

# Executive Summary

## CI 947 Occurrence Investigation

On August 24th, 2012, at 1735h local time<sup>1</sup>, China Airlines flight CI 947, an Airbus A330-300 airplane, registration number B-18353, a scheduled revenue passenger flight, took off from Kaohsiung International Airport for Hong Kong International Airport. Due to Typhoon Libra, the flight took a northern route than planned to dodge the weather system. At 1815:15h, around 155 nautical miles north-east of Hong Kong International Airport with cruise altitude of 34,000 ft, a 'CAB PR EXCESS CAB ALT' warning occurred. Flight crew donned the oxygen masks, performed emergency descent and declared emergency (Mayday) to the ATC. The airplane landed safely at Hong Kong International Airport at 1846h in eventless. Neither injury to the passengers nor damage to the airplane was reported.

Before the occurrence, the airplane was dispatched according to MEL 36-11-07B, due to its High Pressure Valve (HPV) of Engine 2 bleed not open. The maintenance personnel deactivated the HPV and secured it in closed position.

In the post-event interview, the flight crew stated that they were well aware of the ENG 2 Bleed HPV fault and the corresponding operational procedures at different flight phases. Flight Data Recorder (FDR) showed that after engine started, at 1730:15h ENG 2 Bleed switch was at OFF position, at 1730:17h the cross bleed valve was at OPEN position and at 1730:18h ENG 2 bleed pressure was at 35 psi.

---

<sup>1</sup> Taipei local time is UTC time + 8 hours.

The flight crew stated that the captain was Pilot Monitoring (PM) and the first officer was Pilot Flying (PF) as the flight took off. FDR showed that before takeoff, at 1733:47h, ENG 2 bleed switch was at ON position, at 1733:51h the cross bleed valve was at CLOSE position, and at 1733:53h ENG 2 bleed pressure was 0 psi.

FDR data also showed that the airplane began its takeoff roll at 1735:18h, at 1735:39h an ENG 2 Bleed FAULT occurred while the airplane was still rolling. At 1736:28h (Radio Altitude 1,499 ft) Cockpit Voice Recorder (CVR) data recorded an ECAM caution sound; and between 1736:29h and 1737:34h Master caution messages were recorded in the FDR. The flight crew stated that during the climb, an ENG 2 BLEED FAULT was shown and actions taken by following ECAM instructions. FDR further showed at 1738:03h ENG 2 Bleed switch was at OFF position and at 1738:12h the cross bleed valve was at OPEN position, and at 1738:13h ENG 2 bleed pressure was at 33 psi.

The flight crew stated that they attempted to reset ENG 2 bleed after the flight reached cruise altitude of 34,000 feet by pressing the Engine 2 Bleed switch and then the FAULT light went off. According to FDR data, at 1830:45h Engine 2 Bleed switch was at ON position and the fault at ENG 2 Bleed that had recorded since 1735:39h went off. At 1811:07h the cross bleed valve was at CLOSE position and ENG 2 Bleed pressure dropped from 36 psi at 1811:05h to 8 psi at 1811:08h. At this time the cabin altitude was about 6,000 ft.

The flight crew stated that when they requested ATC heading 220 to return to the planned route, cabin altitude warning sounded and it was found that a red ECAM cabin altitude indicated at 10,500 ft. Thus

emergency descent was executed according to cabin altitude warning memory items. Referring to FDR data, at 1814:29h an ECAM “CAB PRESS” page was displayed and cabin altitude was at 8,896 ft. At 1815:15h, cabin altitude was at 9,536 ft, an Excess Cabin Altitude warning occurred. CVR recording showed that at 1815:24h, the flight crew donned oxygen masks and executed emergency descent.

The flight crew stated that the airplane descended to 10,000 ft with the clearance from Guangzhou area control. During the emergency descent, Guangzhou ATC transited the control to Hong Kong Area Control and the flight was further cleared to descend to 9,000 ft, then the cabin altitude came back to normal. FDR data showed that, at 1824:02h, at pressure altitude of 8,988 ft., the cabin altitude was at 9,152 ft., Excess Cabin Altitude warning went away. Between 1821:28h and 1821:36h a cabin differential pressure of -0.55 psi occurred. The airplane landed at Hong Kong safely at 1846h.

Post the occurrence the China Airlines maintenance personnel performed troubleshooting and maintenance actions of the occurrence airplane. The engine 2 bleed system had the HPV, Pressure Regulating Valve (PRV), transferred pressure transducer (Pt), solenoid thermostat (THS), and two sensing lines which connected to Pt and THS replaced. The engine 2 bleed system back to normal after replacing above mentioned components. On the no.1 air-conditioning pack, a broken sleeve resulted in compressed/ conditioned air leaking was found at pack outlet which was located at unpressurized area. After replacing the broken sleeve, the maintenance personnel performed the cabin pressurization test with no.1 pack and the test passed.

According to Article 6 of the ROC Aviation Occurrence Investigation Act, and the content of Annex 13 to the Convention on International Civil Aviation (Chicago Convention), which is administered by the International Civil Aviation Organization (ICAO), the Aviation Safety Council (ASC), an independent agency of the ROC government responsible for civil aviation occurrences investigation, after confirmation of this occurrence, organized a team to conduct the investigation. The investigation team also included members from operator, China Airlines, Civil Aeronautics Administration Taiwan and the state of manufacture, represented by France BEA (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile ) including technical advisor from Airbus Industrie.

### **Findings as the result of this investigation**

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 the probable causes**, **findings related to risk**, and **other findings**.

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

**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 systematic risk, that made this occurrence more likely; however, they cannot be clearly shown to have operated in the occurrence alone. 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 occurrence, 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 interest and are not necessarily analytical, but they are often included in ICAO format accident reports for informational, and safety awareness, education, and improvement purposes.

### Findings Related to Probable Causes

1. Before the occurrence flight, there was an unknown leaking at the no.1 pack outlet which degraded the performance of air-conditioning system and cabin pressurization capability.
2. Both no.2 engine bleed system high pressure valve, HPV, and pressure regulating valve, PRV, failed at the previous two flights, however both items would not be appropriate rectified which adversely affected following operations of engine bleed air system.
3. The HPV and PRV already failed at the previous flights with “AIR ENG 2 HPV NOT OPEN” and “AIR ENG 2 BLEED FAULT” alert messages. The flight crew of previous flights reported that they thought that the “AIR ENG 2 BLEED FAULT” alert message was triggered by his actions for procedure and system checking;

therefore he did not write down that bleed fault message on the Technical Log Book post-flight.

4. The maintenance personnel who performed maintenance actions for the previous flight and dispatched the occurrence flight might access same message from AIRMAN system, but he did not get further understanding of both “AIR ENG 2 HPV NOT OPEN” and “AIR ENG 2 BLEED FAULT” alert messages. He reported that he could not recall the bleed fault message; however he believed that if such messages had shown, the engine 2 bleed fault should have been caused by the high pressure valve failure. And on the Technical Log Book showed the ECAM message “AIR ENG 2 HPV NOT OPEN”. The airplane was dispatched with Minimum Equipment List, MEL, 36-11-07B which corresponded to the high pressure valve failed only. The MEL item for the failure of “AIR ENG 2 BLEED FAULT” was not applied which resulted in the proper MEL operation procedures of engine 2 bleed failure were not taken.
5. The Bleed Monitor Computer of present A330 airplane with GE engine configuration might not properly indicate system failure while the PRV up-stream pressure sensor failed to provide right signal to the computer.
6. During cruise, pilot reset the engine 2 bleed system, and then the fault message disappeared. Pilots thought that the engine 2 bleed system returned to normal and closed the cross bleed valve. Due to the engine 2 bleed system still failed which could not supply pressure air for no.2 pack operation. And the leaking at no.1 pack outlet, the no.1 pack could not provide enough compressed air for cabin pressurization. At 34,000 ft of cruise altitude, the cabin altitude increased continuously after the closure of the cross bleed

valve, and reached the point where cabin altitude warning occurred, followed by the crew's emergency descent.

### Findings Related to Risk

1. Five defects of multi-zone cabin temperature too high or unable to control recorded on the Technical Log Book. The previous flight during climb, the cabin altitude increased obviously while the cross bleed valve closed. Both symptoms indicated that before occurrence the pre-existed broken sleeve at no.1 pack outlet led to the leaking of conditioned air and the difficulty to control cabin temperature.
2. According to the accumulated flight hours of the occurrence airplane and the broken condition of no.1 pack outlet sleeve, the inspection interval of pack outlet on the original airplane Manufacturer MPD and original Operator AMP could not find out the sleeve defect in a timely manner.
3. The accumulated Time Since Check in flight hours (FH) of failed high pressure valve and pressure regulating valve removed from the occurrence airplane were 170 FH and 245 FH respectively, which were less than the mean time between failure 2,703 FH and 3,799 FH respectively.
4. The air-conditioning system of A330 airplane may not provide pack operation status to pilot in a timely manner while pack did not receive enough upstream air pressure/ air flow for normal operation.
5. On the occurrence flight at the time of before/ after engine start or after resetting the engine 2 bleed if pilots could check the ECAM BLEED system page, they might find the failure of engine 2 bleed. The proper MEL or ECAM actions could be taken then the cabin pressure anomaly may be avoided.

6. On A330 QRH, there is no requirement to check related ECAM system page of the computer reset procedure to verify the result of system reset.
7. The flight time from KHH to HKG was short and the weather was bad on the occurrence day. Besides the normal workload, flight crew had to avoid thunderstorm. Due to the tight schedule and heavy workload, flight crew did not notice the “CABIN ALTITUDE” advisory message and ECAM BLEED system page display before airplane reaching the altitude of ‘CAB PR EXCESS CAB ALT’ warning .
8. Flight crew did not follow the Chapter 4, Abnormal Procedure, prescribed on the A330 Airplane Operation Manual to verify the abnormal condition shown on ECAM display.

### Other Findings

1. The certificates of flight crew were in accordance with Civil Aviation Regulations.
2. There was no evidence to show that the flight crew was affected by any alcohol or medication during that flight.
3. According to the Airplane Operations Manual, Chapter 6, Normal Procedures, Flight and Cockpit preparation, with the “RCL” button on the ECAM control panel pilot could recall the previous flight alert message during Cockpit Safety Inspection. This may provide pilots to access the “AIR ENG 2 BLEED FAULT” alert message that was not logged on the Technical Log Book.

### **Safety Recommendations**

Safety recommendations derived as the result of this investigation



are listed. Safety actions that have been accomplished, or are currently being planned by the stakeholders as the result of the investigation process are listed right after the recommendations. It should be noted that the Safety Council has not verified the safety actions.

#### To China Airlines

1. Reinforce flight crew's discipline of logging the ECAM alert message on Technical Log Book, reinforce the system training and operation procedures related to the engine bleed air system and cabin pressurization system. (ASC-ASR-13-09-024)
2. Reinforce maintenance personnel's discipline of using ECAM alert message and Minimum Equipment List, and the system training related to the engine bleed air system and air-conditioning system. Provide more strict motoring of repeated defect to reduce the time of trouble shooting. (ASC-ASR-13-09-025)

#### To Civil Aeronautics Administration, Ministry of Transportation and Communications

1. Require China Airlines, to reinforce flight crew's discipline of logging the ECAM alert message on Technical Log Book, reinforce flight crew's system training and operation procedures related to the engine bleed air system and cabin pressurization system. (ASC-ASR-13-09-026)
2. Require China Airlines, to reinforce maintenance personnel's discipline of using ECAM alert message and Minimum Equipment List, and the system training related to the engine bleed air system and air-conditioning system, to provide more strict motoring of repeated defect to reduce the time of trouble shooting. (ASC-ASR-13-09-027)

#### **Safety Actions Taken or Being Planned**

### According to China Airlines

1. China Airlines revised the Airplane Maintenance Program (AMP R30, effective date August 16, 2012), item 215000-05-1, A/C PACK AIR SUPPLY DUCT, CLAMP AND BELLOWS- VISUAL CK. The inspection interval of pack outlet was shortened from 24,000 FH to 12,000 FH.
2. China Airlines finished the evaluation of airplane manufacturer Service Bulletin (AIRBUS SB 71-3029). It transfers into China Airlines Engineering Order, EO 333-71-00-0007, which is intended to reduce the level of vibration at HPV by changing the bleed system response in adding links attaching the engine compress case.
3. China Airlines A330/A340 fleet issued Crew Notification which requires flight crew must log any discovered fault into TLB and have briefing to maintenance personnel. Any confusion with actions taken by the maintenance shall be clarified before accepting the airplane.
4. The annual recurrent training has incorporated the relevant operation/handling procedure of engine bleed air system and cabin pressurization system to continuously improve flight crew's expertise. This event has been a case study to share with all flight crew at Fleet Technical Forum of China Airlines.

### According to the Civil Aeronautics Administration, ROC

1. CAA has required China Airlines to make sure any inoperative item discovered by flight crew must be logged into TLB. And before accepting the airplane, any concerns shall be clarified with maintenance personnel. CAA also requires China Airlines to enhance aircraft systems knowledge of flight crew, especially to be familiar with the abnormal/ emergency procedure of pneumatics

system and cabin pressurization system. It was found that China Airlines issued relevant Crew Notification in March, 2013 and spot checks of line operation were satisfied. This item will be continuously monitored and improved.

According to the AIRBUS INDUSTRIE

1. Bleed reset in cruise-Airbus ongoing actions: QRH Computer Reset table new entry: Engine BLEED Reset: Will include the possibility of one controlled Bleed reset, Will include a monitoring of the BLEED page after the reset to check correct Bleed configuration
2. Service Bulletin for the HPV (P/N: 6763C080000) installation, AIRBUS SB 71-3029 (GE SB 72-0472), Dec. 23, 2012. Objective: Modification is intended to reduce the level of vibration at HPV by changing the bleed system response in adding links attaching the engine compress case.
3. During the process of drafting Final Report, the Council provided two recommendations to AIRBUS INDUSTRIE as follows,
  - A. Re-evaluate the logic of engine bleed air system fault indication of A330 airplane with GE engine configuration to provide appropriate alert message to pilot while the system fails to supply normal pressure, even the transferred pressure sensor fails to provide right signal to the Bleed Monitoring Computer.
  - B. Re-evaluate the logic of air-conditioning system status indication of A330 airplane to provide alert message to pilots in a timely manner while pack receives low air pressure/ low air flow which may affect pack normal operation.

The Aviation Safety Council received the response from AIRBUS INDUSTRIE on July 29, 2013. AIRBUS INDUSTRIE has taken corresponding safety actions to the recommendations; reference

document G03ME13322215 could be found at Final Report.

This Executive Summary in English includes only the History of flight, Findings as the result of this investigation and Safety Recommendations. Although efforts are made to translate it as accurate as possible, discrepancies may occur. In this case the Final Report in Chinese version will be the official version.