraft is parked or moved away from service areas. The decision to use ramp facilities rests with the pilot, aircraft operator/ airport manager.

c. If you are unable to inform the suspect aircraft of a bomb threat or if you lose contact with the aircraft, advise your supervisor and relay pertinent details to other sectors or units as deemed necessary.

d. When a pilot reports the discovery of a bomb or suspected bomb on an aircraft which is airborne or on the ground, determine the pilot's intentions and comply with his requests in so far as possible. Take all of the actions discussed in the preceding paragraphs which may be appropriate under the existing circumstances.

e. The handling of aircraft when a hijacker has or is suspected of having a bomb requires special considerations. Be responsive to the pilot's requests and notify supervisory personnel. Apply hijacking procedures and offer assistance to the pilot according to the preceding paragraphs, if needed.

9-2-8 STRAYED OR UNIDENTIFIED AIRCRAFT

NOTE:
① The terms "strayed aircraft" and "unidentified aircraft" in this paragraph have the following meanings:
(a). Strayed aircraft. An aircraft which has deviated significantly from its intended track or which reports that it is lost.
(b). Unidentified aircraft. An aircraft which has been observed or reported to be operating in a given area but whose identity has not been established.

② An aircraft may be considered, at the same time, as a "strayed aircraft" by one unit and as an "unidentified aircraft" by another unit

a. As soon as an air traffic services unit becomes aware of a strayed aircraft, it shall take all necessary steps as follows to assist the aircraft and to safeguard its flight.

NOTE:

Navigational assistance by an air traffic services unit is particularly important if the unit becomes aware of an aircraft straying, or about to stray, into an area where there is a risk of interception or other hazard to its safety.

1. If the aircraft's position is not known, the air traffic services unit shall:

a) Attempt to establish two-way communication with the aircraft, unless such communication already exists;

b) Use all available means to determine its position;

c) Inform other ATS units into whose area the aircraft may have strayed or may stray, taking into account all the factors which may have affected the navigation of the aircraft in the circumstances;

d) Inform, in accordance with locally agreed procedures, appropriate military units and provide them with pertinent flight plan and other data concerning the strayed aircraft;

e) Request from the units referred to in c) and d) and from other aircraft in flight every assistance in establishing communication with the aircraft and determining its position.

2. When the aircraft's position is established, the air traffic services unit shall:

a) Advise the aircraft of its position and corrective action to be taken; and

b) Provide, as necessary, other ATS units and appropriate military units with relevant information concerning the strayed aircraft and any advice given to that aircraft.

b. As soon as an air traffic services unit becomes aware of an unidentified aircraft in its area, it shall endeavour to establish the identity of the aircraft whenever this is necessary for the provision of air traffic services or required by the appropriate military authorities in accordance with locally agreed procedures. To this end, the air traffic services unit shall take such of the following steps as are appropriate in the circumstances:

1. Attempt to establish two-way communication with the aircraft;

2. Inquire of other air traffic services units within the FIR about the flight and request their assistance in establishing two-way communication with the aircraft;

3. Inquire of air traffic services units serving the adjacent FIRs about the flight and request their assistance in establishing two-way communication with the aircraft;

4. Attempt to obtain information from other aircraft in the area.

5. The air traffic services unit shall, as necessary, inform the appropriate military unit as soon as the identity of the aircraft has been established.

9-2-9 EMERGENCY DESCENT

a. Upon receipt of advice that an aircraft is making an emergency descent through other traffic, all possible action shall be taken immediately to safeguard all aircraft concerned. When deemed necessary, air traffic control units shall immediately broadcast by means of the appropriate radio aids, or if not possible, request the appropriate communications stations immediately to broadcast an emergency message.

NOTE:

It is expected that aircraft receiving such a broadcast will clear the specified areas and stand by on the appropriate radio frequency for further clearances from the air traffic control unit.

b. Immediately after such an emergency broadcast has been made the ACC, the approach control unit, or the aerodrome control tower concerned shall forward further clearances to all aircraft involved as to additional procedures to be followed during and subsequent to the emergency descent. The ATS unit concerned shall additionally inform any other ATS units and control sectors which may be affected.

PHRASEOLOGY:

ATTENTION ALL AIRCRAFT IN THE VICINITY OF (or AT) (significant point or location) EMERGENCY DESCENT IN PROGRESS FROM (level) (followed as necessary by specific instructions, clearances, traffic information etc).

9-2-10 VFR AIRCRAFT IN WEATHER DIFFICULTY

a. A VFR aircraft reporting that it is uncertain of its position, or lost, or experiencing adverse meteorological conditions, shall be considered to be in a state of emergency. If the pilot requests assistance, request the aircraft to contact the appropriate control unit. Inform that unit of the situation. If the aircraft is unable to communicate with the control unit, relay information and clearances.

b. The following shall be accomplished on a Mode C equipped VFR aircraft which is in emergency but no longer requires the assignment of Code 7700:

1. ***TERMINAL:*** Assign a beacon code that will permit terminal Terrain Obstacle Hazard and Airspace Protection (TOHAP/MSAW) alarm processing.
2. ***EN ROUTE:*** An appropriate keyboard entry shall be made to ensure en route Terrain Obstacle Hazard and Airspace Protection (TOHAP) alarm processing.

9-2-11 RADAR ASSISTANCE TO VFR AIRCRAFT IN WEATHER DIFFICULTY

a. If a VFR aircraft request radar assistance when it encounters or is about to encounter IFR weather conditions, ask the pilot if he is qualified for and capable of conducting IFR flight.

b. If the pilot states he is qualified for and capable of IFR flight, request him to file an IFR flight plan and then issue clearance to destination airport, as appropriate.

c. If the pilot states he is not qualified for or not capable of conducting IFR flight, or if he refuses to file an IFR flight plan, take whichever of the following actions appropriate:

1. Inform the pilot of airports where VFR conditions are reported, provide other available pertinent weather information, and ask if he will elect to conduct VFR flight to such an airport.
2. If the action in subpara c.1. is not feasible or the pilot declines to conduct VFR flight to another airport, provide radar assistance.
3. If the aircraft has already encountered IFR conditions, inform the pilot of the appropriate/ published minimum safe level. If the aircraft is below appropriate/ published minimum safe level and sufficiently accurate position information has been received or radar identification is established, furnish a heading or radial on which to climb to reach appropriate/published minimum safe level.

d. The following shall be accomplished on a Mode C equipped VFR aircraft which is in emergency but no longer requires the assignment of Code 7700:

1. ***TERMINAL:*** Assign a beacon code that will permit terminal Terrain Obstacle Hazard and Airspace Protection (TOHAP /MSAW) alarm processing.
2. ***EN ROUTE:*** An appropriate keyboard entry shall be made to ensure en route Terrain Obstacle Hazard and Airspace Protection (TOHAP/ MSAW) alarm processing.

9-2-12 RADAR ASSISTANCE TECHNIQUES

Use the following techniques to the extent possible when you provide radar assistance to a VFR pilot not qualified to operate in IFR conditions or who is lost:

a. Avoid radio frequency changes except when necessary to provide a clear communications channel.

b. Provide radar assistance only upon the request or concurrence of the pilot.

c. Make turns while the aircraft is in VFR conditions so it will be in a position to fly a straight track while in IFR conditions.

d. Have pilot lower gear and slow aircraft to approach speed while in VFR conditions.

e. Avoid requiring a climb or descent while in a turn if in IFR conditions.

f. Avoid abrupt maneuvers.

g. Vector aircraft to VFR conditions.

h. The following shall be accomplished on a Mode C equipped VFR aircraft which is in emergency but no longer requires the assignment of Code 7700:

1. ***TERMINAL:*** Assign a beacon code that will permit terminal Terrain Obstacle Hazard and Airspace Protection (TOHAP/ MSAW) alarm processing.
2. ***EN ROUTE:*** An appropriate keyboard entry shall be made to ensure en route Terrain Obstacle Hazard and Airspace Protection (TOHAP/ MSAW) alarm processing.

9-2-13 EMERGENCY LOCATOR TRANSMITTER (ELT) SIGNALS

When an ELT signal is heard or reported:

a. ***EN ROUTE:*** Notify the National Rescue Coordination Center (NRCC).

b. ***TERMINAL:*** Notify the ACC.

NOTE:

① Operational ground testing of Emergency Locator Transmitters (ELT's) has been authorized during the first 5 minutes of each hour. To avoid confusing the tests with an actual alarm, the testing is restricted to more than three audio sweeps.

② Controllers can expect pilots to report aircraft position and time the signal was first heard, aircraft position and time the signal was last heard, aircraft position at maximum signal strength, flight level, and frequency of the emergency signal (121.5/243.0)

c. Attempt to obtain fixes or bearings on the signal.

d. Solicit the assistance of other aircraft known to be operating in the signal area.

e. ***TERMINAL:*** Forward fixes or bearings and any other pertinent information to the ACC.

NOTE:

Fix information in relation to a VOR or VORTAC (radial-distance) facilitates accurate ELT plotting by N RCC and should be provided when possible.

f. ***EN ROUTE:*** When the ELT signal strength indicates the signal may be emanating from somewhere on an airport or vicinity thereof, notify the ATC unts concern for their actions. This action is in addition to the above.

g. ***TERMINAL:*** When the ELT signal strength indicates the signal may be emanating from somewhere on an airport or vicinity thereof, notify the ACC for their action. This action is in addition to the above.

h. Air Traffic personnel shall not leave their required duty stations to locate an ELT signal source.

i. ***EN ROUTE:*** Notify the NRCC if signal source is located/terminated.

j. ***TERMINAL:*** Notify the ACC if signal source is located/terminated.

REFERENCE:
RESPONSIBILITY, Para 9-1-4.
INFORMATION REQUIREMENTS, Para 9-2-1.

9-2-14 EMERGENCY AIRPORT RECOMMENDATION

Consider the following factors when recommending an emergency airport:

a. Remaining fuel in relating to airport distances.

b. Weather conditions.

NOTE:
Depending on the nature of the emergency, certain weather phenomena may deserve weighted consideration when recommending an airport, e.g. A pilot may elect to fly farther to land at an airport with VFR instead of IFR conditions.

c. Airport conditions.

d. NAVAID status.

e. Aircraft type.

f. Pilot's qualifications.

g. Vectoring or homing capability to the emergency airport.

9-2-15 GUIDANCE TO EMERGENCY AIRPORT

When necessary, use any of the following for guidance to the airport:

a. Radar.

b. Following another aircraft.

c. NAVAID's.

d. Pilotage by landmarks.

e. Compass headings.

9-2-16 VOLCANIC ASH

a. If a volcanic ash cloud is known or forecast to be present:

1. Relay all information available to pilots to ensure that they are aware of the ash cloud's position and level(s).

2. Suggest appropriate reroutes to avoid the area of known or forecast ash clouds.

NOTE:
Volcanic ash clouds are not normally detected by airborne or air traffic radar systems.

b. If advised by an aircraft that it has entered a volcanic ash cloud and indicates that a distress situation exists:

1. Consider the aircraft to be in an emergency situation.

2. Do not initiate any climb clearances to turbine powered aircraft until the aircraft has exited the ash cloud.

3. Do not attempt to provide escape vectors without pilot concurrence.

NOTE:

① *The recommended escape maneuver is to reverse track and begin a descent (if terrain permits). However it is the pilot's responsibility to determine the safest escape route from the ash cloud.*

② *Controllers should be aware of the possibility of complete loss of power to any turbine powered aircraft that encounters an ash cloud.*

REFERENCE:
LEVEL CHANGE FOR IMPROVED RECEPTION, Para. 9-2-4.

Appendix 11 Comments on Final Draft from Parties

<u>From Hong Kong CAD</u>

Disagree comments on Draft Final Report on CX521 A330 B-HLH 14 Sep 2008 Investigation from Civil Aviation Department, The Government of the Hong Kong Special Administrative Region, Flight Standard and Airworthiness Division are listed as follow：

1. Paragraph 2.1 states that “The flight crew's duties and rest times was legal within 72 hours prior to the occurrence.” This expression may lead to question on the legality prior to the 72 hours. As the flight crew’s duties and rest times were in accordance with the Cathay Pacific Airways Flight Time Limitation Scheme approved by HK CAD, the phrase “within 72 hours” is recommended to be deleted from the sentence.

2. Under “4.1 Recommendations”, we noticed the technical contents of six recommendations addressed “To Hong Kong CAD” are similar to the other six recommendations addressed “To Hong Kong Airways”. HK CAD construes that the intention of these six recommendations under “To Hong Kong CAD” is to require HK CAD to ensure CPA will evaluate the six recommendations under “To Cathay Pacific Airways", and report to TW ASC on the action taken. However, HK CAD does not see the need of issuing these six recommendations “To Hong Kong CAD”. In the Hong Kong civil aviation system, HK CAD is empowered by appropriate legislations and requirements to ensure CPA is in continuous compliance with the relevant legislations and requirements, which cover the specified areas mentioned in the six recommendations. Documented records demonstrated that HK CAD has properly discharged such regulatory responsibility through audits and inspections, and such audits and inspections revealed that CPA does not have systematic failure

in these specific areas. Moreover, the draft Final Report did not indicate any CAD oversight deficiency. In accordance with the spirit of Annex 13, upon receipt of the safety recommendations, HK CAD will inform TW ASC of the preventive action taken or under consideration, or the reasons why no action will be taken. We therefore do not see the need of specifying that HK CAD to “require Cathay Pacific Airways” to address the safety recommendations under “To Cathay Pacific Airways”.

From Cathay Pacific Airways

Disagree comments on Draft Final Report on CX521 A330 B-HLH 14 Sep 2008 Investigation from CPA are listed as follow：

1. Publication of verbatim transcripts

With regard to the CVR data presented in Appendix 1, we wish to strongly re-iterate our earlier advice. The purpose of the report is to present clear and meaningful informatìon that describes and explain the circumstances of an occurrence, not to create confusion or allow information to be misrepresented by media, or misunderstood by the public.

As mentioned in our earlier comments on the draft factual report and at the TR meetings, we wish to bring to the attention of TW-ASC the serious potential risks of including-in a report destined to be made available to the public-any ATC or CVR verbatim transcript, or portions thereof. There are means…other than verbatim records-to include information from audio transcripts in a report that are better suited and equally effective, such as summarizing and/or paraphrasing, as illustrated in the TW-ASC draft final report with regard to the ATC information included in the analysis (ref. s2.8.1, pp.77-82).

As presented in their current tabular form in the draft final report (ref. Appendix 1, pp.104-111), the excerpts from the Cx521 CVR transcripts convey little information that would be readily understandable by non-experts. These excerpts consist of verbatim discussions between the pilots that could appear disjointed and incoherent. Therefore, these excerpts would be confusing to laypersons (non-experts)-especially when presented out of their proper context and could be misrepresented or used inappropriately by media or in subsequent nonsafety proceedings, with significant potential impact to public opinion. We therefore strongly recommend that TW-ASC considers deleting from the report all the CVR information that is included in tabular form and, whenever necessary, summarizing or paraphrasing their content as appropriate in the report.

On the other hand, the relevant excerpts from the CVR and ATC transcripts that are depicted in figure 2.1.1 FDR data on p.63 include information which is useful in providing the reader with a timeline of the events and illustrating the radio communication difficulties encountered both by CX521 and TPE ATC. However, as printed in the report, the text is too small and does not allow the reader to readily access the information. The TW-ASC should consider another way to include the information presented in the figures in the report-perhaps having the figure printed on a separate multi-fold page insert. Also, if not already done, the top part of the figure should be amended with regard to the discrepancy noted during the TR meeting regarding the EPR 1 and 2 data (as already amended in the text of this final version of the draft report).

2. Application of A320 bleed air lessons learned to A330/340 aircraft family

This would apply mostly to analysis section 2.6, and to section 3.2, finding 1 regarding the numerous dual bleed failure events prior to the Cx521 occurrence and the repeated defects that revealed the deficiency of the system reliability and potential operational risks.

The Draft Final Report confirms the following earlier findings:

1. The A330/340 aircraft family bleed system is similar in design to the A320 aircraft family;

2. Airbus was aware of the bleed problem related to overheat on the A320 aircraft family and had launched actions in May 2008 to address the problem, prior to the A330 occurrences experienced by CPA (including CX521);

3. Airbus did not take action for the A330/340 aircraft family until after the CX521 occurrence;

4. The actions since being taken by Airbus to address the A330/340 bleed problems are essentially similar to the actions previously taken for the A320;

It is reasonable for the investigation to consider whether the CX521 and the other A330 bleed air occurrences experienced by CPA could have been prevented had earlier and timely actions been initiated on the A330/340 aircraft family in a similar manner as they had previously done on the A320.

The Draft Final Report includes the following information regarding the post CX521 occurrence actions taken by Airbus with regard to A330 DBL events:

- Of the eight bleed failures noted prior to CX521, five were due to overheat and, of these, three were due to ThC malfunction（i.e. contaminated grid filte）, similar to CX521.

- SIL 36-055 R01 (dated 15 November 2006) does not adequately address overheat from contaminated grid filter.

- The cause of the CX521 DBL from the ThC was identified in October 2008
- In April 2009-seven months after the CX521 occurrence-Airbus initiated a A330 DBL task force to perform a review of the A330 bleed loss events, as they had previously done for the A320 prior to the CX521 occurrence.
- The safety review process performed by the Airbus DBL task force is approved and regularly audited by the Regulatory Authorities (EASA) and takes usually 12 months for those events that are deemed to be not related to 'unsafe condition'.
- The membership of the A330 DBL task force was essentially the same as for the A320 DBL task force.
- A solution for the A330 bleed issue was released by the OEM (Liebherr VSB 342-36-04) on 25 September 2009. The A330 solution is similar to the A320 solution that had been released in May 2008.
- The TW-ASC report concludes that although the A330 DBL task force could have been initiated earlier by Airbus, the solution to the A330 DBL events might not have been available in time to prevent the CX521 occurrence.

The ultimate objective of safety investigations is to prevent accidents and serious incidents such as CX521. As indicated in the report, the fact remains that the EASA-approved safety review process applied by Airbus to the A330 DBL events was not effective in preventing the CX521 and the other DBL events. The TW-ASC report-in its current form-fails in providing further insight or an adequate explanation as to the reasons for this.

The TW-ASC analysis in the report should be taken further and lead to findings and recommendations as to:

1. The EASA-approved safety review process applied by Airbus to the A330 DBL events was not effective in preventing the CX521 and the other A330 DBL events; and,
2. The EASA-approved safety review process needs to be reviewed to ensure that such process is more proactive, and initiated and conducted in a timely manner, and allows the benefits from lessons learned from the review of similar events on other aircraft families.

From the BEA France

ASC sent out the final draft report to all parties on April 26, 2010 and received BEA, CPA, and HKCAD's comments in June 2010. An email with the revised final draft report was sent to all parties again on August 4 with an explanation of the process for appearance at the ASC board meeting within 15 days of receipt of the reviewed draft report as stated above. A CD with the reviewed final draft report was sent to BEA by DHL on August 10.BEA accredited representative and requested a delay for sending comments until September with ASC IIC replied that BEA only had to inform of their intention to present opinions for the comments not been accepted in the coming ASC board meeting, after that time , the final report was published as scheduled.

BEA send the comments on October 11,2010, ASC revised the A330-300 B-HLH final report and appended the BEA's observations in the appendix accordingly as follow.

BEA

Observations on the report to the incident on 14 September 2008 to the A330-300 registered B-HLH

General BEA comment

The three recommendations addressed to DGAC France should have been addressed to EASA, since EASA is now in charge of airworthiness matters.

Specific BEA comments

The BEA disagrees with recommendations 2 and 3 addressed to DGAC France for the following reasons:

- Recommendation 2:

"Require manufacturer to review air dual bleed fault and emergency descent procedures and revise related inconsistent procedures accordingly."

BEA comment:

The documentation referred to in the report is CPA specific and does not reflect Airbus documentation. CPA has developed its own procedures based on Airbus ones and has introduced inconsistency, whereas Airbus procedures are not inconsistent.
This recommendation has no justification.

- Recommendation 3:

"Require manufacturer considering to take the in-service fleet events and family fleet problem solving experiences into Product Safety Process account and form the problem solving task force in an earlier time as proactive risk mitigation measure."

BEA comment:

- In-service events have been taken into account;
- An increased number of occurrences appeared in 2008, mainly from one single operator, and it was promptly addressed by a dedicated action plan proposed by Airbus to CPA;
- This dedicated action plan proved to be efficient as there was already a decrease of events in 2009 compared to 2008 within this airline. Similar trend is observed today.

This recommendation is and was already applied and has no justification.
Moreover, as mentioned in the report, the dual bleed loss is classified as ***major*** therefore there is no justification in questioning Airbus Safety Process.

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