

飛航事故調查報告

ASC-AOR-10-08-002

中華民國 97 年 9 月 14 日

國泰航空公司 CX 521 班機

A330-300 型機

國籍標誌及登記號碼 B-HLH

因暫時性艙壓供氣異常緊急下降事故

行政院飛航安全委員會

AVIATION SAFETY COUNCIL

中華民國 99 年 8 月

本頁空白

依據中華民國飛航事故調查法及國際民航公約第 13 號附約，本調查報告僅供改善飛航安全之用。

中華民國飛航事故調查法第五條：

飛安會對飛航事故之調查，旨在避免類似飛航事故之再發生，不以處分或追究責任為目的。

國際民航公約第 13 號附約第 3 章第 3.1 節規定：

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.

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摘要報告

2008 年 9 月 14 日於臺北時間 1614 時¹，一架國泰航空公司（Cathay Pacific Airways，以下簡稱國泰），班機號碼 CX521，機型 Airbus 330-300，註冊號碼 B-HLH，自日本成田國際機場（以下簡稱成田機場）飛往台灣桃園國際機場（以下簡稱桃園機場），機上載有飛航組員 2 人、客艙組員 11 人、乘客 72 人。該機於自高度 40,000 呎（FL400）下降通過高度約 38,544 呎時，艙壓供氣系統中斷。1929 時飛航組員採取緊急下降程序於桃園機場落地，人機均安。

該機原定由成田機場飛往香港國際機場，因颱風影響，改由成田機場飛往桃園機場。飛航組員於成田機場執行飛行前檢查時，獲悉該機之 1 號發動機供氣閥（Bleed Valve）失效，且依據該型機最低裝備需求表（Minimum Equipment List, MEL）36-11-02 之程序完成檢查放飛。

CX521 約於 1614 起飛，巡航高度 40,000 呎，由正駕駛員（CM1）擔任監控駕駛員（Pilot Monitoring, PM），副駕駛員（CM2）擔任操控駕駛員（Pilot Flying, PF），臺北當時天氣受颱風 Sinlaku 影響，約於 1847，該機 CM1 於航路上向臺北區域管制中心（Taipei Area Control Center, TACC）報到。TACC 於 1852 時，許可 CX521 於適當時機下降至 FL140，該機於通過 FL380 時，CM1 發現 Electronic Centralized Aircraft Monitor（ECAM）內“AIR ENG2 BLEED FAULT”及“AIR ABNORM BLEED CONFIG”之訊息相繼出現。CM1 企圖重置發動機供氣系而未成功，之後發現艙壓高度開始上升，經與 CM2 討論後決定放出減速板快速下降。

於 1856:42 時，TACC 呼叫 CI5321：“Dynasty five three two one contact Taipei

¹ 本報告使用之時間除特別註明外均為臺北時間（國際標準時間（Coordinated Universal Time, UTC）加 8 小時）。

approach one two five decimal one”²。CX521CM1 回答：“One two five one,bye byes”之後將通訊波道轉換至 125.1。於 1857:39 時，ECAM 出現「艙壓高度過高」（「EXCESS CAB ALT」）之主警告訊息，同時艙壓高度顯示 9,700 呎。飛航組員即依緊急程序執行緊急下降並戴上氧氣面罩。於緊急下降過程中，客艙氧氣面罩係由飛航組員以手動方式放下，於下降過程中，艙壓高度最大到達 13,424 呎。於 1858:00 至 1859:54 期間，CM1 經由選擇之波道呼叫 Mayday 三次、緊急波道呼叫 Mayday 一次。於 1858:14 時，臺北近場臺呼叫 “Cathay five three one confirm mayday”³。於 1901:50 時，臺北近場臺同意 CX521 下降高度至 10,000 呎。

於 1906:21 時，客艙組員於客艙中發現強烈焦味，經與飛航組員討論後，於 1907:03 時請求優先於臺北 24 跑道落地獲准。飛機落地後停止於 SP 滑行道，地面消防人員檢查飛機外觀未發現任何異狀，CM2 亦至後艙 4 號門處檢查焦味情況，確認係由氧氣致動器發出之異味。

行政院飛航安全委員會（以下簡稱本會）為負責調查發生於中華民國境內之民用航空器、公務航空器及超輕型載具飛航事故之政府獨立機關，依據中華民國飛航事故調查法以及參考國際民航公約第 13 號附約（Annex 13 to the Convention on International Civil Aviation），於事故發生後依法展開調查工作。受邀參與本次調查之機關（構）包括：交通部民用航空局（簡稱民航局）、國泰航空股份有限公司（簡稱國泰航空）、香港特別行政區政府民航處、法國事故調查委員會（簡稱 BEA）及法國空中巴士公司。

本調查報告於 98 年 3 月 13 日召開中英文事實資料確認會議，98 年 11 月 26 日召開第一次分析結果說明會議、99 年 2 月 2 日應法國 BEA 請求召開第二次分析結果說明會議、99 年 4 月 12 日日中英文調查報告草案送請民航局，HKCAD，

². 文內為航管之抄件內容，CVR 之抄件內容為” Dynasty three two one contact Taipei approach one two five decimal one”。

³. 當時 CX521 係在 TACC 管制空域，但呼叫臺北近場臺之波道；同時 CX531 剛好在臺北近場臺管制空域，因此臺北近場臺確認是否 CX531 呼叫 MAYDAY。

BEA 提供意見。經專案調查小組參採相關機關（構）之回覆意見，匯整本調查報告草案之內容後，於 99 年 7 月 27 日經本會第 135 次委員會議審核通過，並於 99 年 8 月 29 日對外發布。

本會依據事實資料進行分析，提出以下之調查發現及改善建議。

調查發現

與可能肇因有關之調查發現

此類調查發現係屬已經顯示或幾乎可以確定為與本次事故發生有關之重要因素。其中包括：不安全作為、不安全狀況或造成本次事故之安全缺失等。

1. 在 1 號發動機供氣閥失效依最低裝備需求表鎖於關閉情況下，2 號發動機供氣系統乃該機空調系統之唯一氣源，2 號發動機供氣系統處於高供應量之狀況下運作。當飛機高度開始下降時，發動機壓縮段 8 級氣源改由壓力及溫度較高之 14 級提供，使通過預冷器之空氣溫度上升。因扇氣閥溫控器網狀濾網遭受污染，降低推動扇氣閥之氣壓，以致該氣閥無法正常開啓以提供足夠之冷卻空氣，致預冷器下游壓縮空氣過熱，致 2 號供氣閥因過熱而自動關閉，空調系統失效，艙壓高度升高失去客艙加壓之能力。(2.5)

與風險有關之調查發現

此類調查發現係涉及飛航安全之風險因素，包括未直接導致本次事故發生之不安全作為、不安全條件及組織與整體性之安全缺失等，以及雖與本次事故無直接關連但對促進飛安有益之事項。

1. 由該機 1 號供氣系統於事故前發生多次重發性故障及該型機隊於半年內發生多次 2 套氣動系統失效情況，顯示該系統不穩定，對飛航安全有潛在性風險。(2.6)
2. 飛航組員因同一空域內存在近似呼號之航機、系統失效工作壓力、分心及未完

全遵守公司無線電通訊規定等因素，誤聽航管對其他在空機之指令，提前將通訊波道換至臺北近場臺之波道。(2.1.1)

3. CX521 班機不完整的無線電覆誦及呼叫加上與其他航機呼叫重疊，使飛航組員與飛航管制員均失去複查此一不正確指令之機會。(2.1.1)
4. 於 CX521 班機首次誤聽 CI5213 班機之指示後，管制員在班機呼號運用上未依據「飛航管理程序」之相關程序，讓駕駛員易於區別。(2.1.1) (2.8.2)
5. 「飛航管理程序」第 2-4-15 節「為澄清而加重語氣」程序，中文版為非強制性規定，與英文版不同。(2.8.2)
6. 近場臺聽到 125.1 波道中有航機呼叫 Mayday 時未按規定立即處理，於 CX521 班機再次呼叫緊急狀況，近場臺方進行相關確認工作。(2.8.3.1)
7. 管制員對於緊急情況之資訊掌握過晚，指示更換波道之頻率過高、要求緊急情況航空器實施速度限制等，未符飛航管理程序中，提供危難航空器最大之協助、最高之優先次序，亦未考慮駕駛員工作負荷及無線電通信有關之人為因素。(2.8.3.2)
8. 近場臺與塔臺對於該機落地後多次詢問地面支援，顯示航管單位間協調連繫未臻完備。(2.8.3.2)
9. CX521 班機於 1859:56 時在 121.5 緊急波道呼叫“Mayday …”，於 1900:52 時前，區管中心各管制席位皆選擇馬公臺址無線電，以致未聽到 CX521 班機緊急波道通話。(2.8.3.3)
10. 區管中心北部席 121.5 緊急波道可選擇大屯山、馬公兩個無線電臺，但兩電臺因地理位置相距約 140 哩，以及地形影響，無法互為備份。(2.8.3.3)
11. 區管中心北部席之測試程序遺漏緊急波該區東北部 SALMI 及 BULAN 等交管點附近緊急波道接收情況，致事故發生時北部席無法收到 CX521 班機呼叫

Mayday。(2.8.4)

12. 部分客艙組員於氧氣面罩未能自動下落時，未使用工具試圖開啓蓋板，亦未使用座椅附近的可攜式氧氣瓶。(2.9)
13. 部分客艙組員可能不熟悉氧氣面罩須下拉才開始供應氧氣之操作及氧氣面罩之正常操作狀況。(2.9)
14. 部分客艙組員未能使用或未使用氧氣面罩之作爲可能誤導乘客認爲不需依指示戴上氧氣面罩。(2.9)
15. 氧氣瓶啓動後會產生氣味未見於客艙組員相關手冊及訓練內容，可能增加客艙組員解開安全帶尋找火源而產生的風險。(2.9)

其他調查發現

此類調查發現係屬具有促進飛航安全、解決爭議或澄清疑慮之作用者。其中部份調查結果爲大眾所關切，且見於國際調查報告之標準格式中，以作爲資料分享、安全警示、教育及改善飛航安全之用。

1. 飛航組員相關飛航證照，符合香港特別行政區政府民航處民航法規規定。(2.1)
2. 無證據顯示飛航組員於該次飛航中曾受任何受酒精及藥物之影響。(2.1)
3. 飛航組員於執行緊急下降程序下降至約 FL300 時，尚未及執行啓動 APU 程序，即出現「CAB PR EXCESS CAB ALT」警告訊息，因依規定執行「CAB PR EXCESS CAB ALT」之程序而未執行 APU 啓動程序。(2.1.2.1)
4. FDR 資料顯示，航機於下降至 FL100 過程中，艙壓高度最大指示均未超過 14,000 呎，顯示飛航組員無須手動放下客艙氧氣面罩。(2.1.2.2)
5. 「CAB PR EXCESS CAB ALT」程序及「EMER DESCENT」兩程序對設定 Transponder 電碼 7700 之規定不同。(2.1.2.2)

6. 無證據顯示於緊急下降過程中，該機之電碼係置於 7700 位置。(2.1.2.2) (2.8)
7. 當第 2 套供氣系統亦失效時，駕駛員採取緊急下降至安全的高度乃是必要的。
(2.2)
8. 艙壓高度在駕駛員緊急操作下，航空器所經歷之最高艙壓高度仍在適航認證的範圍內。(2.3)
9. 該機艙艙之洩漏速率合於該型機飛機維修手冊規範。(2.3)
10. 使用人對應最低裝備需求表 36-11-02 之維修作為，符合最低裝備需求表之規定。(2.4)
11. 1 號供氣系統之供氣閥送至原廠之拆解結果，無法確認與飛行線上發生之故障有關。(2.6)
12. 1903 時至 1907 時該機與區管中心通聯時，曾發生短暫通訊不良的狀況，無證據顯示區管中心當時無線電系統有異常之情形。(2.7)
13. 部份乘客可能因語言障礙、未能充分了解氧氣面罩啟動程序或未遵守廣播要求，致氧氣面罩未能供氧。(2.9)

飛安改善建議

致香港特別行政區政府民航處

1. 要求國泰航空公司評估最低裝備需求表，增修訂組員操作程序，當飛機在 1 套氣源失效情況下飛行時，能及時啟動 APU，讓飛機儘早恢復艙壓能力，以降低乘員失壓的風險。(ASC-ASR-10-08-004)
2. 要求國泰航空公司在扇溫控器之網狀濾網新設計或改善未完成前，評估縮短扇氣閥溫控器進廠檢視或翻修時限。(ASC-ASR-10-08-005)

3. 要求國泰航空公司對於重複發生故障，且有多套系統同時失效情況下，審慎評估最低裝備需求表使用，或修訂其相關之最低裝備需求表以降低空中多系統失效之風險。(ASC-ASR-10-08-006)
4. 要求國泰航空公司檢視並修訂「AIR DUAL BLEED FAULT」、「CAB PR EXCESS CAB ALT」與「EMER DESCENT」等相關差異性操作程序。(ASC-ASR-10-08-007)
5. 要求國泰航空公司重新檢視客艙失壓之相關程序並加強要求客艙組員確實執行客艙失壓應變程序。(ASC-ASR-10-08-008)

致法國民用航空局 (DGAC, France)

1. 要求空中巴士公司考慮重新設計或改良扇氣閥溫控器之網狀濾網，以降低 A330 型機雙發動機供氣系統失效之風險。在扇氣閥溫控器之網狀濾網新設計或改善未完成前，評估縮短扇氣閥溫控器進廠檢視或翻修時限。(ASC-ASR-10-08-009)
2. 要求空中巴士公司檢視並修訂「AIR DUAL BLEED FAULT」、「CAB PR EXCESS CAB ALT」與「EMER DESCENT」等相關差異性操作程序。(ASC-ASR-10-08-010)
3. 要求空中巴士公司考慮在未來產品安全管制程序 (Product Safety Process) 評估列管過程中，引用同型系列機隊解決方案的經驗對區域性服勤機隊發生之異常事件，及早啟動改善方案的研究並將發布解決方案時程提前以降低操作風險。(ASC-ASR-10-08-011)

致國泰航空公司

1. 評估最低裝備需求表或增修訂組員操作程序，當飛機在 1 套氣源失效情況下飛行時，能及時啟動 APU 運轉，儘早恢復艙壓，以降低乘員失壓的風險。(ASC-ASR-10-08-012)

2. 在扇氣閥溫控器之網狀濾網新設計或改善未完成前，評估縮短扇溫控器進廠檢視或翻修時限。(ASC-ASR-10-08-013)
3. 對於重複性的故障，且存在多系統同時失效情況下，考慮最低裝備需求表之使用項目，或修訂其相關之最低裝備需求表以降低空中多套系統失效之風險。(ASC-ASR-10-08-014)
4. 檢視並修訂「AIR DUAL BLEED FAULT」、「CAB PR EXCESS CAB ALT」與「EMER DESCENT」等相關差異性操作程序。(ASC-ASR-10-08-015)
5. 檢視環境變化資訊、面罩蓋板手動啟動及供氧程序等客艙失壓相關程序及訓練並加以落實。(ASC-ASR-10-08-016)

致交通部民用航空局

1. 要求管制員確實執行近似呼號之航空器特別強調某些數字或文字，並通知相關駕駛員以利區別之飛航管理程序及規定。(ASC-ASR-10-08-017)
2. 修正「飛航管理程序」中文版第 2-4-15 節「為澄清而加重語氣」程序，以符合第 1-2-1 節「字義」規定，並與英文版之意義一致。(ASC-ASR-10-08-018)
3. 加強管制員對遇險航空器之緊急協助及狀況警覺，確依飛航管理程序之緊急協助規定，儘速掌握「緊急情況之性質」及「駕駛員之期望」時效，提供危難航空器最大之協助、最高之優先次序，並考慮駕駛員工作負荷及無線電通信有關之人為因素。(ASC-ASR-10-08-019)
4. 審閱程序中有關緊急情況下航管員應考量以指示正常航空器更換無線電波道方式，以避免更增加危難航空器駕駛員工作負荷。(ASC-ASR-10-08-020)
5. 強化航管單位間溝通協調連繫以及航管作業之訓練、考核，及緊急情況之處理。(ASC-ASR-10-08-021)

6. 規劃無線電備份系統時，需考慮空域無線電之需求，於選擇備用台址時應不致降低其原有效能或影響航管作業。(ASC-ASR-10-08-022)
7. 修正區管中心北部席之測試紀錄表測試程序，使能涵蓋本區東北部 SALMI 及 BULAN 等交管點附近區域之工作情況。(ASC-ASR-10-08-023)

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第一章 事實資料

1.1 飛航經過

2008 年 9 月 14 日於臺北時間 1614 時⁴，一架國泰航空公司（Cathay Pacific Airways，以下簡稱國泰），班機號碼 CX521，機型 Airbus 330-300，註冊號碼 B-HLH，自日本成田國際機場（以下簡稱成田機場）飛往台灣桃園國際機場（以下簡稱桃園機場），機上載有飛航組員 2 人、客艙組員 11 人、乘客 72 人。該機於自高度 40,000 呎（FL400）下降通過高度約 38,544 呎時，艙壓供氣系統中斷。1929 時飛航組員採取緊急下降程序於桃園機場落地，人機均安。

該機原定由成田機場飛往香港國際機場，因颱風影響，改由成田機場飛往桃園機場。飛航組員於成田機場執行飛行前檢查時，獲悉該機之 1 號發動機供氣閥（Bleed Valve）失效，且依據該型機最低裝備需求表（Minimum Equipment List, MEL）36-11-02 之程序完成檢查放飛。

CX521 約於 1614 起飛，巡航高度 40,000 呎，由正駕駛員（CM1）擔任監控駕駛員（Pilot Monitoring, PM），副駕駛員（CM2）擔任操控駕駛員（Pilot Flying, PF），臺北當時天氣受颱風 Sinlaku 影響，約於 1847，該機 CM1 於航路上向臺北區域管制中心（Taipei Area Control Center, TACC）報到。TACC 於 1852 時，許可 CX521 於適當時機下降至 FL140，該機於通過 FL380 時，CM1 發現 Electronic Centralized Aircraft Monitor（ECAM）內“AIR ENG2 BLEED FAULT”及“AIR ABNORM BLEED CONFIG”之訊息相繼出現。CM1 企圖重置發動機供氣系而未成功，之後發現艙壓高度開始上升，經與 CM2 討論後決定放出減速板快速下降。

⁴ 本報告使用之時間除特別註明外均為臺北時間（國際標準時間（Coordinated Universal Time, UTC）加 8 小時）。

於 1856:42 時，TACC 呼叫 CI5321：“Dynasty five three two one contact Taipei approach one two five decimal one”⁵。CX521CM1 回答：“One two five one, bye byes”之後將通訊波道轉換至 125.1。於 1857:39 時，ECAM 出現「艙壓高度過高」（「EXCESS CAB ALT」）之主警告訊息，同時艙壓高度顯示 9,700 呎。飛航組員即依緊急程序執行緊急下降並戴上氧氣面罩。於緊急下降過程中，客艙氧氣面罩係由飛航組員以手動方式放下，於下降過程中，艙壓高度最大到達 13,424 呎。於 1858:00 至 1859:54 期間，CM1 經由選擇之波道呼叫 Mayday 三次、緊急波道呼叫 Mayday 一次。於 1858:14 時，臺北近場臺呼叫 “Cathay five three one confirm mayday”⁶。於 1901:50 時，臺北近場臺同意 CX521 下降高度至 10,000 呎。

於 1906:21 時，客艙組員於客艙中發現強烈焦味，經與飛航組員討論後，於 1907:03 時請求優先於臺北 24 跑道落地獲准。飛機落地後停止於 SP 滑行道，地面消防人員檢查飛機外觀未發現任何異狀，CM2 亦至後艙 4 號門處檢查焦味情況，確認係由氧氣致動器發出之異味。

1.2 人員傷害

人員無傷害。

1.3 航空器損害情況

航空器無受損。

1.4 其它損害情況

無。

1.5 人員資料

⁵ 文內為航管之抄件內容，CVR 之抄件內容為 “Dynasty three two one contact Taipei approach one two five decimal one”。

⁶ 當時 CX521 係在 TACC 管制空域，但呼叫臺北近場臺之波道；同時 CX531 剛好在臺北近場臺管制空域，因此臺北近場臺確認是否 CX531 呼叫 MAYDAY。

飛航組員之基本資料如表 1.5-1。

表 1.5-1 飛航組員之基本資料

項次	正駕駛員	副駕駛員
性別	男	男
年齡	36	34
進公司日期	1996 年 10 月 26 日	2004 年 9 月 13 日
證照類別	ATPL	ATPL
檢定機型／有效截止日期	A330／2014 年 4 月 29 日	A330／2018 年 6 月 17 日
體檢種類／有效截止日期	1 st ／2008 年 7 月 10 日	1 st ／2008 年 2 月 6 日
上次飛航檢定日期	2008 年 6 月 20 日	2008 年 5 月 04 日
總飛航時間	10,994:00 hrs	8,749:00 hrs
近 12 個月內飛航時間	632:00 hrs	736:00 hrs
近 90 日內飛航時間	164:00 hrs	216:00 hrs
近 7 日內飛航時間	15:00 hrs	21:00 hrs
A330 總飛航時間	2,396:00 hrs	980:00 hrs
事故當日飛航時間	3:20 hrs	3:20 hrs
事故前休息時間	21 hrs	66:23 hrs

1.5.1 正駕駛員

正駕駛員（CM1）36 歲，於 1996 年 10 月 26 日進入國泰，持有民航運輸業駕駛員證照。具備 BE-76 及 A-330 型機之正駕駛資格及 A-330、A-340 型機之副駕駛資格。

CM1 進入國泰之首次職務係擔任 B-747-400 型機之第二副駕駛員（Second officer, S/O），於 2000 年 8 月升任 A-340 型機之副駕駛員並於 2008 年 6 月 20 日升任 A-330 型機之正駕駛員，其總飛行時間為 10,994 小時，其中 2,396 小時為 A-330 型機之正駕駛時間。

依據國泰之訓練紀錄；CM1 於 2008 年 6 月 19 及 20 日完成年度複訓及考試（Recurrent Training and Proficiency Check），於 2008 年 7 月 12 日完成年度航路考

試 (Annual Line Check)，相關訓練資料無異常訓練紀錄。其最近完成之緊急下降訓練日期為 2007 年 11 月 6 日。

CM1 上次體檢及格日期為 2008 年 7 月 10 日，體檢及格證上無相關限制註記。CM1 員於 2008 年 9 月 11 及 12 日在印度馬德拉斯 (Madras) 休假，9 月 13 日曾執行印度欽奈 (Chennai international airport, MAA) 飛香港之航班飛航。

1.5.2 副駕駛員

副駕駛員 (CM2) 34 歲，於 2004 年 9 月 13 日進入國泰，持有民航運輸業駕駛員證照。具備 BE-76 型機之正駕駛資格及 A-330 型機之副駕駛資格。

CM2 進入國泰之首次職務係擔任 A-340 型機之第二副駕駛員，於 2007 年 8 月升任 A-330 型機之副駕駛員，其總飛行時間為 8,749 小時，其中 980 小時為 A-330 型機之副駕駛時間。

依據國泰之訓練紀錄；CM2 於 2008 年 5 月 3 及 4 日完成年度複訓及考試、於 2008 年 9 月 1 日完成年度飛航考試，相關訓練資料無異常紀錄。

CM2 上次體檢及格日期為 2008 年 2 月 6 日，體檢及格證上無相關限制註記。CM2 於 2008 年 9 月 11 日執行 CX501 班機作業，自成田機場飛香港之任務，12 日及 13 日休假在家休息。

1.5.3 客艙組員

本班機上共計有 11 位客艙組員，所有客艙組員均於年度內完成複訓，客艙組員訓練資料如表 1.5-2。

表 1.5-2 客艙組員訓練資料

職稱	任職日期	客艙安全相關訓練實施日期
ISM	1985 年 12 月 16 日	2007 年 10 月 25 日
SP2	1990 年 1 月 8 日	2008 年 2 月 28 日
FP2	1995 年 4 月 4 日	2008 年 1 月 18 日
FP5	2000 年 1 月 18 日	2008 年 4 月 10 日
FP6	2000 年 2 月 24 日	2007 年 12 月 14 日
J1	2005 年 5 月 26 日	2008 年 5 月 1 日
J2	2006 年 3 月 2 日	2008 年 3 月 19 日
Y1	2008 年 8 月 4 日	2008 年 8 月 18 日
Y2	2006 年 3 月 2 日	2008 年 2 月 20 日
Y3	2003 年 1 月 6 日	2008 年 3 月 19 日
Y4	2008 年 6 月 30 日	2008 年 7 月 14 日

1.5.4 管制員

相關管制員之基本資料及事故前 72 小時之活動如表 1.5-3。

表 1.5-3 管制員基本資料及事故前 72 小時活動

管制員	資歷	事故前 72 小時活動
臺北區域管制中心 (以下簡稱區管中心) 北部管制區雷達管制員	1991 年 10 月擔任塔臺管制員。 1995 年 2 月取得雷達管制資格。	9 月 12 日：0800 時至 1300 時執行管制員之任務。 9 月 13 日：休假。 9 月 14 日：1300 時至 2100 時執行管制員之任務。
區管中心北部管制區協調員	1990 年 3 月擔任塔臺管制員。 1993 年 8 月取得雷達管制資格。 2008 年 5 月晉升協調員。	9 月 12 日：休假。 9 月 13 日：1300 時至 1900 時執行協調員之任務。 9 月 14 日：1300 時至 2100 時執行協調員之任務。
臺北近場管制塔臺 (以下簡稱近場臺) 桃南管制區雷達管制員 1	2001 年 1 月擔任塔臺管制員。 2007 年 7 月取得雷達管制資格。	9 月 12 日：0900 時至 1900 時執行管制員之任務。 9 月 13 日：休假。 9 月 14 日：0800 時至 1900 時執行管制員之任務。

近場臺桃南管制區 雷達管制員 2	2002 年 7 月擔任塔臺管制員。 2008 年 2 月取得雷達管制資格。	9 月 12 日：0730 時至 1730 時執行管制員之任務。 9 月 13 日：0900 時至 1900 時執行管制員之任務。 9 月 14 日：0830 時至 1430 時、1900 時至隔日 0800 時執行管制員之任務。
近場臺督導	1985 年 12 月擔任塔臺管制員。 2002 年 6 月取得雷達管制資格。 2004 年 4 月晉升協調員。 2007 年 2 月晉升督導。	9 月 12 日：0830 時至 1430 時、2030 時至隔日 0830 時執行督導之任務。 9 月 13 日：休假。 9 月 14 日：1430 時至 2030 時執行督導之任務。

1.6 航空器資料

1.6.1 航空器基本資料

航空器基本資料如表 1.6-1，發動機基本資訊如表 1.6-2。事故後，1 號發動機供氣閥（Bleed Air Valve）、2 號發動機扇氣閥（Fan Air Valve, FAV）及溫度控制器（Thermostat），因維修因素將其拆下，此 3 元件之基本資料如表 1.6-3。

表 1.6-1 航空器基本資料

航空器		
項次	項目	內容
1	國籍	香港，中國
2	登記號碼	B-HLH
3	所有人	Cathay Pacific Airways Limited
4	使用人	Cathay Pacific Airways Limited
5	登記證編號	420
6	適航證編號	282-10
7	適航證書有效期限	05 Feb 2008 – 19 Feb 2009
8	航空器總使用時數	37666:01
9	航空器總落地次數	13880
10	上次定期檢查種類	A4（600 小時）
11	上次定期檢查日期	08 Sept 2008
12	上次定期檢查後使用時數	42:38
13	上次定期檢查後落地次數	23

機身		
No.	項目	內容
1	製造廠商	空中巴士 (AIR BUS)
2	機型	A330-342
3	出廠序號	121
4	製造年	1996
5	最大起飛重量	217,000 公斤

表 1.6-2 發動機基本資料

發動機		
No.	項目	內容
1	製造廠商	勞斯萊斯 (Rolls Royce)
2	型別	Trent 772-60
3	出廠序號	41057/41022
4	總使用時數	24943:39/30797:09

表 1.6-3 供氣系統元件基本資料

名稱	件號	序號	TSI (FH)	TSN (FH)	MTBF (FH)	安裝日期
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 維修紀錄

根據航空器維修紀錄簿 (Aircraft Maintenance Log)，摘錄有關本事故與事故發生前三個月之維修紀錄如附錄 2，摘要如下：

- 自 2008 年 7 月 29 日始有 “ENG 1 BLEED PRESSURE LOW” 重複性故障
- 自 2008 年 8 月 19 日始有 “ENG 1 BLEED NOT CLOSED” 重複性故障
- 2008 年 9 月 13 日自韓國仁川機場飛往香港航次，缺點為“AIR ENG BLEED

NOT CLOSED THIS TIME OCCURING DURING ENGINE WIND DOWN AFTER ENG MASTER SX'D OFF.”，維修動作爲“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.”該 MEL 36-11-02 如附錄 3。

- 該機依據 MEL 36-11-02 放飛後，繼續飛行 6 個航次（HKG-MNL-HKG-MNL-HKG-NRT-TPE）。根據飛機修護紀錄簿之記載，此 6 航次均非 ETOPS 飛行。
- 2008 年 9 月 14 日，事故發生後有關客艙缺點包括“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）”。

事故發生前之延遲改善缺點如附錄 4，在 9 月 13 日有關本案之延遲改善缺點爲 SADD617 “AIR ENG BLEED NOT CLOSED THIS TIME OCCURING DURING ENGINE WIND DOWN AFTER ENG MASTER SX'D OFF.”。

該機維修系統電腦具有記錄「目前航班維修報告（maintenance current flight report）」之功能，本航次（CX521）目前航班維修報告如附錄 5。此報告顯示該機在巡航時有“AIR ENG 2 BLEED FAULT”之故障，相關元件爲“THRM (5HA2) / FAN AIR-V”。

2 號發動機扇氣閥溫控器之主過濾器最近於 2008 年 7 月 19 日執行更換，該工作之維修紀錄如附件 14。

1.6.3 雙發動機供氣系統失效事件

根據國泰有關雙供氣系統失效（Dual Bleed Loss, DBL）之報告，事故航機第 1 次遭遇供氣系統失效的時間在 2008 年 4 月 10 日，該事件為在爬升至 11,000 呎時，2 號供氣系統失效，接著 1 號供氣系統也跟著失效。該機之 1 號發動機超壓閥（Overpressure Valve, OPV）及扇氣閥溫控器（FAV ThC）拆下後送至 Leiberherr 製造廠檢查，檢查結果發現溫控器之過濾器髒污阻塞，使得進入扇氣閥之控制壓力不足，無法開啓扇氣閥。當扇氣閥未開，使進入預冷器（precooler）之冷卻空氣不足，則來自發動機之熱空氣在無適當冷卻情況下，溫度愈來愈高，最後導致過熱（OVERTEMP），使供氣系統自動關閉。該檢查結果亦確認超壓閥（OPV）故障。

第 2 次失效事件發生在 2008 年 5 月 28 日，飛機在 1 號發動機供氣系統既已故障情況下，依據 MEL 規定放飛，在下降的過程中，2 號發動機供氣系統又因壓力過低而失效，事後檢查發現，1 號供氣系統之扇氣閥溫控器（FAV ThC）故障，2 號系統因調壓閥（PRV）故障造成失效。

第 3 次失效事件發生在 2008 年 6 月 13 日，在巡航時天氣為結冰的情況，發動機及機翼除冰系統皆啓動情況下，發生 2 套發動機供氣系統均失效情形，檢查發現 2 套供氣系統均因過熱造成失效。1 號發動機供氣系統是因為扇氣閥失效，2 號則是因為在扇氣閥及扇氣閥溫控器之間之偵測管路漏氣。

1.6.4 載重與平衡

本機之最大起飛重量為 217,000 公斤，最大落地重量為 179,000 公斤，最大零油重量為 169,000 公斤。該機於事故前之重心為 36.48% MAC (Mean Aerodynamics Chord)。表 1.6-4 為 CX521 該班次事故之載重與平衡相關資料，依 A330 機之 FCOM 資料，該型機之起飛、落地重心限制範圍為 15%至 41% MAC，飛航中之重心限制範圍為 14%至 42% MAC。

表 1.6-4 CX521 載重與平衡資料

零 油 重 量	138,881 公斤
起 飛 油 量	33,100 公斤
起 飛 重 量	171,839 公斤
起 飛 重 心 位 置	25.87% MAC
起 飛 中 消 耗 油 量	16,300 公斤
落 地 重 量	155,681 公斤

1.7 天氣資料

9 月 14 日民航局臺北航空氣象中心之颱風警報單顯示，1700 時至 2000 時輕度颱風辛樂克（Sinlaku）中心約於桃園國際機場北方 13 哩，向西北東轉東北方移動，其暴風半徑 60 哩，強度逐漸減弱。圖 1.7-1 為 1900 時紅外線衛星雲圖。

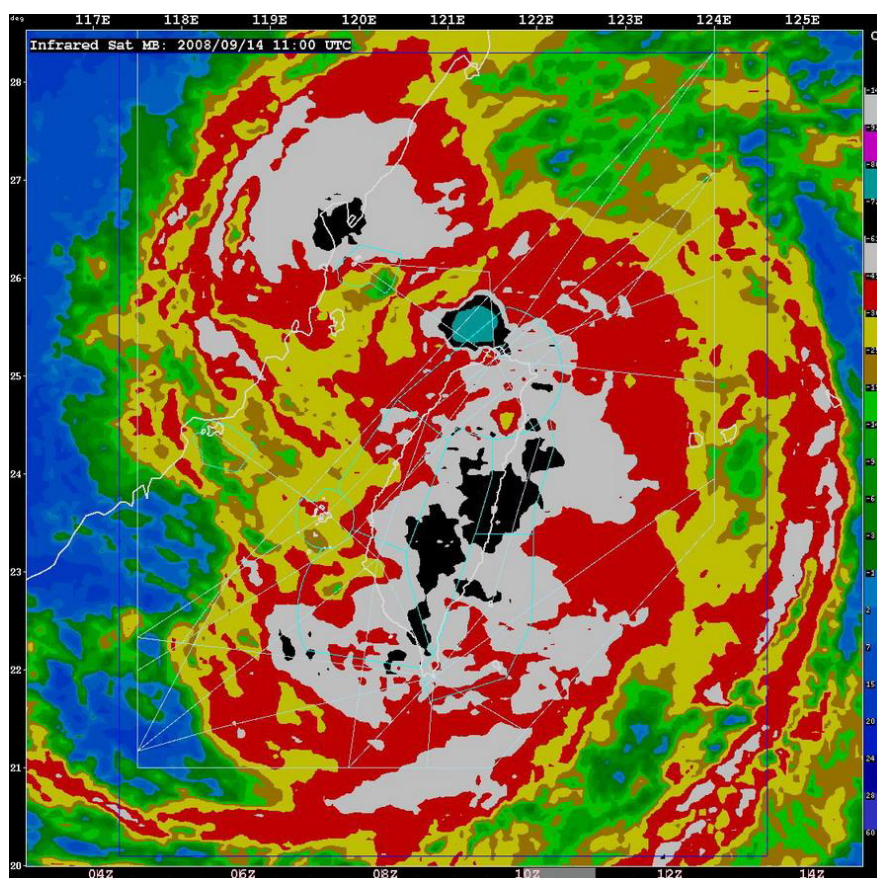


圖 1.7-1 1900 時之紅外線衛星雲圖

桃園機場 1930 時之例行天氣報告為：風向 220 度，風速 15 浬/時；能見度 4,500 公尺；陣雨；疏雲 500 呎、裂雲 1,000 呎、積雨雲稀雲 1,200 呎、裂雲 1,500 呎；溫度 26°C、露點 24°C；高度表撥定值 991 百帕；補充資料—23/24 號跑道有低空風切警示；趨勢預報—暫時性變動：能見度 2,000 公尺、陣雨；附註—積雨雲位於東邊至西南邊（ATIS B）。

1.18 助、導航設施

與本次事故無關。

1.9 通信

依據區管中心及近場臺之無線電通訊測試紀錄，事故當日之所有無線電波道（含 121.5 MHz 頻率之緊急波道），其通訊測試皆正常。

區管中心、近場臺及臺北機場管制臺（以下簡稱臺北塔臺）分別以 125.5、125.1/124.2 及 118.7/121.7 MHz 頻率與該機進行無線電通訊。

1.10 場站資料

與本事故無關。

1.11 飛航紀錄器

1.11.1 座艙語音紀錄器

該機裝置固態式座艙語音紀錄器（Solid-State Cockpit Voice Recorder, SSCVR），製造商為 Honeywell 公司，件號及序號分別為 980-6022-001 及 1562。所記錄之語音資料共 120 分鐘 55 秒（1823:59 時~2024:54 時⁷），下載情形正常，記錄品質良好。

⁷ 記錄時間為「UTC 時間」，臺北時間=UTC 時間+8 小時。

該具座艙語音紀錄器包含 4 軌錄音，聲源分別來自 CM1 員麥克風、CM2 員麥克風、座艙區域麥克風(CAM)及客艙廣播系統。CVR 抄件開始時間為 1854:14.4 時，即該機自高度 40,000 呎 (FL400) 開始下降高度，抄件結束時間為 1924:37.5 時，該機與臺北塔臺構成聯繫。抄件內容詳附錄 1。

1.11.2 飛航資料紀錄器

該機裝置固態式飛航資料紀錄器 (Solid-State Flight Data Recorder, SSFDR)，製造商為 Honeywell 公司，件號及序號分別為 9800-4700-003 及 1253。所記錄之飛航資料共 26.24 小時，下載情形正常，記錄品質良好。

本會依據取得之解讀文件⁸，該紀錄器之紀錄參數約 450 項，重要參數解讀結果詳附錄 6，解讀發現摘要如下：

1. 該型飛航資料紀錄器符合 ICAO Annex 6 “Type 1” 規範，滿足記錄 32 項必要紀錄參數。
2. 該機於 1614:04 起飛，SSFDR 持續記錄至 2222:05 (安全落地於桃園機場)。
3. 1855:46~1919:01 期間，該機之「Flow CTL Valve 1 disagree」及「Flow CTL Valve 2 disagree」紀錄均為「disagree」，標準氣壓高度由 38,544 呎降至 6,384 呎。
4. 1857:39~1857:42 期間，該機「Master Warning」作動，標準氣壓高度 30,064 呎、空速 311 浬時、磁航向 232 度。1857:39 時，IRU 經度/緯度紀錄為 N26.5136 度，E123.233 度，此位置位於 A1 航路距鞍部航點 (APU) 為 122 浬。
5. 1857:39~1912:23 期間，「Exceed Cabin Alt.」作動，標準氣壓高度由 30,064 呎降為 8,000 呎。

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

6. 1929:11 時，該機於桃園機場 24 跑道主輪著陸；1943:00 時，停止移動。

事故發生後，本會自國泰取得 QAR 原始資料及工程參數，摘錄艙壓高度（Cabin Altitude）及標準氣壓高度之變化如下：

1. 1640:11~1854:40 期間，艙壓高度均為 7,952 呎，標準氣壓高度紀錄約 40,000 呎。
2. 1857:39 時，「Exceed Cabin Alt.」作動，艙壓高度均為 9,680 呎。
3. 1854:41~1902:28 期間，艙壓高度增加至 13,424 呎，標準氣壓高度由 39,612 呎減為 13,512 呎。
4. 1902:29~1912:14 期間，艙壓高度由 13,424 呎降至 9,328 呎，標準氣壓高度由 13,464 呎減為 9,328 呎。

1.12 航空器殘骸與撞擊資料

與本事故無關。

1.13 醫學與病理

與本事故無關。

1.14 火災

與本次事故無關。

1.15 生還因素

11 位客艙組員的責任代碼及指定座位如後圖 1.15-1 所示。

1.15.1 客艙經歷

機長在飛行前簡報中向座艙長及客艙組員提及受颱風 Sinlaku 影響，抵達臺

北前預期會遭遇亂流，當時 CM1 即指示客艙組員在開始下降時確保乘客作好安全準備。依據客艙組員報告，開始下降前客艙安全準備已經完成，CM1 以廣播通知客艙組員回座前，所有客艙組員已回座，雖然有些顛簸但沒有預期嚴重。

專案調查小組無法確認氧氣面罩落下之確實時間，氧氣面罩落下後，隨後客艙燈光亮起，並啟動預錄英語、廣東語及日語發音之客艙廣播，告知乘客繫緊安全帶，戴上氧氣面罩。

氧氣面罩落下後，坐於 R4 門的 FP6 及 Y3 客艙組員注意到廚房區有塑膠燒焦味，FP6 於 1906:21 時即向駕駛員報告焦味並通知座艙長，座艙長要該員以嚴重程度 1-5 級評估此異味，5 級為最強，該員判斷此情況應為 4 級，在落地前，座艙長多次詢問該員異味狀況，直到落地該員均回覆異味持續，其他客艙組員亦注意到塑膠燒焦味及客艙溫度升高現象。

機長在 1911:16.3 時告知座艙長將在臺北緊急落地，並指示座艙長執行客艙準備。

依據座艙語音紀錄抄件，機長（正駕駛員）在 1911:38.4 時廣播告知乘客由於客艙失壓造成緊急下降，目前航機已降至安全高度，乘客可正常呼吸，並於 15 至 20 分鐘於桃園機場落地，CM1 廣播後隨即被譯成日語及粵語廣播，座艙長電告所有客艙組員進行緊急落地之客艙準備。

依據座艙語音紀錄抄件，機長於 1914:40 時向桃園機場要求緊急應變準備作業。

該機落地後脫離跑道，即停止於 SP 滑行道上，便於消防人員目視觀察是否有失火冒煙及損害狀況。

該機停於 SP 滑行道上時，CM2 受機長命令至客艙檢視 4 號門區的焦味狀況，CM2 確認其為氧氣瓶啓用後伴隨所造成的。

隨後該機滑入地勤支援人員待命的 B4 號停機坪，所有乘客由 1 號門正常下機，地面機務人員上機重新整備氧氣面罩作業。

1.15.2 乘客氧氣

在緊急情況時，乘客緊急氧氣系統提供乘客及客艙組員使用。乘客緊急氧氣系統主要包括分佈在乘客座椅上方、廁所、客艙組員座椅及廚房工作區之氧氣盒。每一個氧氣盒含一個化學氧氣產生器及兩個到四個不等之氧氣面罩。當客艙失壓時，氧氣面罩會自動落下。假如面罩未自動落下時，可以使用手動工具使面罩落下。

1.15.3 氧氣面罩

該機在此事故中，除了氧氣面罩外，沒有使用其它緊急裝備，59 位乘客啟動了 56 個氧氣面罩。依據客艙紀錄，數名乘客未戴氧氣面罩。在 11 位客艙組員中，有 8 位說氧氣面罩有掉下可用，其餘 3 位（ISM,FR2,J1）無氧氣面罩可用，8 位氧氣面罩正常掉落的客艙組員有 3 位（Y1,Y3,Y4）覺得氧氣面罩未能正常供氧，8 位氧氣面罩正常掉落的客艙組員僅有 3 位（J2,Y1,Y2）使用氧氣面罩，故無氧氣面罩可用。事故後經地面機務人員檢視發現因氧氣面罩蓋板卡住，造成氧氣面罩未能掉落。詳見表 1.15-1。

表 1.15-1 CX521 客艙組員氧氣面罩使用情況

客艙組員代碼	所在客艙位置	面罩是否掉下	面罩是否被使用(拉下)	氧氣瓶是否啟動化學反應供氧	客艙組員描述
ISM	L1	否	否	否	面板僅輕微開啓
SP2	L2	是	未用	否	該狀況不覺得需要使用氧氣面罩
FP2	R1	否	否	否	面板僅輕微開啓
FP5	R2	是	否	否	該狀況不覺得需要使用氧氣面罩

FP6	R4	是	否	是	僅覺得有小的氧氣流量，另一個面罩掉落地板。
J1	L1A1	否	否	否	面板僅輕微開啓
J2	L1A2	是	是	否	面罩正常
Y1	R3	是	是	是	不覺得面罩有在供氧
Y2	L3	是	是	是	僅覺得有小的氧氣流量，持續 10 秒
Y3	R4A	是	否	是	兩個面罩均無氧氣供應
Y4	L4	是	否	是	無氧氣氣流

圖 1.15-1 顯示客艙配置及氧氣面罩使用情形，包含所有乘客座位、已啓動的氧氣瓶、組員代碼及座位及未落下的氧氣面罩位置之分佈。

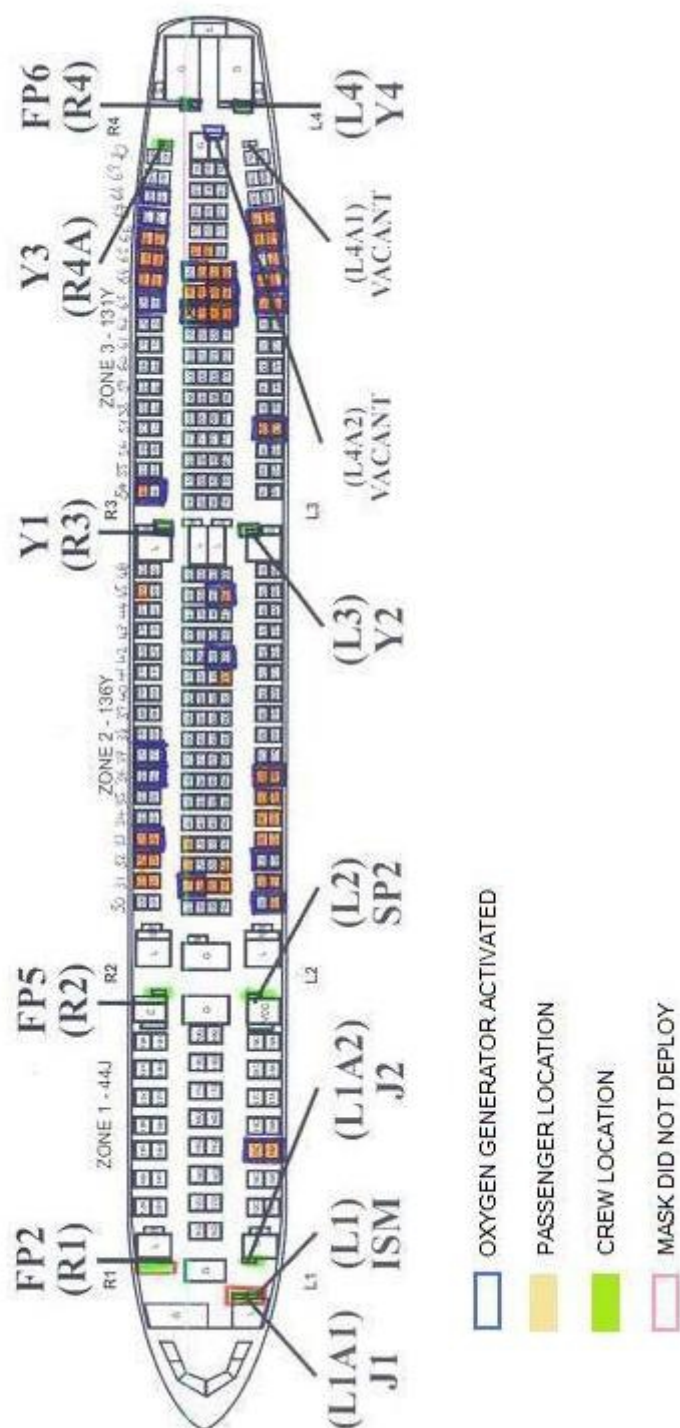


圖 1.15-1 1900 客艙配置及氧氣面罩使用情形位置分佈圖

1.15.4 客艙組員訓練

檢視所有客艙組員均已完成年度複訓課程，最後一次緊急失壓應變作業課程亦包括緊急失壓應變。

1.15.5 機場緊急應變作業

根據機場消防隊日誌，機場航務組約於 1919 時通知消防隊，CX521 客艙失壓將於 24 號跑道落地，消防隊隨即通知南站分隊、西站分隊及東站分隊，隨後約於 1924 時，15 輛消防車輛抵達 608 機坪、S2 滑行道、北站分隊及 N6 滑行道待命點待命，該機於 1928 時於 24 號跑道落地後，其中 3 輛消防車跟隨該機，在 SP 滑行道及 B3 機坪間目視觀察該機狀況，確定該機安全無虞後，消防車約於 1945 時返回各分站。

1.16 測試與研究

1.16.1 艙壓洩漏速率

事故發生後，國泰維修人員於桃園航空站執行該機艙壓洩漏速率 (Leak rate) 測試，於 2008 年 9 月 14 日之航空器維修紀錄簿登錄 “TEST C/OUT IAW AMM 05-53-00-780-803-01 TEST SATIS A/L LEAK RATE APPROX 0.8 PSI/MIN”，顯示該測試結果符合航空器維修手冊的規範。

1.16.2 元件測試

於 2008 年 9 月 14 日，國泰維修人員於桃園航空站拆下 1 號發動機調壓閥 (bleed air valve 或 pressure regulator valve, PRV)，2 號發動機之扇氣閥 (fan air valve, FAV) 及扇氣閥溫控器 (thermostat, FAV ThC)。拆下來的元件送往法國吐魯斯之製造廠 “Liebherr-Aerospace” 進行測試。於 2008 年 10 月 22 日由製造廠依據元件維修手冊進行測試，參與者包括法國失事調查局、國泰、空中巴士設計部門及顧客服務部門之代表。詳細測試報告如附錄 7，各元件測試結果摘要如下：

扇氣閥溫控器 (FAV ThC) 測試報告摘要

ThC 基本資料如下：件號：398E020000、序號：00163、組合日期：05/1994、TSI 10,145 飛時、TSN 31,547 飛時。目視檢查無異常發現，根據元件維修手冊 (Component Mainenance Manual, CMM) 36-11-35 執行完整的 GO / NOGO 測試。在供氣溫度為 205°C 及壓力為 3 Bar 情況下。其減少的壓力 (reduced pressure) 為 266 mbar，不符 CMM 的規範 (300±20 mbar)。拆下主要過濾器進行測試，其滲透檢查為 20 mbar，小於允許之最大值 100 mbar，表示該主過濾器為乾淨的。

進一步檢查其網狀過濾器 (grid filter)，發現明顯污染。測試小組刺破該受污染的網狀過濾器，以檢查整個 ThC 的性能。在同樣的測試條件，其減少的壓力為 317 mbar，此數值符合 CMM 的規範。

測試結果：在標準的測試條件下，此測試顯示網狀過濾器減少的壓力低於規範，確認 ThC 之故障是因為網狀過濾器遭受污染，使壓力 (推動扇氣閥之壓力) 減少至低於正常範圍，使扇氣閥無法至全開的位置，造成 2 號發動機供氣系統過熱情況；網狀過濾器之污染來自於正常工作時經過主過濾器時之大氣。

扇氣閥 (FAV) 測試報告摘要

FAV 基本資料如下：件號：6733A030000、序號：00156、組合日期：10/1994、TSI 17,305 飛時、TSN 25,203 飛時。目視外部檢查發現明顯的污染，根據元件維修手冊 36-11-24 執行完整的 GO / NOGO 測試，通過氣動測試 (pneumatic test)，測試發現在開關連桿與連桿之間的磨耗，使氣閥在關閉時沒有顯示，空中巴士公司解釋此問題只有在供氣溫度過低時才会有影響。

測試結果：扇氣閥功能與造成 2 號發動機供氣系統過熱情況無關。

調壓閥 (PRV) 測試報告摘要

PRV 基本資料如下：件號：6764B040000 Admit a、序號：00573、組合日期：

12/1999、TSI 7,895 飛時。目視檢查無異常發現，根據元件修護手冊 36-22-35 執行完整的動態測試，測試顯示氣閥關閉的時間會有小幅延遲，壓力調整亦微幅增加，在低壓條件時（2 bars），關閉指示時間為 3.1 秒，壓力調節為 3.636 bar，比 CMM 規範之最大時間 3 秒及最大調節壓力 3.6bar 略高，製造廠認為如此差異非常微小，為了檢視關閉指示的問題，另使用靜態測試發現，開關的初始設定可能會影響關閉的指示時間。

空中巴士說明，系統設定觸發『BLEED NOT CLOSED』訊息的時間是 10 秒，靜態測試亦發現氣閥有外部漏氣及活塞漏氣的問題，是因為碳封（carbon seal）磨耗，以致壓力調節受到影響。拆解檢查發現活塞有腐蝕痕跡，可能影響活塞氣密，這些腐蝕可能因亞洲潮濕的環境所引起。

測試結果：調壓閥的功能與 1 號發動機供氣系統『BLEED NOT CLOSED』的訊息無關。

1.16.3 乘客氧氣面罩落下測試

事故班機在緊急下降時，客艙氧氣面罩被啟動落下，所有乘客及客艙組員的位置除 L1 及 R1 門邊之客艙組員氧氣面罩未落下外，其餘氧氣面罩均落下。根據航空器修護手冊 AMM 35-21-00，執行該機氧氣面罩落下測試，發現有問題的氧氣面罩蓋板因受到相鄰的蓋板之妨礙，而無法順利落下。

為了解其他同型機隊客艙氧氣面罩落下情況，國泰技術服務部門根據 AMM 35-23-00-720-059，設計特別的工單『SWC-17585』，在駕駛艙內使用手動方式啟動『MASK MAN ON』開關，測試客艙氧氣面罩落下功能。2009 年 3 月 27 日實施測試時，使用註冊編號 B-HLI，機型 A330-342 之同型機，由地面電源供電，未使用輔助動力單元（Auxiliary Power Unit, APU），根據工單 SWC-17585，在香港特別行政區政府民航處（CAD）資深適航檢查員及國泰技術服務工程師觀察下執行該項測試。該測試在按下『MASK MAN ON』開關時，所有客艙氧氣面罩蓋板

均正常落下，一一檢查所有乘客及座艙組員位置的氧氣面罩蓋板，均落下，同時緊急客艙廣播在測試時亦自動啟動。

抽樣檢查機隊 20% 的同型機客艙氧氣面罩落下情形，結果均為正常。

1.17 組織與管理

無相關。

1.18 其他資料

1.18.1 飛航組員訪談資料

1.18.1.1 正駕駛員

CM1 表示該機原計劃由成田機場飛往香港，因當地有颱風影響而改飛臺北。於成田回頭之準備過程正常，地面檢查時獲知該機之 1 號發動機供氣閥（Bleed Valve）失效，依據 Minimum Equipment List（MEL）之程序完成檢查放飛。起飛、爬升及巡航都很正常，於 4 萬呎巡航與臺北區管中心取得聯繫，獲准下降保持 FL140，進場落地資訊為 24 跑道。因天候不佳，於下降前曾提醒乘客坐妥及繫安全帶。

當飛機通過 FL370 時，發現 ECAM 先後出現#1 及#2 兩具發動機供氣閥均失效之訊息，將相關艙壓頁次選出，檢視後發現艙壓高度有上升之異常現象，該訊息與 ECAM 顯示相符，於是決定增加下降率，快速下降航機。此時座艙出現警告訊息，ECAM 顯示緊急下降指示訊息，於是戴上氧氣面罩，依照緊急下降程序下降航機至已獲准之 FL140，同時呼叫 Mayday。初始下降時之下降率約為 5,000 FPM 至 6,000 FPM。

當航機高度到達 FL150 時，請求繼續下降至 FL100 獲准，並獲告知於 24 跑道落地，於航機下降過程中告知 ATC 需要地面緊急支援並需於落地脫離跑道後立即停機。飛機落地後停機於滑行道處約 2 分鐘以檢查飛機狀態，經確認無問題後

始滑回停機坪。航路及下降過程中天氣不良，全程下大雨並有中度亂流，為預期現象，所以告知機上全員均坐於座位上並繫妥安全帶。

於檢查艙壓頁次時，發現艙壓高度上升率為 1,000 FPM，於檢查過程中其上升速度增加並發現艙壓與大氣差壓下掉，艙壓高度增加至 9 仟至 1 萬呎，差壓並持續下掉，因而確認係艙壓異常。

本次飛航係由 CM2 擔任操控駕駛員，CM1 擔任監控駕駛員並負責執行相關艙壓檢查程序及無線電通聯，於落地階段始由 CM1 接手。於下降過程中曾向東偏離 A1 航路約 5 哩與航路平行飛航，並曾以無線電發佈緊急情況。於緊急下降中曾檢查客艙中之氧氣開關，確認當時氧氣開關為開啓，客艙氧氣面罩為手動落下之狀態。緊急下降時減速板位於放出位置，約保持 300 哩／時之速度，該外型之速限為 330 哩／時。於下降過程中於完成緊急程序後曾檢視艙壓系統並嘗試重置（Reset）動作但未成功，之後於約高度 8 千呎時重置成功。

於飛行前已獲悉 1 號發動機供氣閥失效，因屬次要問題且符合派飛規定，飛航操作相關程序是確定要將 1 號發動機之供氣閥置於“Off”位置並將 Cross Bleed 開關置於“Open”位置，有關詳細之程序及細節於提示中均已述及。

有關申請地面緊急支援之原因，係因後艙組員報告，於客艙中有類似冒煙之味道，為防萬一，所以請求地面緊急支援。

1.18.1.2 副駕駛員

CM2 表示該機 1 號發動機供氣閥失效，依據 Minimum Equipment List (MEL) 程序完成檢查放飛，飛航過程正常，直至由 FL400 下降至 FL370 時，於 ECAM 發現兩具發動機供氣異常訊息，其中 1 號發動機供氣閥失效係為已知之故障，經檢查艙壓顯示，發現艙壓高度上升，艙壓下降。

CM2 擔任 PF 職責，因飛機處於下降過程，所以當艙壓警告出現並於 ECAM 顯示緊急下降程序時，僅將下降率由約 1,000 FPM 增加至約 6,000 FPM，同時將

客艙氧氣面罩開關置於放下位置，持續注意艙壓之變化，並確認客艙氧氣面罩已下掉。

CM2 操控飛機偏離航路，並與航路平行飛航，聽見 CM1 連續向航管呼叫 Mayday，最後獲得許可下降至 1 萬呎。於下降至 1 萬呎以下時已完成緊急程序，落地過程中一切正常。

CM2 表示因其於緊急下降過程中專注於操控飛機，並未注意期間相關艙壓及系統之變化，僅知 CM1 曾嘗試重置系統 2 次，並不知是否重置成功。CM2 表示於執行任務前 72 小時休假，並未服用任何藥物。

飛航組員曾於落地前因後艙組員報告有燃燒之煙味而申請緊急地面支援，落地後停機於滑行道上，CM2 至後艙觀察並未發現異狀，認為該煙味可能係氧氣致動器因製造氧氣而產生之怪味。

1.18.2 航管人員訪談資料

1.18.2.1 臺北區域管制中心北部管制區雷達席管制員

此次值班時間由 1300 時至 2100 時，依輪值表每做一小時即休息半小時之作業模式，1830 時前在西部席，1830 時至 1900 時休息，1900 時後值北部席。1858 時上席位時與前一位管制員交接，狀況正常，當時的飛機不多，大約有 5 架，前一位管制員許可 CX521 下降至 FL140。約 1900 時接班後只有給另一架航機下降指示，尚未與 CX521 通聯，便接到近場臺經由 Hot line 通知 CX521 emergency descend。當時管制區有雷達席及資料席，得知該機有狀況，協調員及督導均至北部席協助處理，與近場臺協調後，同意近場臺許可 CX521 下降至 10,000 呎。

協調員請近場臺指示該機將無線電切換回區管中心，試圖問該機發生什麼狀況，能提供什麼協助，但是無線電雜音很大，好幾個人在聽，但是都聽不出來，所以經過協調員及督導協調，在無其他相關航情的狀況下，提早把它換到近場臺，因為近場臺的通話品質較好，請近場臺做進一步處理。

該機駕駛員說話的時候雜音很大，後來與其他航機通話是清楚的。一般若遇到此種狀況時，會請駕駛員重講一次或換備用波道，此次未換備用波道係因該機已漸接近場臺管制空域，而且是要落地的飛機，換到近場臺的波道，請他們抄收比較恰當。

依據規定，每天早班的管制員於早班的時段內，都會依據無線電通訊測試紀錄表，測試無線電每個波道與收訊狀況，管制員在晚上交接時並不需要測試。121.5 MHz 緊急波道是在喇叭播放的位置，正常狀況可從喇叭聽得到，當時並沒有聽到該機由 121.5 MHz 呼叫。

1.18.2.2 臺北區域管制中心北部管制區航路協調席管制員

當天上班時間為 1300 時至 2100 時，白天協調席有 2 個席位，各負責 2 個管制區，1900 時協調席只有 1 個席位，負責東、西、南、北 4 個管制區，協調席沒有表定的休息時間，要自己找時間用餐及休息。該協調員在 1900 時之前負責西、南 2 個管制區，約 1857 時與另一位協調員交接，他告訴該協調員北部管制區的飛機會偏航，但是沒有其他要注意的事情。該協調員原先在西部管制區監看雷達席交接，約 1900 時至北部管制區，當時北部管制區飛機不多，雷達幕上只有 4、5 架飛機，只是因為颱風偏航。

近場臺電話通知該機無線電波道切換到他們波道時，才知道 CX521 呼叫 Mayday，最初電話是北部管制區資料席接的，該協調員並沒有聽到內容。因為這架飛機是在區管的空域換錯波道，而且一般和近場臺是在距鞍部 40 浬的位置交接飛機（23／24 跑道落地的飛機，交接高度為 14,000 呎；05／06 跑道為 20,000 呎），這架飛機約在鞍部東北 90 浬的位置，近場臺雷達看不到，而在區管管制下有雷達服務，便請近場臺將該機無線電波道轉回區管。無線電波道換回來後確認該機的呼號和狀況，想了解有什麼需求，但是該機說 unstable 或 standby，便不再詢問，以不妨礙該機操作。之後便通知近場臺，請他們提早接手，早做處置，再問該機有什麼需求及問題。後來該機在距鞍部約 60 浬、高度 10,000 呎，區管和近場臺

做雷達的自動交接(那個位置近場臺雷達可看到 CX521)，看到該機接過去以後，區管就換無線電波道。

另外，因為當時是在交接期間，又曾問北部席有沒有換錯無線電波道，該協調員不清楚 CX521 在 Guard 波道有沒有呼叫。在與該機通話時，該機的聲音不清楚，認為是該機駕駛員在做一些處置，講話有一點模糊，不一定是無線電不好，但因為該協調員大部分的時間是在和近場臺做協調，無線電聽得不多。

1.18.2.3 臺北近場管制塔臺桃南席雷達席管制員 1

當天值班時間由 0800 時至 1900 時，1800 時至 1830 時休息，1830 時後在桃南席，協調員在旁邊監聽。當時沒有很多架飛機，但因為都在躲天氣，所以很忙。正要與下一位管制員交接前，給另一班機準備轉五邊發進場時，聽到很微弱的 Mayday Mayday Mayday…，剛開始該管制員以為是無線電串音，又因為當時大部分的注意力在國泰 531 上面，因為呼號很類似，就想到是不是國泰 531 在宣告緊急狀況 (declare emergency)，便詢問國泰 531 的駕駛員，他覺得很奇怪為什麼會問他這個問題，他說沒有 declare emergency，該管制員就繼續發給他進場許可，他當時距離機場約 15 哩，高度 4、5 千呎。後來 CX521 再呼叫，但是當時颱風剛過，很多飛機都在躲天氣，該管制員的注意力都在如何安排飛機的順序，認為 CX521 不是範圍內該管到的飛機，就不是很認真的在聽，只是知道有一架飛機換錯無線電波道或串音過來。那時候在旁監聽的協調員也聽到了，協調員就想到是不是別的單位或其他地方的飛機，後來該機在緊急波道也有講國泰 521，協調員也有聽到，便更懷疑，問區管北部是否有這一架國泰 521 的飛機，最後澄清 521 是區管中心的飛機。

隨後完成交接，該管制員下席位準備下班，協調員請他在後面等一下，可能有緊急的狀況會出現。後來督導就請他幫忙另開一個波道 (124.2 MHz) 專門管制國泰 521，他就等待協調員與區管中心協調，之後區管中心交接給他，接手後一開始好幾次都沒有呼叫到該機，後來才聯絡上。該管制員用專門波道管制國泰

521 前，並沒有人告訴他 521 是什麼原因叫 Mayday。

1.18.2.4 臺北近場管制塔臺桃南席雷達席管制員 2

當天剛上班，值班時間由 1900 時至隔天 0800 時。約於 1856 至 57 時交接，交接很複雜，花了很多時間。那時辛樂克颱風剛過，很多飛機從香港進來，同時管制超過 6、7 架飛機。而且當時天氣很不好，很多飛機都不在既定的航線上，再繞回來原來航線，所以通話量非常大，有時講一句話就被別人卡住，一個許可要發 2、3 次。

尚未交接完 CX521 就呼叫進來，當時不確定他是誰，因為那個呼號聽起來很像是他們手上一架飛機的呼號（CX531），但是又不像，因為 CX531 在雷達幕已經 5,000 呎，不需要做緊急下降，便重新發了一次 CX531 的進場許可。後來一聽到呼叫 Mayday，他們就跟旁邊的督導說有航機宣告緊急，其他人就開始幫忙處理，他們再繼續管制其它飛機。後來確認該機並不是他們空域內的飛機，督導說該機距離還有一百多呎（當時近場臺雷達幕的顯示半徑為 60 呎）。因為當時是用 23、24 跑道，陽明山比較高，飛機接近五邊都有接近地障的問題，所以那裡的空間不是很大。當時無線電很擁擠，該機一插進來他們有能力就去回應它，因為航管最大的目的是要做隔離，該機請求下降時，該管制員不知道它在哪裡，是哪一架？所以沒有把握在第一時間就同意它，不敢直接發許可，這個部份是由督導和區管中心去協調的，督導說下一萬，該管制員就直接頒發下降至一萬呎之許可。

該管制員當時忙到沒有時間去收集該機的資料，所有相關的指示都是督導先做協調，再請他發出去。在該機發出請求時，他希望能先了解該機的位置，但駕駛員應該很忙，沒有時間報出來，督導就要他請該機無線電波道換回 125.5 MHz。後來該機又自己回來，因為他手上飛機很多，並不清楚中間的過程。

後來過了 8、9 分鐘，該機已經在一萬呎高度平飛一段時間，該管制員手上的飛機也紓解到一定程度，比較有機會去和該機做較長的溝通，那時請該機報告距

離鞍部的位置，當駕駛員報出湮數時，航機剛好從雷達螢幕邊緣出現，他便依照位置報告識別這架飛機，區管中心並沒有做雷達交接，他認為應該是督導和區管中心協調交接。識別之後該機要求要落桃園，便問該機要用那一條跑道，接著督導就要求他換給另外一個臨時加開的席位（124.2 波道）去管，之後便沒有再經手。

當他在管制該機時，無線電通話品質很不好，聽不清楚，而且該機的呼號一直不明顯，一下說 cathay five two one，一下說 Mayday five two one，一直交錯使用，所以當下無法立即知道該機是誰，確切呼號不太能掌握到。他認為駕駛員當時應該是戴氧氣面罩，聲音聽起來也是朦朧的，跟平常很清晰的音質不一樣。

1.18.2.5 臺北近場管制塔臺督導

當天是星期天，席位沒有全開，較基本人力少兩個人，桃南席飛機多了，便請松山席幫桃南席代管一些飛機（當時松山機場尚未開放），剛進來的飛機由松山席代管，沒問題後再給桃南席帶五邊進去，所以是 2 個人在管一個席位，事件發生時是晚班和日班要交接的時候，航情算是中上，在控制之內。

當 CX521 由桃南席 125.1 波道呼叫的時候，該機講得很不清楚，只講「臺北」「臺北」，他們不知道該機在呼叫哪個單位，因為 Taipei Approach 和 Taipei Control 都叫做「臺北」。該機的呼號講得很清楚，但是管制員沒有在管這一架飛機，該機突然呼叫進來的時候第一位管制員在帶五邊（CX531），覺得呼號很接近，而且當時有好幾架國泰，就問國泰 531 是不是在呼叫第一位管制員，後來國泰 531 說不是，就認為是串音，所以再來就沒有回答該機。

後來該機又呼叫進來，他們就覺得奇怪，便看管制條，才知道後面有一架國泰 521 要進來。但是 CX521 在區管中心手上，因為時間還沒到，根本就不會給近場臺管制，便問區管中心北部管制區是什麼情況，為什麼沒有聯絡他們就把飛機交過來，因為都是做雷達交接，但那個時候沒有做雷達交接飛機就跳進來了，區

管中心也搞不清楚狀況。

CX521 要求緊急下降，他們就和區管中心北部管制區協調，讓該機下降到一萬呎。後來區管中心要求換回區管波道，但是換回去後好像聯絡不順暢，又要求換到近場臺，該督導要求換到 124.2，但是中心傳遞訊息沒有聯絡好，CX521 又回到 125.1。當時在 124.2 的管制員已經就位，用雷達系統交接的方式將 CX521 由區管中心交接進來，但是 CX521 換錯波道至 125.1，所以 125.1 的管制員就覺得很奇怪，沒有交接就把波道換給他，當時 125.1 的管制員比較忙，帶很多飛機轉五邊又要躲天氣，又因為沒有交接動作，所以問飛機的位置在哪裡，重新雷達識別 CX521 就會比較慢一點。

後來他要求 125.1 的管制員指示該機再換波道至 124.2，換至 124.2 後他們就問該機狀況及需求，是否需要地面支援。另外該機要用的跑道，前面還有很多架飛機，本來請該機調整速度慢一點進場，後來將其它飛機引導至其它跑道落地，提高該機的進場順位。另外，不知是什麼原因，該機駕駛員無線電的聲音一直是忽大忽小，不容易聽清楚。

1.18.3 通聯時間序

本次事故航機與航管通聯順序係綜合訪談紀錄、航管錄音紀錄及座艙資料紀錄器之內容說明如下：

- 飛航組員於飛航前已知該機之 1 號發動機供氣閥依據 MEL 關閉及鎖死。
- 1614:04：該班次飛機起飛。
- 1847:42：該機向 TACC 報到接受管制。
- 1852:32：TACC 許可該機下降至 FL140。
- 1854:14：CX521 CM2 呼叫開始下降至 FL140。

- 1854:21 至 1856:06：該機下降率約保持在 1,000 FPM。TACC 許可 CI5213 直飛 Grace。CX521 CM1 複頌許可 CX521 直飛 Drake，TACC 告知其係呼叫 CI5213。
- 1855:46：於高度 38,544 呎時，Flow CTL valve #1 and #2 顯示 “disagree”（FDR 資料）。
- 1856:05：CX521 CM1 呼叫 “air engine two bleed fault” 經 CM1 證實。
- 1856:14：飛航組員發現艙壓高度上升而決定快速下降。
- 1856:17 至 1856:39：飛機下降率變化為 2,016 FPM 至 5,116 FPM。
- 1856:42：TACC 指示 CI5321 轉換至臺北近場臺波道 125.1。
- 1856:48：CX521 CM1 回答 “one two five one bye bye”，當時下降率為 -6,016 FPM。
- 1857:01 至 1057:33：飛航組員討論供氣閥之失效資訊，CM1 建議減低下降率。
- 1857:22：飛機下降率為 8,416 FPM。
- 1857:39：於 FL300 時，座艙出現主警告（“Master Warning”）及 “EXCESS CAB ALT” 資訊，下降率為 5,152 FPM。飛機位於 A1 航路上，距鞍部北面約 122 哩。
- 1857:40：CX521 CM1 呼叫 “okay emergency sounds”。
- 1858:00：CX521 CM1 使用 125.1 呼叫 “mayday, mayday, mayday” 並告知該機正緊急下降中。
- 1858:14：臺北近場臺回答：“Cathay five three one confirm mayday”。

- 1858:18 至 1859:04：飛航組員執行緊急下降程序。
- 1859:13：CX521 CM1 再度使用 125.1 呼叫 mayday。
- 1859:34：臺北近場臺確認 CX521 機使用之波道為 125.1。
- 1859:55：於 FL200 時 CX521 CM1 使用 121.5(Guard 波道)呼叫 Mayday。
- 1859:56：臺北近場臺使用電話告知 TACC 北區管制席：CX521 使用近場臺波道（125.1）及緊急波道呼叫 Mayday。
- 1900:20：TACC 企圖與 CX521 構聯。
- 1900:59：CX521 CM1 使用 125.1 請求繼續下降。
- 1901:04：臺北近場臺請 CX521 報位置。
- 1901:12：CX521 CM1 回答通過 FL140 請求繼續下降。
- 1901:28：臺北近場臺以電話聯繫 TACC 請求同意 CX521 繼續下降至 1 萬呎。
- 1901:50：臺北近場臺同意 CX521 下降至 FL100。
- 1903:03：TACC 以電話通知臺北近場臺轉告 CX521 換回由 TACC 管制。
- 1903:13：臺北近場臺告知 CX521 將波道換回至 125.5。
- 1904:46：飛機到達飛航空層 FL100。
- 1905:43：因無線電雜訊，TACC 無法與 CX521 清楚通聯，而與臺北近場臺協調使用 124.2 波道與 CX521 通聯，並提早將 CX521 交予臺北近場臺管制。
- 1906:21：CX521 後艙組員報告客艙有燒焦味。
- 1907:03：CX521 CM1 請求許可優先落地。
- 1907:26：雷達交接程序完成。

- 1907:38：TACC 北區管制席指示 CX521 變更波道為 125.1 交由臺北近場臺管制。
- 1907:48：CX521 更換波道至 125.1。
- 1907:52：TACC 北區管制席更改指令，要求 CX521 更換波道 124.2，但未獲回應。
- 1908:00：TACC 電話告知臺北近場臺 CX521 在 125.1 波道。
- 1908:14：CX521 CM1 請求優先落地。
- 1908:49：CX521 CM1 報告其位於鞍部北面 62 哩。
- 1910:09：臺北近場臺許可 CX521 下降至 8,000 呎。
- 1911:14：臺北近場臺指示 CX521 更換波道至 124.2。
- 1912:23：座艙內“EXCESS CAB ALT”之顯示消除。
- 1919:00：於 6,392 呎時，Flow CTL valve #1 and #2 顯示“not D/A”（FDR 資料）。
- 1919:14：CM1 嘗試重置供氣閥之開關。
- 1919:20：CM1 報告 2 號供氣閥恢復正常。
- 1923:02：臺北近場臺指示 CX521 與塔臺連絡。
- 1929:17：飛機於桃園國際機場 24 跑道落地。

1.18.4 臺北區域管制中心與臺北近場管制塔臺之管制空域、交接點及事件發生時之雷達交接過程

依據臺北飛航情報區飛航指南，臺北區域管制中心北部管制區劃分及高度(下 / 上限)為：244600N 1240000E、243900N 1213400E、250000N 1212500E、260000N 1200000E 4 點連線範圍以北（除終端管制空域外），高度 1,200 FT AGL 以上；臺北終端管制區域劃分及高度（下 / 上限）為：自鞍部多向導航臺 005 輻向，與以松山機場為中心，40NM 為半徑弧線之交叉點開始，沿該弧線順時針方向至鞍部多向導航臺 205 輻向與該弧線之交叉點連接至 2422N 12100E，再連接至 2448N 12025E，然後再連接至開始點，高度為 FL200（含） / 1200FT AGL（含）之間，詳圖 1.18-1。

CX521 為至桃園機場之到場航空器，依臺北區域管制中心與臺北近場管制塔臺之工作協議書及離到場航空器協調程序，A1 航路雷達交接參考點為 AN 定位點（APU 052R / 36DME），鞍部多向導航臺 052 輻向 36 浬；使用 23/24 跑道之交接高度為 FL140。

依飛航管理程序 5-4-5 節管制員之交接，交管管制員在航空器進入接管管制員空域前，應完成雷達交接；並依照「無線電通信轉換規定」，在完成雷達識別交接後，儘早通信交接。

由區管中心及近場臺雷達螢幕顯示紀錄，1907:05 時區管中心利用航管自動化系統開始實施該機之雷達交接，並於 1907:26 時區管中心與近場臺完成雷達交接，當時該機距離鞍部約 71 浬、高度 10,000 呎。於 1907:38 時，區管中心指示該機轉換波道至近場臺。

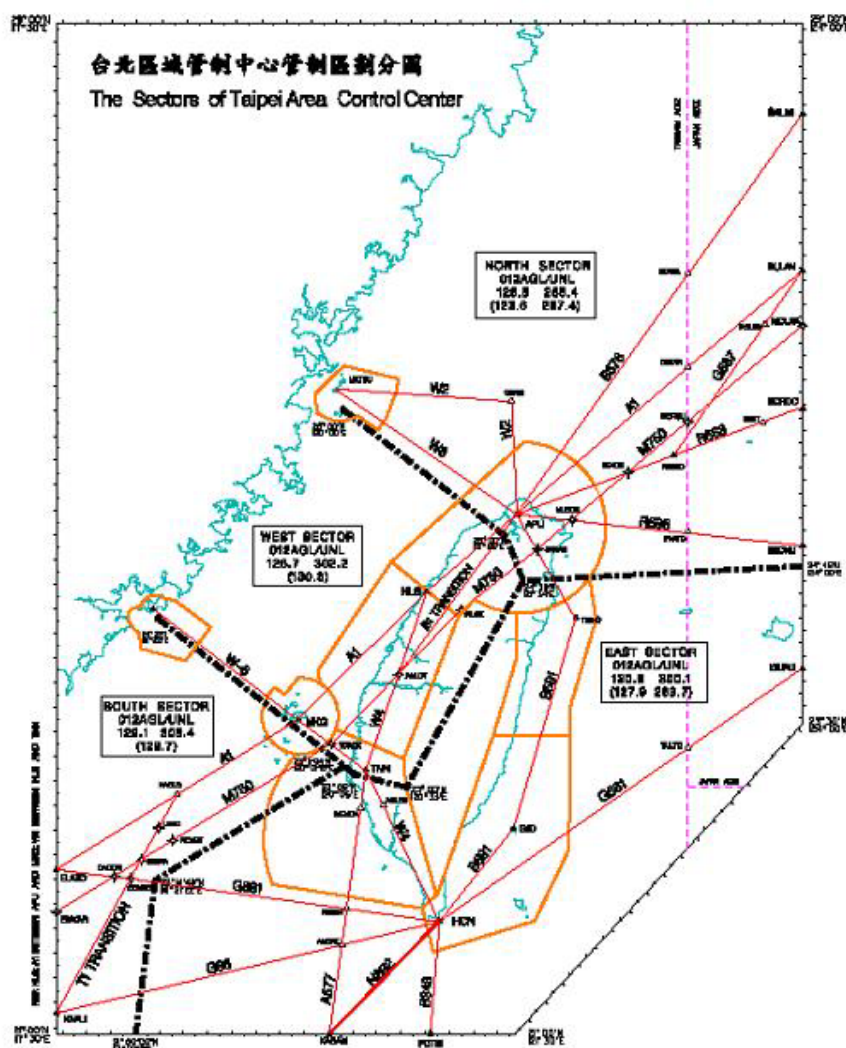


圖 1.18-1 臺北區域管制中心與臺北近場管制塔臺管制空域劃分圖

1.18.5 A330 型機氣動力系統

根據 A330 型機維修手冊，Chapter 36-00-00 PNEUMATIC—GENERAL—DESCRIPTION AND OPERATION，相關原文摘錄如下：

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. (系統概要圖參考圖 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).*

根據 A330 航空器維修手冊，Chapter 36-11-00 ENGINE BLEED AIR SUPPLY SYSTEM—DESCRIPTION AND OPERATION，相關原文摘錄如下：

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. System description: 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°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°C. A second level of control at 150°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.

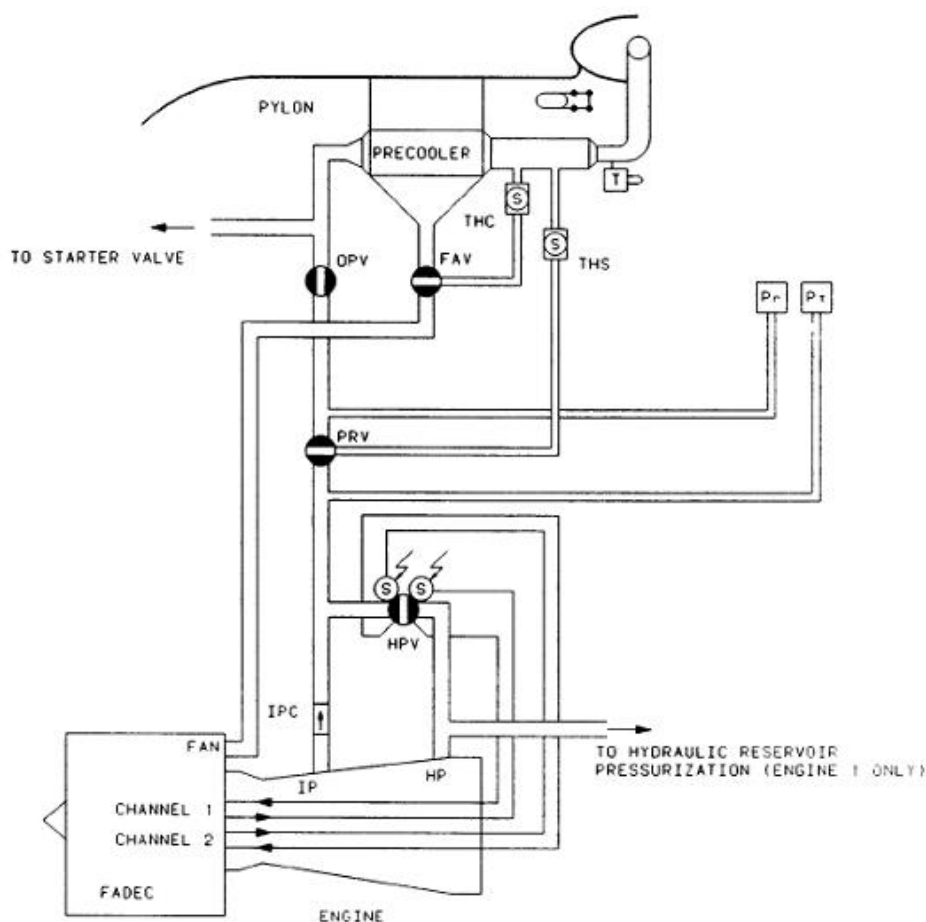


圖 1.18-2 A330 FCOM 供氣系統示意圖

1.18.6 A330 型機空調及客艙加壓系統

根據 A330 型機維修手冊，Chapter 21-00-00，相關原文摘錄如下：

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 扇氣閥溫度控制器之過濾器清潔與更換

為增進發動機供氣系統之可靠度，空中巴士飛機製造廠於 2004 年 6 月 28 日發布一份與扇氣閥溫控器 (ThC) 有關之服務資訊信函 (Service Information Letter,

SIL) 編號 36-055。2006 年 11 月 15 日發佈更新版 (REV 01)，如附錄 8。引述該信函之說明如下：

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.

本事故發生前國泰工程部門即已審視該濾網清潔的需求，依空中巴士維修計畫文件 (Maintenance Planning Document, MPD) 之要求，每隔 6,000 飛時必須清潔濾網；參考上述之服務資訊信函 (SIL 36-055)，國泰認為實務上須要更換該濾網，而不僅是清潔而已。扇氣閥溫控器之濾網清潔原本為 1C (週期 15 個月) 之定檢項目，國泰 A330 型機隊平均每天約使用 11 飛行小時，每隔約 9 個月均會清潔該濾網。審視國泰計畫每隔 3,000 飛時拆下並更換所有的扇氣閥溫控器之主濾網。於 2008 年 7 月底前，共已更換 38 個主濾網。事故班機之主濾網屬每隔 3,000 飛時均拆下並更換計畫項目，最近一次更換時間為 2008 年 7 月 19 日，該維修紀錄如 1.6.2 為所述。

事故後，國泰工程部門做了一次扇氣閥溫控器之元件可靠度分析 (component reliability analysis)，該分析顯示如果以每隔 3,100 飛行航次 (flight cycles) 作為更換該溫控器之翻修期限，則其失敗率將會低於 25%。目前國泰已將 3,100 飛行

航次作為溫控器翻修的期限，納入其元件追蹤系統。

1.18.8 相關操作程序及規則

與本事故航務操作有關之緊急程序及通訊規定如附錄 9。相關飛航管制操作程序詳如附錄 10。

第二章 分析

2.1 飛航操作

該機飛航組員飛航資格符合香港特別行政區政府民航處（Hong Kong CAD）民航法規之規定；事故前 72 小時之休息及活動正常，無證據顯示飛航組員於飛航中曾受藥物及酒精之影響。飛機載重平衡在限制範圍內。依事實資料 1.7 節之天氣資訊顯示，事故發生前後之天氣受輕颱辛樂克外圍環流影響為陣雨，氣流不穩定。

該機飛航組員艙壓失效與緊急下降之處置大致符合規定，調查小組就提前更換無線電波道、飛航組員之處置程序等項，分析於如下：

2.1.1 提前更換無線電波道

該機 1 號發動機供氣閥（Bleed Valve）失效，且依據該型機最低裝備需求手冊（Minimum Equipment List, MEL）36-11-02 程序完成檢查放飛。於 1855:56 時，該機在台北區管中心管制下，自巡航高度 FL400 下降，於下降約通過 FL380 時，飛航組員發現另一具發動機供氣閥亦相繼失效，艙壓高度上升，決定快速下降。依 CVR 紀錄，1856:42 時區管中心呼叫：「dynasty three two one contact Taipei approach one two five decimal one」，接著 CX521 CM1 回答“one two five one bye bye”，由上述通話內容得知，CX521 誤聽區管中心呼叫管制區內近似呼號之 CI5321 航機，更換波道至臺北近場臺波道 125.1 之指示，而提前將通訊波道變更至臺北近場臺 125.1 之管制波道。

飛航組員誤聽航管指示之可能原因為：

- 同一空域內存在多架近似呼號之航機：當時在附近空域有近似呼號之航機（如華航 CI5321、華航 CI5213 及國泰 CX531 等...詳 CVR 抄件），於同一管制波道內之近似呼號，容易導致飛航組員或管制員收發錯誤之訊息，例如於 1854:21 時 CX521 開始下降時，區管中心允許 CI5213 直飛至導航點 Grace，CX521 CM1 即

誤認為區管中心允許其直飛至導航點 Drake，但經 CX521 CM1 複誦後，區管中心更正其係針對 CI5213 下達之指令故未使錯誤延續；於 1856:42 時區管中心允許另一近似呼號之 CI5321 航機更換波道至台北近場臺，CX521 又誤認並且更換波道，同樣在 1858:13 時及 1858:20 時，臺北近場臺之管制員亦誤認呼叫 mayday 之航機為其管制區內之 CX531 航機。

- 因系統失效之工作負荷及分心：CX521 於 1856:05 時，飛航組員發現 2 號發動機供氣閥失效，艙壓高度有上升現象，由座艙語音紀錄器錄音抄件 1856:00 時至 1856:50 時約 50 秒之通話（內容如附錄 1），證實當時飛航組員確因討論艙壓相關失效訊息而異常忙碌。飛航組員面臨系統失效及艙壓高度上升而突增之工作壓力，相互討論供氣閥失效、艙壓高度上升相關訊息及決定加速下降處置過程中，未能專注於無線電之守聽，產生無線電接收及回應之失誤，誤聽區管中心呼叫 CI5321 更換波道之指示而提前更換無線電波道至近場臺波道。經比對 CVR 抄件及 FDR 資料，該機於回覆區管中心將通訊頻率轉換至 125.1 時，正值下降階段，當時高度約 35,000 呎，距鞍部航點（APU）距離約為 120 哩以上。依據臺北飛航情報區飛航指南資料（詳如 1.18.4 節），區管中心與臺北近場臺之交接點應約為距鞍部導航點北方 40 哩，交接高度約 10,000 呎至 20,000 呎，飛航組員於誤聽區管中心指示時，應瞭解目前航機仍屬於區管中心之管制範圍，區管中心應不會指示其提前轉換管制波道。
- 未完全按國泰無線電通訊規定：CI5213 回覆臺北近場臺指示與 CX521 回答管制員同一時間，加上 CX521 飛航組員回覆臺北近場臺之呼號未包含完整班機呼號。依照國泰航務手冊無線電通訊規定（如附錄 9），於接收航管轉換波道之指令時，飛航組員需覆誦全部指令，且於覆誦完畢後報出班機呼號，於更換波道後應與新波道之飛航管制員構成通聯。依據 CVR 抄件證實，CX521 飛航組員於航程中於 1854:22 時及 1856:42 時二次誤聽航管指示，CM2 於轉換波道前之覆誦，並未包含飛機呼號，CM1 亦未提醒，不完整的無線電覆誦及呼叫加上 CX521 與其它航機覆誦重疊，使飛航組員與飛航管制員均失去複查接收正確指令之機會。

2.1.2 飛航組員處置程序：

與本次事故有關之異常及緊急操作程序 (Abnormal and Emergency) 計有「AIR ENG 1(2) BLEED FAULT」、「AIR DUAL BLEED FAULT」、「CAB PR EXCESS CAB ALT」及「EMER DESCENT」等 4 項 (如附錄 9)。本次事故飛航組員之處置程序分析概依「CAB PR EXCESS CAB ALT」警告訊息出現前及「CAB PR EXCESS CAB ALT」警告訊息出現後分析如下：

2.1.2.1 艙壓高度過高「CAB PR EXCESS CAB ALT」警告訊息出現前：

依 CVR 抄件，該機派飛時依最低裝備需求表 MEL36-11-02 之規定，將 1 號發動機之供氣閥閉鎖，並於完成檢查後放飛，2 號供氣系統為唯一的空調氣源。依飛航組員訪談資料、FDR 資料及 CVR 抄件，CX521 約於 1855:46 時，該機高度約為 38,500 呎，下降率約為 1,000 呎／分，FDR 資料出現「FLOW CTL Valve Disagree」的訊息，CM1 於 1056:05 時呼叫：「AIR ENG 2 BLEED FAULT」，表示此時 2 號供氣系統發生故障，依程序，此失效訊息出現後，飛航組員應重置 2 號發動機之供氣閥開關。

於 1856:05 時，CM2 回答：「ENG TWO BLEED FAULT OH YEAH」依 CVR 抄件，該機飛航組員於「AIR ENG 2 BLEED FAULT」訊息出現後，相互確認此失效訊息，依程序 CM1 隨即執行該進氣系之重置動作未成功，並於重置失敗後，決定使用減速裝置加大下降率儘速下降，FDR 資料顯示其最大下降率約到達 8,000 呎／分。依該機最低裝備需求表 MEL36-11-02 規定，如發生 2 套供氣失效時，飛航組員應於完成 ECAM 程序後依 QRH2.2.1 節內容執行「AIR DUAL BLEED FAULT」程序，使用全減速板儘速下降，如於下降過程中供氣系統尚未恢復，應啟動輔助動力裝置 (APU)，於到達 FL220 或以下後，應關閉機翼防冰 (WING A.ICE) 並打開輔助動力裝置供氣閥 (APU Bleed Valve)。

該機飛航組員於遭遇「AIR ENG 2 BLEED FAULT」警告訊息後，依程序重置

該系統，並於重置失敗後，加大下降率及速度儘速下降，符合 QRH 操作程序之規定；APU 啓動程序包含在「AIR DUAL BLEED」檢查表，亦即當該機下降通過 FL380，「AIR ENG 2 BLEED FAULT」警告訊息出現後執行，但飛航組員於下降至約 FL300 時，尚未執行啓動 APU 程序隨即出現「CAB PR EXCESS CAB ALT」警告訊息。飛航組員隨即另依「CAB PR EXCESS CAB ALT」之警告處置程序執行緊急下降，緊急下降檢查表中未包含啓動 APU，飛航組員在「CAB PR EXCESS CAB ALT」訊息出現後，戴氧氣面罩執行緊急下降，考量時間壓力及工作負荷及與航管構聯各項狀況下，未執行 APU 啓動程序。

2.1.2.2 艙壓高度過高「CAB PR EXCESS CAB ALT」警告訊息出現後：

依 CVR 抄件、訪談紀錄及 FDR 資料顯示，該機於 1857:40 時，約通過 FL300 時，遭遇艙壓失效之警告訊息，飛航組員應執行「CAB PR EXCESS CAB ALT」處置及緊急下降之程序。緊急下降程序除明確定義 PF 與 PM 應執行之工作外，與「CAB PR EXCESS CAB ALT」程序內容相近，對開啓 7700 電碼要求不同。緊急下降程序中規定，如無法與 ATC 構聯，應使用緊急波道呼叫 ATC，並將電碼置於 7700，而「CAB PR EXCESS CAB ALT」程序律定，如無法與 ATC 構聯，應將 Transponder 電碼置於 7700 或使用緊急波道呼叫 ATC。上述兩程序對設定 Transponder 電碼之規定不同。

緊急下降程序為：組員戴上氧氣面罩後，由 PF 執行使用自動駕駛下降，使用最大允許速度，油門慢俚，減速板全放，PNF 則執行打開客艙警示號誌（SIGN-ON），發動機啓動電門置於“IGN”位置及與 ATC 通聯；下降中如艙壓高度高於 14,000 呎，PNF 應以手動方式放下客艙氧氣面罩，並確認其已放下。

緊急下降程序為飛航組員之背誦項目，執行此 QRH 項目時，PM 應監控 PF 之飛航情況如：預計改平高度、速度等，並與 ATC 通聯。該公司在其最佳操作“Best Practice”建議：下降至預定高度改平飛後，監控組員 PM 應再次執行 ECAM 或 QRH 程序，以確認所有應執行之程序均已完成。

依據 FDR 資料及 CVR 抄件（如附錄 1）及訪談紀錄，當座艙出現“CAB PR EXCESS CAB ALT”主警告訊息時，艙壓高度為 9,680 呎，ECAM 出現應執行之程序，飛航組員應據以執行。因 CX521 已獲許可下降至 FL140，飛航組員於 1857:45 時加速下降，CM2 宣告主控及執行 ECAM 內容，當時該機距鞍部導航點北方約 121 海浬，於 1901:08 時，CM1 使用 125.1 波道申請持續下降，並依程序偏離航路。1904:28 時，2 位飛航組員取下氧氣面罩，當時該機距鞍部約 83 海浬，1904:31 時，該機到達 FL100。

CX521 執行緊急下降之情形依 FDR 之資料如圖 2.1-1。

該機艙壓高度如大於 14,000 英呎，客艙氧氣面罩將自動下掉。依緊急下降程序規定，如艙壓高度超過 14,000 呎，飛航組員應以手動將客艙氧氣面罩放下，其目的在使飛航組員確證氧氣面罩於艙壓高度高於 14,000 呎以上時，位於放下位置。依 CVR 抄件於 1906:02 時，PM 以手動方式將客艙氧氣面罩放下，於訪談時，PM 陳述當時無法判讀艙壓高度，顯示 PM 當時並不確定艙壓高度已超過 14,000 呎。依 FDR 資料，當時航機於全程下降至 FL100 過程中，艙壓高度之最大指示為 13,424 呎（如圖 2.1-1），均未超過 14,000 呎。故飛航組員應無必要以手動方式將客艙氧氣面罩置於放下位置。

依 CVR 抄件顯示，飛航組員曾使用 121.5 波道呼叫緊急情況，但查證 ATC 地面紀錄之錄影資料中，並無該項訊息，而此電碼 Transponder 裝備亦無失效之紀錄。無證據顯示於緊急下降過程中，該機電碼 Transponder 係置於 7700 電碼位置。

本頁空白

2.2 供氣系統與緊急下降

參考 1.18.5 A330 型機供氣系統及 1.18.6 空調系統，供氣系統係提供客艙空調系統，機翼及發動機除冰系統等氣源，其中之空調系統除調節駕駛艙及客艙之空氣溫度外，並且是航空器在高空飛行所需艙壓空氣的來源。

該機在 38,500 呎（大氣氣壓約 2.9 psi）遭遇供氣系統失效時（1855:46 時），當時的艙壓高度約 8,000 呎（艙壓約 10.9 psi），加壓艙內外之差壓約 8.0 psi。在最大容許艙壓洩漏率 1.1 psi/min 情況下，估算可能失壓的時間，在短時間（約 2 分 22 秒）艙壓高度將會上升到適航認證的最高限制 15,000 呎（艙壓約 8.3 psi），若未採適當措施，將可能發生失去艙壓，甚者造成人員高空缺氧的情況。因此，駕駛員緊急下降至安全的高度乃是必要的。本會認為如果在一套供氣系統失效之情況下，操作者可考慮降低其最高之操作高度以減少高空失壓的風險。

2.3 加壓艙與客艙緊急氧氣系統

參考 1.11.2，檢視 B-HLH 飛航資料紀錄（含 QAR 及 FDR），該機在正常操作下，艙壓高度均小於 8,000 呎；當第 2 套供氣系統失效後，其所經歷之艙壓高度最高為 13,424 呎（1902:28 時，當時飛機已下降至大氣高度約 13,500 呎）。參考美國航空與太空總署的規範，FAR 運輸類飛機適航標準 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.*（譯：加壓艙(a) 在正常操作下艙壓高度不得高於 8,000 呎。(1)假如超過適航認證飛機操作高度 25,000 呎，則飛機必須確認在艙壓系統失效情況下，乘員暴露之艙壓高度不可高過 15,000 呎)。

綜上所述，機艙壓高度在駕駛員操作下，客艙乘員所經歷之最高艙壓為 13,424 呎，仍在適航認證規定的範圍內。

參考 1.16.1 艙壓洩漏速率測試，B-HLH 之洩漏率為 0.8 psi/min。參考維修手冊 05-53-00 TASK 05-53-00-780-803 Pressurization Retest and Leakage Rate Measurement（譯：艙壓測試及洩漏率量測），A330 型機容許最大洩漏率為 1.1 psi/min，其艙壓艙之洩漏率合於飛機維修手冊規範。

根據飛機維修手冊 35-20-00 乘客緊急氧氣系統的說明，當艙壓高度過高，約在 14,000 呎（+250, -750）時，客艙氧氣面罩將會自動落下，亦可以手動操作使其落下。

據駕駛員陳述，該機客艙氧氣面罩係駕駛員以手動制動。該機所經歷之最高艙壓高度為 13,424 呎，高度正介於維修手冊 14,000 呎（+250, -750）之設計門檻內，在此艙壓高度，客艙氧氣面罩可能但未必然一定會自動落下。

2.4 航空器氣源備份系統與最低裝備需求表

航空器運作時主要供氣來源為發動機，但航空器系統設計具有多重互相支援（redundancy）之功能。以供氣系統而言，氣的來源可以是 1 號發動機、2 號發動機或輔助動力單元（APU）。但 APU 操作會受到飛行高度限制，以下降過程而言，必須下降到高度 22,000 呎時才能供氣，且啟動 APU 至少需要 60 秒的加速時間才能到達正常運作之轉速。

根據事故當時之最低裝備需求表，在 1 套氣源失效情況下，無須啟動 APU 待命。該機在 38,500 呎，失去供氣系統，以當時高度 APU 無供氣功能，如果 APU 能在 1 套氣源失效情況下即保持運轉；或在第 2 套氣源失效時立即啟動，則 APU 的供氣將可儘早恢復艙壓。

本會建議使用人評估最低裝備需求表或增修訂程序，當飛機在 1 套氣源失效情況下飛行，如第 2 套系統亦失效時，能及時啟動使 APU 運轉，讓飛機儘早恢復

艙壓，以降低客艙失壓的風險。

根據 A330 型機最低裝備需求表 36-11-02（如附錄 3），該機允許在 1 具發動機供氣情況下簽放，配合之維修作為必須把失效供氣閥鎖在關閉位置，且必須在 10 曆日內修復，並限制僅能 1 次 ETOPS（Extended-range Twin-Engine Operational Performance Standard, 雙渦輪發動機航空器延展航程作業規定）飛行。

參考 1.6.2 之維修紀錄，本事故 1 號發動機之供氣系統調壓閥（PRV）在 2008 年 9 月 13 日韓國仁川機場，因故障已經鎖在關閉的位置，因此，CX521 班機在運作時其艙壓氣源僅來自 2 號發動機。參考 B-HLH 飛機維修紀錄簿，在 9 月 13 日離開空橋的時間（BLOCK OFF）為 0136 UTC 至 9 月 14 日抵達空橋時間（BLOCK ON）為 1139 UTC，累計其曆日時間為 35 小時。在這期間該機歷經飛行航次為 CX2411、CX919、CX918、CX905、CX904、CX520 及 CX521 等。在維修紀錄簿上 ETOPS 欄位，乃作為該班機是否為 ETOPS 飛行之註記，檢視上述七個班次之紀錄，其中並無 ETOPS 之飛行紀錄。

本案調查小組檢視以上所述有關最低裝備需求表 36-11-02 國泰對應之維修作為；包括鎖住 PRV、修復時限及 ETOPS 飛航限制，均符合最低裝備需求表之規定。

2.5 氣動系統失效原因

參考 1.1，於 1854:14 時，B-HLH 自飛航高度 FL400 開始下降，當 1855:46 時，駕駛艙發生 2 號發動機供氣失效 ECAM 訊息及警告。參考 1.18.1 CM1 駕駛員訪談，駕駛員在執行完緊急程序後嘗試第一次重置 2 號供氣系統，但該系統無法恢復正常；下降至高度約 8,000 呎時，駕駛員第二次重置後，2 號系統始恢復正常。

參考 1.16.2 元件測試，1 號發動機之供氣閥、2 號發動機扇氣閥及其溫控器送至原廠拆解，拆解結果發現 1 號發動機之供氣閥其關閉指示時間，雖微幅偏離維

修手冊之規範，但該氣閥事故發生前即被鎖在關閉的位置，與 2 號供氣系統空中失效無直接關聯。2 號發動機扇氣閥之檢查結果，發現其外觀污染明顯，但氣動測試（pneumatic test）顯示功能正常，惟氣閥關閉指示功能失效。根據飛機製造廠的說明，此失效僅於供氣溫度太低情況才有影響，與本事故之供氣系統失效致使溫度過高無關。2 號發動機扇氣閥溫控器檢查，發現無法通過 GO/NO GO 之測試，進一步檢查發現，主進氣濾網（inlet filter）正常，但網狀濾網（grid filter）受明顯污染，測試時以刺破該濾網檢測濾網的性能，在刺破濾網後，控制扇氣閥之推動氣壓（muscle air pressure）立刻恢復正常值。測試結果確認網狀濾網遭受污染，阻隔氣壓，使得推動氣壓過低，導致扇氣閥無法正常作動，致 2 號供氣系統功能失效。

檢視 B-HLH 在起飛、爬升及平飛階段，2 號發動機供氣功能正常，在下降後才發生不正常，主要原因除上述扇氣閥溫控器失效外，另外相關的因素如下：當飛機下降前高度約 40,000 呎，（1854:15 時）發動機 EPR⁹約 1.41，開始下降後發動機推力 EPR 逐漸由 1.41 逐漸下降至 1.17，依據供氣系統設計，在發動機正常運轉時氣源由壓縮段第 8 級供應，在發動機較低轉速時，因壓縮段第 8 級氣壓下降，供氣會自動轉由為更高壓之第 14 級提供¹⁰，第 14 級之供氣除了具更大之壓力外，其溫度亦比第 8 級高。因此在供氣溫度更高之情況下，扇氣閥需開至更大，以提供更多之冷卻空氣。但如前節所述，2 號發動機供氣系統之網狀濾網受嚴重污染，導致開啓扇氣閥之氣壓不足，無法開啓扇氣閥。因此，當進入預冷氣之冷卻空氣不足情況下，使得供氣溫度過高，供氣系統啓動保護動作而自動關閉相關氣閥¹¹。

⁹ EPR: Engine Pressure Ratio 用以量測發動機之推力。

¹⁰ 檢視飛航資料，在 1054:23 第 14 級供氣之高壓氣閥（High Pressure Valve, HPV）打開，當時 ENG2 EPR 為 1.23。

¹¹ 參考飛航資料紀錄，發現於 1855:35 時二號發動機之高壓氣閥（High Pressure Valve, HPV）關閉，1855:37 供氣閥（Pressure Regulator Valve, PRV）亦關閉，最後二號供氣系統失效。

綜上所述，在 1 號發動機供氣閥失效依最低裝備需求表鎖於關閉情況下，2 號發動機供氣系統乃該機空調系統之唯一氣源，2 號發動機供氣系統處於高供應量之狀況下運作。當飛機高度開始下降時，發動機壓縮段 8 級氣源改由壓力及溫度較高之 14 級提供，使通過預冷器之空氣溫度上升。因扇氣閥溫控器網狀濾網遭受污染，降低推動扇氣閥之氣壓，以致該氣閥無法正常開啓以提供足夠之冷卻空氣，致預冷器下游壓縮空氣過熱，致 2 號供氣閥因過熱而自動關閉，空調系統失效，艙壓高度升高失去客艙加壓之能力。

2.6 雙供氣系統失效改善

參考 1.6.3 雙供氣系統失效（Dual Bleed Loss, DBL）事件，2008 年 4 月至 6 月間，國泰航空 A330 型機發生 3 件雙供氣系統失效事件，加上 2008 年 9 月發生之本事故，半年來計有 4 件雙供氣系統空中失效事件。

參考表 2.6-1 雙供氣系統失效元件，檢視供氣系統故障現象，供氣過熱的情況共 5 次（FAV ThC 故障 3 次，FAV 故障及檢測管路漏氣各 1 次）；PRV 故障 2 次及 OPV 故障 1 次。FAV ThC 故障為最大宗。

檢視該機 1 號供氣系統於事故前發生多次重發性故障及上述該型機隊於半年內發生多次兩套氣動系統失效情況，顯示供氣系統穩定性不足，可能對飛航安全產生潛在性風險。

表 2.6-1 雙供氣系統失效元件

項次	故障現象	故障元件／原因	失效確認
1	低壓力	No.1 OPV	確認失效
2	供氣過熱	No.2 ThC	確認失效
3	供氣過熱	No.1 ThC	確認失效
4	低壓力	No.2 PRV	確認失效
5	供氣過熱	No.1 FAV	確認失效
6	供氣過熱	Sense line leak	漏氣
7	關閉指示錯誤	No.1 PRV	未確認失效
8	供氣過熱	No.2 ThC	確認失效

參考 1.18.17，國泰航空根據飛機製造廠服務資訊通告（Service Information Letter）SIL 36-055, R01, dated 15 Nov. 2006, PREVENTIVE CLEANING / REPLACEMENT OF THE TEMPERATURE CONTROL THERMOSTAT FILTER（譯：預防性清潔／更換溫度控制器濾網），制定溫度控制器濾網之修護計劃，每 3,000 飛時清潔或更換進氣濾網。該服務資訊通告通知操作者溫度控制器濾網的預防性維修工作，可增進發動機供氣系統之可靠度。參考 1.6.2 維修紀錄，濾網已於 2008 年 7 月 19 日更換，另參考 1.16.3 元件測試，事故機進氣濾網是乾淨的，功能正常，發生問題為網狀濾網（grid filter）綜上所述 SIL36-055 並無法解決本次事故 ThC 所發生網狀濾網受污染的情況。

根據飛機維修手冊，進氣濾網可在停機線上進行維修清潔或更換；而網狀濾網非屬停機線上更換元件（Line Replaceable Unit, LRU），該網狀濾網之清潔或更換無法透過線上維修完成，必須隨 ThC 拆下後進廠維修。參考 1.16.3 元件測試，原廠拆檢本次故障 ThC 之測試報告，其網狀濾網之污染乃大氣中常見之正常污染，其污染會因停留的機場及飛行路線不同而有所不同。

在既有 SIL 36-055 無法有效改善網狀濾網受污染，且空氣污染無法避免情況下，本會認為有必要重新檢視及設計該 ThC 網狀濾網。在新的設計或改善未完成前，製造廠及操作者應評估縮短 ThC 進廠檢視或翻修之時限。

調查小組於 2010 年 2 月 2 日召開 CX521 調查結果討論會，國泰航空在會中提出針對空中巴士於事故後，為改善 A330 型機 DBL 系統問題，供應商（Liebherr）於 2009 年 9 月 25 日發布 VSB 342-36-04，將溫控器之內部濾網（mesh/grid filter）改成一個保護蓋（protective cap），改裝內容與前 A320 型機溫控器供應商服務通告（VSB 342-36-08）改裝內部濾網之內容類似，國泰航空質疑 A320 型機空調與供氣系統工作小組（Air and Bleed Working Group）於研發解決 A320 型機雙供氣系統失效問題時，應將 A330 型機納入，並認為為確保及時的改正措施，調查小組有必要重新檢視空中巴士處理服勤機隊異常狀況之流程。

調查小組針對該項關切，分別從空中巴士內部管控程序、A320 型機空調與供氣工作小組緣起、VSB 342-36-04 服務通告發布內容、A330 型機供氣系統任務小組（Task Force）作業及時程等議題綜整如後：

依空中巴士提供文件，空中巴士對服勤機隊發生之異常事件（In-service Occurrences）之產品問題，均用產品安全管制程序（Product Safety Process）評估列管，列管過程每一階段（篩選、分析、改正措施）均考慮是否可能對其他機隊造成衝擊，再決定改正措施是否適用單一機隊或多機隊。此管制程序經主管機關（EASA）核可，並接受定期查核。依空中巴士 A330 系統安全評估（System Safety Assessment¹²）適航檢定文件，ATA36 失效之風險程度從重大的（Major¹³）到危險的（Hazardous）。雙供氣系統失效屬重大的失效，但未歸類於不安全（unsafe¹⁴）失效，該文件亦經適航主管機關的核可。

A320 型機空調與供氣工作小組成立緣自 2007 年召開之 A320 機隊技術研討會提案，小組以系統可靠性及經濟上的衝擊為著眼點，由機隊操作者互相分享 ATA21 及 ATA36 之技術性解決方案。成員包含 Airbus、Liebherr 及有興趣參與之操作者，工作小組工作範疇由所有參與成員討論後決定，成立之初即未包含 A330 機隊。根據空中巴士回覆資料，2007 年底 A320 工作小組著手研發 DBL 解決方案時，A330 型機 DBL 發生率尚低，與前期相較無明顯增加的趨勢。當時發現 A330 DBL 主要失效原因為入口濾網髒污、溫控器老化、扇氣閥老化及漏氣，尚未確認任何 A330 型機 DBL 失效原因為內部濾網遭受污染，2008 年 9 月 CX521 事故發生後，於 2008 年 10 月在 Liebherr 拆解檢查溫控器時，首次確認溫控氣內部濾網髒污為 CX521 DBL 之根本原因。

2008 年 5 月 30 日空中巴士發布服務通告（SB A320-36-1061），這份服務通

¹² Requirement to be met: JAR 25.0903 b & JAR 25.1309 b,c,d

¹³ 系統失效情況（failure condition）從最輕微到最嚴重，依序為無安全考量（No safety effect），輕微的（Minor），重大的（Major），有危險的（Hazardous），災難性的（Catastrophic）。

¹⁴ Hazardous 及 Catastrophic 之失效被規範屬於不安全的情況（unsafe condition）。

告發布的目的為通知所有 A320 機隊之航空器操作人有關設備製造商 LIEBHERR 之服務通告，包含服務通告（No. 342-36-08）該服務通告描述 TCT 的改裝，從件號 342B040000 到件號 342B050000，這 TCT 元件升級包含網格濾網（mesh/grid）之改裝。該服務通告也同時建議改善 FAV（Liebherr VSB 6730-36-03, or 6730F-36-03）及 TLT（Liebherr VSB 341-36-06）。空中巴士說明機載裝備改裝（modification）涉及供應商服務通告（Vender Service Bulletin, VSB），由裝備供應商負責發布，並需要適航主管機關 EASA 的核可。

空中巴士於 2009 年 4 月成立 A330 型機供氣系統任務小組（Task Force, TF），飛機製造廠及設備供應商參與之專家與前 A320 型機空調與供氣工作小組成員相同。該小組針對 A330 型機機隊雙供氣系統失效主要原因發現如下：50%失去第 2 套供氣系統因為超溫，大部分發生在巡航及巡航改下降時且為裝置勞斯萊斯（RR）發動機的 A330 型機機隊，主要原因是空氣污染溫控器濾網（ThC filter/mesh），加上溫控器調節功能老化，使推動扇氣閥的壓力降低。另外扇氣閥本身漏氣及老化，亦使氣閥降低開啓的能力；另 50%失去第 2 套供氣系統是因為超壓或低壓，大部分發生在起飛爬升階段，且為裝置通用/普惠（GE/PW）發動機的 A330 型機機隊，主因為超壓閥設定壓力飄移，使超壓閥太早關閉，尤其在起飛時容易超壓造成供氣失效訊息（BLEED FAULT），另外壓力感測器失效及起飛時因急推推力（thrust ramp-up）之不當操作所致。有關改善 A330 DBL 之解決方案（VSB 342-36-04）於 2009 年 9 月發布，參考 1.6.3 國泰航空於 2008 年 4 月至 6 月已經發生數起 A330 型機 DBL 事故。

調查小組檢視 A320 型機空調與供氣工作小組及 A330 型機空調與供氣專案小組自成立至發布有關 DBL 改善措施時程，A320 型機空調與供氣工作小組於 2007 年 11 月展開工作，於 2008 年 5 月 30 日發布 A320 DBL 改善措施（SB A320-36-1061），期間歷時約 7 個月；於 2008 年 10 月拆解檢查確認 CX521 DBL

故障的原因，2009 年 4 月成立 A330 型機 DBL 專案小組，2009 年 9 月發布對應解決方案（VSB 342-36-04），從了解原因至產出改善措施歷時約 12 個月。參照空中巴士提供資料，當服勤事件與不安全的情況無關時，在相關事業單位能量限制與優先順序考量下，會盡可能使改善措施反映時間最佳化。通常解決此類重大失效狀況的標準時間，從調查結果確認到供應商發出服務通告需歷經 12 個月。

本會認為空中巴士在 2007 年底研擬解決 A320 型機 DBL 問題時，未納入 A330 型機，符合空中巴士既有之產品安全管制流程，包括當時 A330 DBL 失效發生率未及於在發布改善 A320 DBL 裝備服務通告時需立即納入 A330 機隊標準。惟調查小組檢視 2008 年中 A330 型機 DBL 事件已有上升的現象，但 DBL 事故屬重大失效（非屬不安全情況），且依空中巴士發布解決方案（產生一個 VSB）之標準時間，未必能夠及時阻止 CX521 的發生。如果當時空中巴士在能在產品安全管制程序（Product Safety Process）評估列管過程中，引用前 A320 DBL 解決方案的經驗，以預防角度針對區域性服勤機隊發生之異常事件，啟動改善 A330 DBL 失效的研究，或許可以將發布 A330 DBL 的解決方案時程提前。同樣的，當統計數字顯示區域性的 A330 型機 DBL 事件上升時，尤其是在已有一套供氣系統失效以最低裝備需求表派遣時，業者亦應主動積極的評估並考量調整內部維修與查核機制以降低操作風險。

2.7 供氣系統重複性故障與最低裝備表之使用

如 2.3 所述 1 號供氣系統之供氣閥因故障以最低裝備需求表 36-11-02 簽放，其修護時限未超過 10 曆日，未違反相關規定，但如 1.6.3 節所述，事故前半年發生多次空中兩套氣源系統均失效情況，顯示該系統並不穩定，對飛航安全存有潛在風險。在修護時限 10 曆日，期間該機曾 2 次停留香港機場，為短暫停留的過境檢查，使該公司不易於短時間修復該故障。如果國泰能以相關程序如最低裝備需求表限制飛機當 1 套供氣系統失效情況下，不允許在香港機場放飛，盡可能及時

修復該故障，或可降低空中因多系統失效之風險。參考 1.6.2，進一步檢視該故障之修護紀錄後發現，供氣閥故障大多發生在發動機將近完全關閉及少數在剛啟動時，該氣閥的故障在於未能正確指示氣閥關閉的狀態。屬於『指示故障』，且發生在發動機運轉非常低轉速且供氣壓力低時，未發生在正常的飛行中。該供氣閥送至原廠拆解結果，無法確認該故障。

本會認為供氣系統重複發生的故障，存有多套系統同時失效之顧慮，操作者應評估最低裝備需求表使用，或修訂相關之最低裝備需求表以降低飛航時多套系統失效之風險。

2.8 飛航服務

依據事故當時區管中心北部席之雷達螢幕錄影資料，未顯示 CX521 班機駕駛員曾切換雷達迴波器電碼至規定之 7700 緊急電碼，當天之雷達系統操作無異常，事故後之緊急電碼信號測試亦無異常。1903 時至 1907 時該機與區管中心通聯，曾發生短暫通訊不良的狀況，但是臺北區管中心與翔安通設臺之工作日誌，均無大屯山或馬公臺址無線電接收發射不正常之紀錄。依據臺北區管中心各席位與航空器之無線電通聯紀錄，無證據顯示區管中心當時使用無線電系統有異常之情形，較有可能之原因，應為管制員使用無線電臺低高度涵蓋的問題，但民航局無各無線電臺址低高度涵蓋圖之更新資料，無法進行比對。

本事故與航管相關之因素包含：近似呼號之航空器通信程序、危難航空器之處置、緊急波道、無線電台之配置及無線電台通訊測試等項目，分析如下：

2.8.1 飛航管制相關事件歷程

該機自成田機場起飛，目的地為桃園機場，巡航高度 FL400、經 A1 航路進入臺北飛航情報區，電碼 3766，由臺北區管中心北部席負責管制，無線電頻率為 125.5 MHz。

綜整 CVR、FDR、雷達、航管波道、緊急波道及平面通訊錄音之飛航管制歷

程如表 2.7-1 及圖 2.7-1。

表 2.8-1 飛航管制歷程

時間	區管中心／近場臺管制員	CX521 駕駛員	備註
1847:42	區管中心與該機構聯後，許可該機經 AN2B RNAV 到場至 AUGUR		該機當時於 A1 航路，巡航高度 FL400
1852:25	區管中心許可 CX521 下降至 FL140		
1854:22	區管中心許可 CI5213 班機直飛 GRACE	駕駛員誤以為航管指示 CX521 直飛 DRAKE，經管制員指正	
1856:18		駕駛員發現 2 具發動機供氣閥失效，艙壓高度上升，決定快速下降	
1856:42	區管中心指示 CI5321 轉換至近場臺 125.1 波道	駕駛員以為區管中心呼叫該機，誤換波道至 125.1	該機當時距鞍部 VOR 約 129 哩，高度約 35,700 呎
1857:48		駕駛員配戴氧氣面罩	
1858:03		CM1 於近場臺 125.1 波道呼叫「Mayday、緊急下降」	近場臺桃南席當時以 125.1 波道與其他航機通聯
1858:14	近場臺管制員管制下正有一 CX531 班機實施桃園國際機場 24 跑道進場，管制員向 CX531 澄清是否呼叫緊急情況後，重新頒發 CX531 班機進場許可		該機距鞍部 VOR 約 119 哩，高度約 28,000 呎
1859:13		CM1 再度於 125.1 波道呼叫「Mayday、緊急下降通過 FL217」	
1859:34	近場臺管制員與該機確認使用之波道為 125.1、呼號為 CX521		
1859:55		CM1 使用緊急波道呼叫「Mayday、FL200」	

1859:56	近場臺向區管中心澄清，是否有 CX521 班機宣布緊急下降。區管中心北部席說明有此一班機，但未報告緊急下降		區管中心北部席隨後於 125.5 波道呼叫 CX521 班機 2 次
	CX521 於緊急波道呼叫 Mayday 之後，1859:55 時至 1905:21 時，多架航機於緊急波道詢問及傳遞此訊息。		
1900:07	SQ879 在臺北區管中心西部席管制波道通知航管，於 121.5 緊急波道聽到有航空器呼叫 Mayday		
1900:52	區管中心各席位開始可以聽到其他航機於緊急波道之通話。		
1900:59		CM1 使用 125.1 波道向近場臺請求進一步下降	該機距鞍部 VOR 約 100 哩，高度約 15,000 呎
1901:50	近場臺協調區管中心許可該機下降至 10,000 呎。		
1901:15	CLX843 因為於 121.5 緊急波道聽到 Mayday，在區管中心東部席之管制波道詢問 CX521 的狀況		
1902:32	日本那霸區管中心（NAHA Control）電話詢問 CX521 班機是否正常，區管中心北部資料席答覆：「不知道、正在確認、無線電連絡不上」；那霸區管中心即轉述其他飛機廣播：「CX521 班機呼叫 Mayday」。		
1903:03	區管中心要求近場臺將該機無線電換至北部席		
1903:13	近場臺指示該機換波道至區管中心 125.5 波道連絡		
1903:48	區管中心與該機構聯	CM1 說明正緊急下降至 10,000 呎、航向 230	該機距鞍部 VOR 約 86 哩
1904:28		卸下氧氣面罩	該機下降到達 10,000 呎
1905:10	區管中心向該機詢問作業是否正常，或需要任何協助	CM1 回答狀況穩定，等候進一步通知	
1906:03	區管中心請近場臺提早接管該機，近場臺要求以 124.2 波道管制		區管中心認為該機有異常，請近場臺及早處理
1907:03		CM1 呼叫臺北區管中心請求進場及優先降落許可	
1907:26	區管中心與近場臺 124.2 管制員完成雷達交接		該機距鞍部 VOR 約 69 哩

1907:39	區管中心回答收訊不清楚，請該機換至近場臺 125.1 波道連絡	CM1 覆誦指示後切換至近場臺 125.1 波道	隨後區管中心請該機改換近場臺 124.2 波道連絡，但是該機已轉換頻率
1908:06		CM1 與近場臺桃南席 125.1 波道構聯並報告緊急情況，高度 10,000 呎、航向 225，請求優先進場	
1908:29	近場臺桃南席詢問該機距鞍部 VOR 之位置	CM1 報告距鞍部 VOR 053 幅向 56 哩	桃南席並不知道已完成雷達交接
1910:10	近場臺桃南席於確認該機航向 225 後，許可其下降保持 8,000 呎	CM1 向管制員詢問是否 Radar Contact	
1910:24	近場臺桃南席請駕駛員稍待，並向駕駛員澄清是否宣布緊急情況	CM1 確認實施緊急下降，正離開 10,000 呎下降至 8,000 呎，距鞍部 VOR 52 哩	
1910:41	近場臺桃南席通知 Radar Contact，並詢問擬使用 23 或 24 跑道降落	CM1 回答使用 24 跑道	
1911:14	近場臺桃南席請駕駛員轉換無線電頻率至近場臺 124.2 連絡		
1912:41	近場臺 124.2 管制員與駕駛員構聯，並於瞭解駕駛員欲使用 24 跑道降落後，詢問緊急情況之性質	CM1 說明係座艙快速失壓，實施緊急下降	
1913:48	近場臺 124.2 管制員許可該機下降至 7,000 呎		
1914:17	近場臺 124.2 管制員詢問於落地後是否需地面支援	CM1 回答降落後預計滑行至停機坪，需地面支援在旁待命	
1914:35	近場臺 124.2 管制員進一步澄清航空器是否需在 24 跑道上停留數分鐘	CM1 重覆說明預計自行滑離跑道，需地面支援在旁待命	
1914:55	近場臺 124.2 管制員許可該機下降至 6,000 呎		
1916:00		CM1 請求直飛 FLASH	

1916:05	近場臺 124.2 管制員同意，但要求可能的話空速不要超過 220 浬	CM1 拒絕，並請求優先降落，隨後獲得管制員許可	
1916:32	近場臺 124.2 管制員許可該機實施 24 跑道 ILS/DME 進場		
1917:07	近場臺另一位管制員再度澄清，落地後是否需停在跑道上等待拖車	CM1 回答將自行脫離跑道，並重申需地面支援在旁待命	
1923:02	近場臺 124.2 管制員指示該機換塔臺無線電頻率連絡		
1924:22	塔臺管制員與該機構聯，於提供降落資訊後許可該機落地		
1929:17			CX521 安全降落

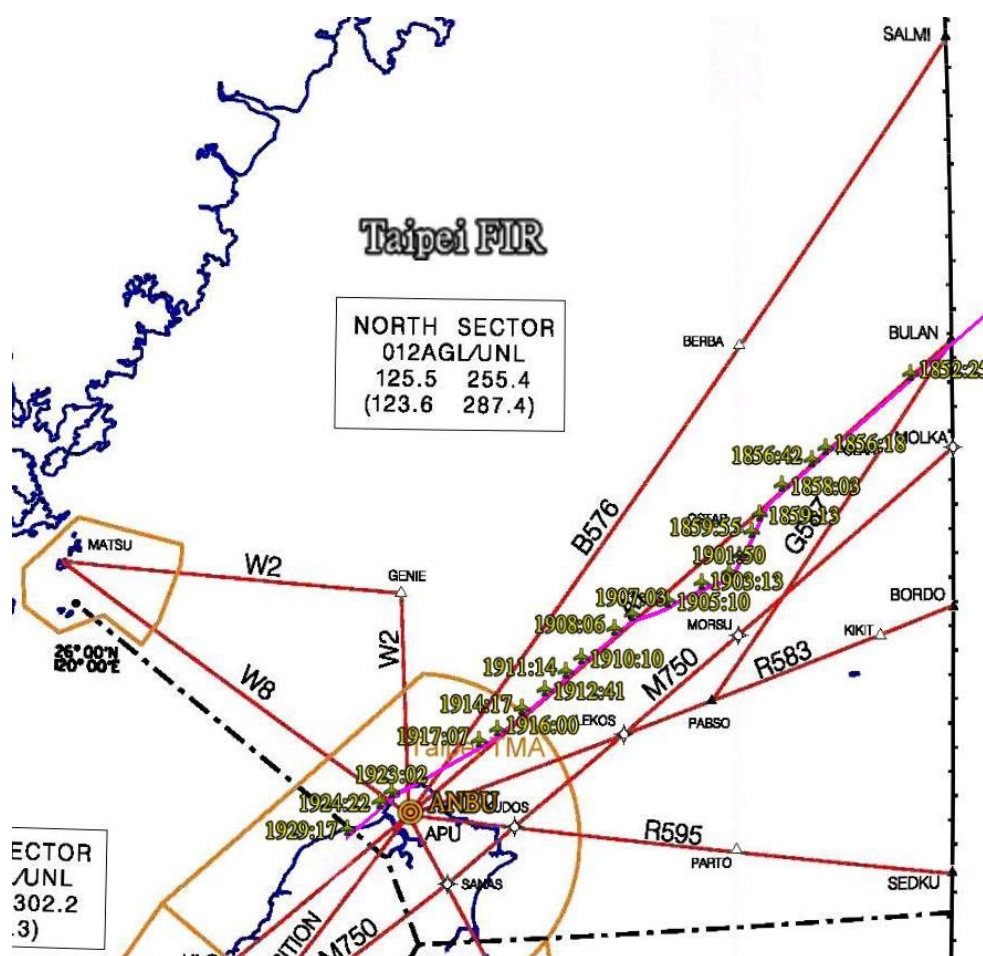


圖 2.8-1 該機飛航軌跡與區管中心北部席、臺北近場臺管制區示意圖

2.8.2 近似呼號之航空器通信程序

參照座艙語音紀錄及航管錄音抄件，1854:22 時區管中心許可另一架 CI5213（呼號為 dynasty five two one tree）班機直飛 GRACE，CX521 CM1 誤以為航管指示 CX521（呼號為 cathay five two one）班機，經管制員指正。1856:42 時臺北區管中心指示 CI5321（呼號為 dynasty five tree two one）轉換至臺北近場臺波道 125.1，CX521 班機之 CM1 又誤以為區管中心呼叫該機，依無線電通訊規定，僅回答“one two five one bye bye”，未敘明班機呼號便轉換波道，幾乎同時 CI5321 亦回答“one two five one dynasty five tree two one good day”，以致管制員未能察覺錯誤並指正 CX521 機。當時該機距鞍部約 129 哩，高度約 35,700 呎。

當時在北部席管制下，有 CX521、CI5213、CI5321 等近似呼號之航機於同一空域內運作，依「飛航管理程序」第 2-4-15 節「為澄清而加重語氣」規定，為易於區別航空器間類似之呼號，宜強調某些數字，字母或近似音之字…。於 CX521 班機首次誤聽 CI5213 班機之指示後，管制員在班機呼號運用上應使用 CATHAY FIVE TWO ONE CATHAY 或 DYNASTY FIVE TWO ONE THREE DYNASTY，讓駕駛員易於區別。

對照「飛航管理程序」第 2-4-15 節程序，民航局中英文版本規定不同，依中英文版第 1-2-1 節字義規定，「飛航管理程序」訂有「應，或具有強制意義之動詞」（Shall, or an action verb in the imperative sense）、「得」（Should）、「可」（May）、「將」（Will）之字義規定，管制員依此定義執行業務。依字義規定，英文版第 2-4-15 節，Emphasize appropriate digits, letters, or similar sounding words to aid in distinguishing between similar sounding aircraft identifications…，為強制性規定（內容與 FAA Order JO 7110.65S Air Traffic Control 第 2-4-15 節相同），中文版第 2-4-15 節使用「宜」字，不在前述字義定義範圍內，讓航管人員誤會此為非強制性規定。

2.8.3 危難航空器之處置

2.8.3.1 緊急情況之資訊處理

近場臺桃南席於 1858:03 時以無線電頻率 125.1 MHz 與其他航機通聯，CX521 班機於此波道呼叫 Mayday。桃南席管制員同時管制數架飛機，包括與該機呼號近似之 CX531 班機，當時正實施桃園國際機場 24 跑道進場，管制員與 CX531 班機於澄清是否呼叫緊急情況後，重新頒發 CX531 班機之進場許可。當時 CX521 距鞍部約 120 哩，高度約 28,700 呎。

依據航空通信規範，收到遇險航空器訊息之電臺應：a) 對遇險訊息儘速確認。b) 掌控通信，明確清楚地做責任接管，並告知航空器接管是否完成。c) 採取立即行動，確保遇險訊息有效地傳達予相關之飛航服務單位。

雖然 CX521 班機駕駛員錯換至近場臺波道，但是近場臺在第一次聽到 125.1 波道中有航機呼叫 Mayday 時，一開始以為是 CX531，後來認為是無線電串音誤聽，未對此訊息儘速確認，於 1 分多鐘後 CX521 班機再次呼叫緊急狀況，近場臺方進行相關確認工作。本事故發生後，日本那霸管制中心及航行中之航空器均有依前述規定之原則處理，近場臺對遇險航空器之緊急協助，在狀況警覺及時效上仍有改善空間。

2.8.3.2 協調連繫與航管服務

自 CX521 班機呼叫 Mayday 至該機安全降落期間，除駕駛員誤聽航管指示提前轉換波道外，航管內部協調連繫與航管服務相關問題分析如下：

依飛航管理程序之緊急協助規定，管制員於獲得足夠的資料，應儘快採取行動予以協助；對於飛航中航空器發生緊急情況時，所需基本資料為：航空器識別及機型、緊急情況之性質及駕駛員之期望。參照航管錄音抄件，自 1058:03 時 CX521 班機呼叫 Mayday 起，至該機緊急下降至安全高度 10,000 呎止，約達 7 分鐘時間，航管單位對該機狀況並不十分了解，直到 15 分鐘後 1113:03 時近場臺 124.2 管制員詢問後，始掌握「緊急情況之性質」及「駕駛員之期望」，在時效掌

控上仍有改善空間。

由於該機駕駛員遭遇艙壓高度上升而決定快速下降並呼叫緊急狀況，駕駛員的工作負荷劇增，此時管制員應適時提供協助並減少干擾，卻發生近場臺與區管中心多次要求 CX521 更換波道、125.1 通話波道擁塞並多次妨礙該機發話。雖然航管人員指示 CX521 更換波道係為提供該機更適當之服務，但是在緊急情況下，更換波道是否會更增加駕駛員工作負荷，管制員應考量以指示正常航空器更換無線電波道方式辦理。

飛航管制員於緊急情況資訊掌握過晚，指示更換波道之頻率過高、要求緊急情況航空器實施速度限制等，未符飛航管理程序中提供危難航空器最大之協助、最高之優先次序，亦未考慮駕駛員工作負荷及無線電通信有關之人為因素。又近場臺與塔臺對於該機落地後多次詢問地面支援，顯示航管單位間協調連繫未臻完備。

綜前所述，本事故發生航管作業中有關無線電通訊程序、緊急情況處理、危難航空器優先次序、駕駛員工作負荷之考量、無線電通信人為因素及航管單位間之協調連繫等議題分析，顯示主管機關對航管作業之訓練、考核及緊急情況之處理尚待加強。

2.8.3.3 緊急波道無線電臺之配置

CX521 班機於 1859:56 時在 121.5 緊急波道呼叫“Mayday …”，隨後有數架在空航機於 121.5 緊急波道詢問及轉知 CX521 班機之緊急情況。日本那霸區域管制中心亦於 1902:38 時以平面通訊詢問區管中心，在 121.5 緊急波道聽到 CX521 班機呼叫 Mayday 的訊息，但於 1900:52 時之前，區管中心各管制席位皆未聽到 CX521 班機緊急波道之通話。區管中心之 121.5 緊急波道有 2 個無線電收發臺址，分別位於臺北大屯山及馬公。依據兩臺址之錄音，馬公電臺無法收到 CX521 班機 Mayday 的發話，而大屯山電臺則無法收到臺灣南部小琉球附近在空航機轉知

CX521 班機訊息的發話，顯示兩座無線電臺之訊號涵蓋截然不同：大屯山電臺之無線電主要涵蓋區域為區管中心北、東部管制區，馬公電臺之無線電則主要涵蓋西、南部管制區。另由區管中心、近場臺 121.5 緊急波道之席位錄音，事故當時臺北近場臺使用大屯山電臺，而區管中心各席位卻均使用馬公電臺，以致區管中心無一席位聽到該機於 121.5 緊急波道的呼叫。

經調查區管中心北部席 125.5 作業頻率有大屯山、三貂角、南竿等三個無線電臺；121.5 緊急波道有大屯山、馬公兩個無線電臺，管制員可選擇大屯山或馬公為緊急波道之接收電臺，或同時接收此二電臺之訊號。

事故時區管中心北部席管制員緊急波道選擇馬公無線電臺，惟因馬公臺址無線電無法涵蓋本事故之範圍，致無法收到 CX521 班機在緊急波道之呼叫。大屯山、馬公兩個無線電臺因地理位置相距約 140 哩，以及地形影響，無法互為備份，為避免類似情況再度發生，區管中心北部席緊急頻率之備份系統宜比照 125.5 作業頻率規劃，其他席位亦宜比照相關作業頻率規劃。

2.8.4 無線電通訊測試

依飛航管理程序第 2-4-2 節規定，管制員應隨時監聽平面通信和指定的無線電頻率。區管中心每天早班各席位管制員依據「臺北區管中心 DVCSS 航管通訊電路每日測試紀錄表」，分別測試其管制範圍最遠數個航點的無線電通訊狀況，以瞭解其收、發品質，作成紀錄後交由班務督導員簽署，轉交無線電維護單位通訊設備臺處理。

經查區管中心北部席之測試紀錄表，測試點為其管制範圍最遠之西部馬祖±0.5 哩、北部 SALMI±20 哩及東部 SEDKU±20 哩三個點，但是 SALMI±20 哩並不測試 121.5 及 243.0 緊急波道，該測試程序遺漏該區東北部 SALMI 及 BULAN 等交管點附近緊急波道之接收情況，致事故發生時，北部席無法收到 CX521 班機呼叫 Mayday。若無線電測試程序包含 SALMI 航點之緊急波道，管制員可及早發

現馬公電臺無法正常收訊，修正測試程序，以避免類似事件再度發生。

2.9 生還因素

檢視客艙組員均經歷完整客艙失壓應變訓練，客艙組員與飛航組員之溝通及客艙組員之緊急應變大致符合公司程序。依該機系統設計，當客艙高度超過 14,000 呎時，客艙氧氣面罩將（自動／手動）落下，同時，禁止抽煙及繫緊安全帶警示燈亮起，隨後自動以三種語言（英語、日語及廣東話）播放指示廣播，其指示包括乘客禁止抽煙、戴上氧氣面罩及繫緊安全帶。依據國泰空服作業手冊第五章「CABIN CREW SAFETY AND EMERGENCY PROCEDURES MANUAL」第 4.2 節說明「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.」，意即該機氧氣面罩落下後，須下拉才能開始供應氧氣。另客艙氧氣面罩未自動落下時，客艙組員可使用手動工具打開蓋板使面罩落下。

依本報告第 1.15.3 節，氧氣面罩駕駛員手動放下後伴隨三動語言自動廣播，但部份乘客可能因語言障礙、未能充分了解自動播放廣播中之氧氣供應啟動程序或未遵守廣播要求，共有 3 位乘客的氧氣面罩未能供氧。

本報告表 1.15-1，該機於 L1 及 R1 門處，有 3 具客艙組員氧氣面罩未能自動掉落，該機客艙組員未使用工具試圖開啓蓋板，亦未使用座椅附近的可攜式氧氣瓶。

依本報告表 1.15-1，8 具自動落下之客艙組員氧氣面罩中有 4 具可能未被客艙組員啟動供氧。另有掉落氧氣面罩之 2 位客艙組員未使用氧氣面罩，客艙組員自述未使用理由為不認為需要使用；有客艙組員使用正常供氧之氧氣面罩，敘述「不覺得面罩有在供氧」；亦有客艙組員之氧氣瓶無化學作用進行，事後客艙組員自述「面罩正常」。顯示部分客艙組員未能充分了解氧氣面罩之正常操作狀況。

依據國泰空服作業手冊第五章第 7 節說明若航機艙壓高度繼續維持在事故發

生時之 38000 英尺，乘員於 30 秒內將可能產生失能症狀。

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

上述資訊顯示客艙組員不熟悉氧氣面罩設計特色及須下拉才開始供應氧氣之操作；雖然在此次艙壓高度未超過 14,000 英尺之事故中，部分客艙組員未能使用或未使用氧氣面罩之作爲未對自身產生影響，但此舉可能誤導乘客認爲不需依指示帶上氧氣面罩。

依本報告第 1.15.1 節，氧氣系統啓動後，部分客艙組員誤認客艙焦味爲客艙冒煙或起火，客艙組員於發現異常狀況後，主動通報機長及座艙長，並持續回報狀況，雖符合程序要求，惟氧氣瓶啓動後會產生氣味未見於客艙組員相關手冊及訓練內容，可能增加客艙組員解開安全帶，尋找火源而產生的風險。

第三章 結論

本章中依據調查期間所蒐集之事實資料以及綜合分析，總結以下三類之調查發現：「與可能肇因有關之調查發現」、「與風險有關之調查發現」及「其它調查發現」。

與可能肇因有關之調查發現

此類調查發現係屬已經顯示或幾乎可以確定為與本次事故發生有關之重要因素。其中包括：不安全作為、不安全狀況或造成本次事故之安全缺失等。

與風險有關之調查發現

此類調查發現係涉及飛航安全之風險因素，包括未直接導致本次事故發生之不安全作為、不安全條件及組織與整體性之安全缺失等，以及雖與本次事故無直接關連但對促進飛安有益之事項。

其它發現

此類調查發現係屬具有促進飛航安全、解決爭議或澄清疑慮之作用者。其中部分調查發現為大眾所關切，且見於國際調查報告之標準格式中，以作為資料分享、安全警示、教育及改善飛航安全之用。

3.1 與可能肇因有關之調查發現

1. 在 1 號發動機供氣閥失效依最低裝備需求表鎖於關閉情況下，2 號發動機供氣系統乃該機空調系統之唯一氣源，2 號發動機供氣系統處於高供應量之狀況下運作。當飛機高度開始下降時，發動機壓縮段 8 級氣源改由壓力及溫度較高之 14 級提供，使通過預冷器之空氣溫度上升。因扇氣閥溫控器網狀濾網遭受汙染，降低推動扇氣閥之氣壓，以致該氣閥無法正常開啓以提供足夠之冷卻空氣，致預冷器下游壓縮空氣過熱，致 2 號供氣閥因過熱而自動關閉，空調系統失效，艙壓高度升高失去客艙加壓之能力。(2.5)

3.2 與風險有關之調查發現

1. 由該機 1 號供氣系統於事故前發生多次重發性故障及該型機隊於半年內發生多次 2 套氣動系統失效情況，顯示該系統不穩定，對飛航安全有潛在性風險。(2.6)
2. 飛航組員因同一空域內存在近似呼號之航機、系統失效工作壓力、分心及未完全遵守公司無線電通訊規定等因素，誤聽航管對其他在空機之指令，提前將通訊波道換至臺北近場臺之波道。(2.1.1)
3. CX521 班機不完整的無線電覆誦及呼叫加上與其他航機呼叫重疊，使飛航組員與飛航管制員均失去複查此一不正確指令之機會。(2.1.1)
4. 於 CX521 班機首次誤聽 CI5213 班機之指示後，管制員在班機呼號運用上未依據「飛航管理程序」之相關程序，讓駕駛員易於區別。(2.1.1) (2.8.2)
5. 「飛航管理程序」第 2-4-15 節「為澄清而加重語氣」程序，中文版為非強制性規定，與英文版不同。(2.8.2)
6. 近場臺聽到 125.1 波道中有航機呼叫 Mayday 時未按規定立即處理，於 CX521 班機再次呼叫緊急狀況，近場臺方進行相關確認工作。(2.8.3.1)
7. 管制員對於緊急情況之資訊掌握過晚，指示更換波道之頻率過高、要求緊急情況航空器實施速度限制等，未符飛航管理程序中，提供危難航空器最大之協助、最高之優先次序，亦未考慮駕駛員工作負荷及無線電通信有關之人為因素。(2.8.3.2)
8. 近場臺與塔臺對於該機落地後多次詢問地面支援，顯示航管單位間協調連繫未臻完備。(2.8.3.2)
9. CX521 班機於 1859:56 時在 121.5 緊急波道呼叫“Mayday …”，於 1900:52 時前，區管中心各管制席位皆選擇馬公臺址無線電，以致未聽到 CX521 班機緊急波道通話。(2.8.3.3)

10. 區管中心北部席 121.5 緊急波道可選擇大屯山、馬公兩個無線電臺，但兩電臺因地理位置相距約 140 哩，以及地形影響，無法互為備份。(2.8.3.3)
11. 區管中心北部席之測試程序遺漏緊急波該區東北部 SALMI 及 BULAN 等交管點附近緊急波道接收情況，致事故發生時北部席無法收到 CX521 班機呼叫 Mayday。(2.8.4)
12. 部分客艙組員於氧氣面罩未能自動下落時，未使用工具試圖開啓蓋板，亦未使用座椅附近的可攜式氧氣瓶。(2.9)
13. 部分客艙組員可能不熟悉氧氣面罩須下拉才開始供應氧氣之操作及氧氣面罩之正常操作狀況。(2.9)
14. 部分客艙組員未能使用或未使用氧氣面罩之作爲可能誤導乘客認爲不需依指示戴上氧氣面罩。(2.9)
15. 氧氣瓶啓動後會產生氣味未見於客艙組員相關手冊及訓練內容，可能增加客艙組員解開安全帶尋找火源而產生的風險。(2.9)

3.3 其它發現

1. 飛航組員相關飛航證照，符合香港特別行政區政府民航處民航法規規定。(2.1)
2. 無證據顯示飛航組員於該次飛航中曾受任何受酒精及藥物之影響。(2.1)
3. 飛航組員於執行緊急下降程序下降至約 FL300 時，尚未及執行啓動 APU 程序，即出現「CAB PR EXCESS CAB ALT」警告訊息，因依規定執行「CAB PR EXCESS CAB ALT」之程序而未執行 APU 啓動程序。(2.1.2.1)
4. FDR 資料顯示，航機於下降至 FL100 過程中，艙壓高度最大指示均未超過 14,000 呎，顯示飛航組員無須手動放下客艙氧氣面罩。(2.1.2.2)
5. 「CAB PR EXCESS CAB ALT」程序及「EMER DESCENT」兩程序對設定

Transponder 電碼 7700 之規定不同。(2.1.2.2)

6. 無證據顯示於緊急下降過程中，該機之電碼係置於 7700 位置。(2.1.2.2) (2.8)
7. 當第 2 套供氣系統亦失效時，駕駛員採取緊急下降至安全的高度乃是必要的。
(2.2)
8. 艙壓高度在駕駛員緊急操作下，航空器所經歷之最高艙壓高度仍在適航認證的範圍內。(2.3)
9. 該機艙艙之洩漏速率合於該型機飛機維修手冊規範。(2.3)
10. 使用人對應最低裝備需求表 36-11-02 之維修作為，符合最低裝備需求表之規定。(2.4)
11. 1 號供氣系統之供氣閥送至原廠之拆解結果，無法確認與飛行線上發生之故障有關。(2.6)
12. 1903 時至 1907 時該機與區管中心通聯時，曾發生短暫通訊不良的狀況，無證據顯示區管中心當時無線電系統有異常之情形。(2.7)
13. 部份乘客可能因語言障礙、未能充分了解氧氣面罩啟動程序或未遵守廣播要求，致氧氣面罩未能供氧。(2.9)

第四章 飛安改善建議

本章中，4.1 節為依據本調查之結果而提出之飛安改善建議。各相關機關（構）於調查過程中已完成或進行之改善措施，列於 4.2 節，惟本會並未對其所提列之飛安改善措施進行驗證，故相關之飛安改善建議仍列於 4.1 節中。

4.1 改善建議

飛安改善建議

致香港特別行政區政府民航處

1. 要求國泰航空公司評估最低裝備需求表，增修訂組員操作程序，當飛機在 1 套氣源失效情況下飛行時，能及時啟動 APU，讓飛機儘早恢復艙壓能力，以降低乘員失壓的風險。（ASC-ASR-10-08-004）
2. 要求國泰航空公司在扇溫控器之網狀濾網新設計或改善未完成前，評估縮短扇氣閥溫控器進廠檢視或翻修時限。（ASC-ASR-10-08-005）
3. 要求國泰航空公司對於重複發生故障，且有多套系統同時失效情況下，審慎評估最低裝備需求表使用，或修訂其相關之最低裝備需求表以降低空中多系統失效之風險。（ASC-ASR-10-08-006）
4. 要求國泰航空公司檢視並修訂「AIR DUAL BLEED FAULT」、「CAB PR EXCESS CAB ALT」與「EMER DESCENT」等相關差異性操作程序。（ASC-ASR-10-08-007）
5. 要求國泰航空公司重新檢視客艙失壓之相關程序並加強要求客艙組員確實執行客艙失壓應變程序。（ASC-ASR-10-08-008）

致法國民用航空局（DGAC, France）

1. 要求空中巴士公司考慮重新設計或改良扇氣閥溫控器之網狀濾網，以降低 A330

型機雙發動機供氣系統失效之風險。在扇氣閥溫控器之網狀濾網新設計或改善未完成前，評估縮短扇氣閥溫控器進廠檢視或翻修時限。(ASC-ASR-10-08-009)

2. 要求空中巴士公司檢視並修訂「AIR DUAL BLEED FAULT」、「CAB PR EXCESS CAB ALT」與「EMER DESCENT」等相關差異性操作程序。
(ASC-ASR-10-08-010)

3. 要求空中巴士公司考慮在未來產品安全管制程序 (Product Safety Process) 評估列管過程中，引用同型系列機隊解決方案的經驗對區域性服勤機隊發生之異常事件，及早啟動改善方案的研究並將發布解決方案時程提前以降低操作風險。
(ASC-ASR-10-08-011)

致國泰航空公司

1. 評估最低裝備需求表或增修訂組員操作程序，當飛機在 1 套氣源失效情況下飛行時，能及時啟動 APU 運轉，儘早恢復艙壓，以降低乘員失壓的風險。
(ASC-ASR-10-08-012)

2. 在扇氣閥溫控器之網狀濾網新設計或改善未完成前，評估縮短扇溫控器進廠檢視或翻修時限。(ASC-ASR-10-08-013)

3. 對於重複性的故障，且存在多系統同時失效情況下，考慮最低裝備需求表之使用項目，或修訂其相關之最低裝備需求表以降低空中多套系統失效之風險。
(ASC-ASR-10-08-014)

4. 檢視並修訂「AIR DUAL BLEED FAULT」、「CAB PR EXCESS CAB ALT」與「EMER DESCENT」等相關差異性操作程序。(ASC-ASR-10-08-015)

5. 檢視環境變化資訊、面罩蓋板手動啟動及供氧程序等客艙失壓相關程序及訓練並加以落實。(ASC-ASR-10-08-016)

致交通部民用航空局

1. 要求管制員確實執行近似呼號之航空器特別強調某些數字或文字，並通知相關駕駛員以利區別之飛航管理程序及規定。(ASC-ASR-10-08-017)
2. 修正「飛航管理程序」中文版第 2-4-15 節「為澄清而加重語氣」程序，以符合第 1-2-1 節「字義」規定，並與英文版之意義一致。(ASC-ASR-10-08-018)
3. 加強管制員對遇險航空器之緊急協助及狀況警覺，確依飛航管理程序之緊急協助規定，儘速掌握「緊急情況之性質」及「駕駛員之期望」時效，提供危難航空器最大之協助、最高之優先次序，並考慮駕駛員工作負荷及無線電通信有關之人為因素。(ASC-ASR-10-08-019)
4. 審閱程序中有關緊急情況下航管員應考量以指示正常航空器更換無線電波道方式，以避免更增加危難航空器駕駛員工作負荷。(ASC-ASR-10-08-020)
5. 強化航管單位間溝通協調連繫以及航管作業之訓練、考核，及緊急情況之處理。(ASC-ASR-10-08-021)
6. 規劃無線電備份系統時，需考慮空域無線電之需求，於選擇備用台址時應不致降低其原有效能或影響航管作業。(ASC-ASR-10-08-022)
7. 修正區管中心北部席之測試紀錄表測試程序，使能涵蓋本區東北部 SALMI 及 BULAN 等交管點附近區域之工作情況。(ASC-ASR-10-08-023)

4.2 已完成或進行中之改善措施

交通部民用航空局

飛航服務總臺臺北近場臺於 97 年 11 月 10 日地區複訓時，針對本案講授「緊急應變處理」注意事項，另於 98 年 1 月 8 日製作「航空器飛航中遭遇緊急狀況」席位檢查表置於席位；於 12 月 1 日再發布通告；另飛航服務總臺已於每日測試中增設 B576 SALMI 點附近之測試。

國泰航空公司

國泰航空公司已採取之飛安改善措施原文引述如下:

- *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.*

法國空中巴士公司

法國空中巴士公司已採取之飛安改善措施原文引述如下：

- 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.

附錄 1 座艙語音紀錄器錄音抄件 1056:00 至 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 ...

hh	mm	ss	Source	Context
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
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

hh	mm	ss	Source	Context
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
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

hh	mm	ss	Source	Context
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
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

hh	mm	ss	Source	Context
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
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

hh	mm	ss	Source	Context
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
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

附錄 2 事故發生前三個月之維修紀錄

From/To Block Off/On	Defect/Action
From	Defect
Block OFF	
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	DURING ENG #1 START BOTH SECTORS BLEED PSI WAS ONLY

2008/8/6 10:53	INDICATING 14-18 PSI HOWEVER ENG #1 STARTED NORMALLY
HKG	ADD 597 #1 ENG BLEED PRESSURE IND LOW BTW 12-20 PSI BUT START APPEAR NML
2008/8/7 11:25	
SGN	REF ADD 597 NO.1 ENG BLEED PX IND LOW.
2008/8/14 11:58	
SGN	REF ADD 597 PLS CHK FOR WATE RCONTAMINATION ON SENSE LINE AND CARRY OUT FUNCTIONAL TEST OF BLEED REGUIDED PRESS XDCR.
2008/8/14 11:58	
HKG	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.
2008/8/14 14:41	
SGN	REF ADD 597 NO.1 ENG START BLEED PRESSURE INDICATES LOW.
2008/8/14 11:58	
HKG	G2 BEV MAKER CUATER SUPPLY LINE AIR BLEEDING CARRIED OUT & CHKED SATIS
2008/8/17 06:00	
DEL	AIR ENG 1 BLEED NOT CLOSED DURING ENG SHUTDOWN
2008/8/19 21:54	
HKG	NIL RELATED ON CM2R ENG 1 BLEED SW CYCLED BMC 1 SYS TEST AND GND RPT OK
2008/8/20 03:52	
HKG	AMM TASK 36-11-15-720-801 C/OUT FUNCTIONAL TEST AT BLEED TRANSFERRED PRESS TRANSDUCER PASS ADD REMAINS
2008/8/21 12:19	
DEL	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
2008/8/23 13:32	
HKG	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
2008/8/23 19:20	
DEL	REF ADD 597 ENG 1 BLEED PRESS IND UNDER READ

2008/8/24 08:57	
HKG	HISTORY REVIEWED AND WIRING I/R CHK C/OUT AS PER ASM
2008/8/24 14:42	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	BLEED REG PX XDCR REINSTALLED REF ITEM 7
2008/8/24 14:42	
DEL	DURING ENG START AND CROSS BLFED START NO.1 ENG BLEED
2008/8/24 08:57	PX INDICATING LOW.
HKG	FOUND LINE BETW PNEU DUCT AND BLEED REG PX XDCR
2008/8/24 14:42	SHEARED. LINE REPLACED. ENG START WITH CROSS BLEED, PX SHOWED 28 PSI
HKG	AIR ENG 1 BLEED NOT CLSD AFTER LANDING
2008/8/26 08:29	
ICN	BMC #1 SYSTEM TESTS C/OUT PASSED. ENG 1 BLEED VLV OPS
2008/8/26 11:55	TEST OK. PLS OBS FURTHER
SUB	ENG 1 BLEED FAULT / ON FOR 1 SECOND IN CRUISE
2008/8/29 01:21	
CGK	ENG 1 BLEED NOT CLOSED OCCURRED AFTER SHUTDOWN

2008/8/31 01:40	VALVE OPEN AMBER ON BLD PAGE THEN SELF CLEARED AFTER TWO MINS
HKG	NO FAULT MSG CAPTURE. ENGIN 1 GROUND RUN CARRIED OUT BLEED VALVE OPERATION NORMAL. AMM 71-00-00
2008/8/31 06:24	
HKG	INBD CREW VERBAL REPORT. ENG 1 BLEED STS FAULT IN CRZ.
2008/9/1 08:20	
HKG	AIR ENG 1 BLEED NOT CLSD AFTER ENG SHUTDOWN.
2008/9/3 16:09	
HKG	AIR ENG 1 BLEED NOT CLOSED. WHIST TAXI-ING IN AFTER LANDING.
2008/9/12 21:03	
ICN	361152 PRESS REG-V/SOV CLASS 1 NOTED, #1 BLEED VLV EXERCISED & ECAM ERASED.
2008/9/13 00:40	
ICN	AIR ENG BLEED NOT CLOSED THIS TIME OCCURING DURING ENGINE WIND DOWN AFTER ENG MASTER SX'D OFF.
2008/9/13 01:36	
HKG	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.
2008/9/13 05:04	
NRT	AIR ENG 2 BLEED FAULT @APPROX 36000 INITAL RESET UNSUCCESSFUL ,2ND O.K SEE ASR.
2008/9/14 07:54	
NRT	SADD 617 "AIR ENG 1 BLEED NOT CLOSED"ECAM MSG
2008/9/14 07:54	
TPE	ENG 1 BLEED VALVE (4001HA)REPLACED PER AMM 36-11-52 LEAK CHK C/OUT SATIS REF TO ITEM 11
2008/9/14 11:39	
NRT	PLS C/OUT BOTH ENG BLEED AIR VALVE OPS CHK WITH ENG RUN
2008/9/14 07:54	
TPE	ENG IDLE RUN C/OUT ON BOTH ENG ,BOTH BLEED AIR VLVS OPS CHK SATIS
2008/9/14 11:39	
NRT	ETOPS DOWNGRADES BOTH ENG BLEED AIR SYS HAVE BEEN DISTURBED
2008/9/14 07:54	
HKG	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
2008/9/14 23:15	

TPE	AS PER WORKREQUEST 39703 ITEM 02 C/OUT TSM TASK
2008/9/14 21:45	36-11-81-810-913 ON NO.2 ENG
HKG	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
2008/9/14 23:15	NOTED REF CRD NLH01149
TPE	AS PER WORK REQUEST 39703 ITEM 03 C/OUT TSM TASK
2008/9/14 21:45	36-11-81-810-850 ON NO.1 ENG
HKG	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
2008/9/14 23:15	REF CARD NLH01149
TPE	AS PER WORKREQUEST 39703 ITEM 04 C/OUT TSM TASK
2008/9/14 21:45	36-11-81-810-861 ON NO.2 ENG
HKG	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
2008/9/14 23:15	REF CARD NLH01149
TPE	AS PER WORK REQUEST 39703 ITEM 05 BMC 1 + 2 DATA PRINT
2008/9/14 21:45	OUT
HKG	BMC 1 + 2 DATA PRINT OUT AND FAX TO IOC IAW AMM
2008/9/14 23:15	36-11-00-710-811 REF CARD NLH01149
TPE	AS PER WORK REQUEST 39703 ITEM 06 BOTH ENG BLEED SYSTEM
2008/9/14 21:45	OPS CHK
HKG	BOTH ENG BLEED SYSTEM OPS CHK C/OUT IAW AMM
2008/9/14 23:15	36-11-00-710-813 NO.1 ENG BLEED 38 PSI AND BLEED TEMP 150C AT IDLE 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	AS PER WORKREQUEST 39703 ITEM 07 FUNCTIONAL TEST OF
2008/9/14 21:45	BLEED VLV

HKG	BOTH ENG BLEED VLV FUNCTIONAL TEST C/OUT IAW AMM
2008/9/14 23:15	36-11-52-720-809 SATIS REF CARD NLH01149
TPE	AS PER WORK REQUEST 39703 ITEM 08 FUNCTIONAL TEST OF HP
2008/9/14 21:45	BLEED VLV
HKG	BOTH ENG HP BLEED VLV FUNCTIONAL TEST C/OUT IAW AMM
2008/9/14 23:15	36-11-51-720-810 SATIS REF CARD NLH01149
TPE	AS PER WORK REQUEST 39703 ITEM 09 CPC 1 AND 2 OPS CHK
2008/9/14 21:45	
HKG	CPC 1 + 2 OPS CHK C/OUT IAW AMM 21-31-00-710-801 TEST OK REF
2008/9/14 23:15	CARD NLH01149
HKG	TEST C/OUT IAW AMM 05-53-00-780-803-01 TEST SATIS A/L LEAK
2008/9/14 23:15	RATE APPROX 0.8 PSI/MM

附錄 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 (AIB 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 (AIB DUAL BLEED FAULT)]

[]

11-06 IP Check Valve

b)

- After start, during taxi:

Crossbleed SelOPEN
Associated ENG 1(2) BLEED pb SWOFF

- Just before take-off:

Associated ENG 1(2) BLEED pb SWON
Crossbleed SelAUTO

- Before initiating descent and until landing:

Crossbleed SelOPEN
Associated ENG 1(2) BLEED pb SWOFF

- Just before engine shutdown:

Associated ENG 1(2) BLEED pb SWON
Crossbleed SelAUTO

附錄 4 事故發生前之延遲改善缺點

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 PDU ROLLER 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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附錄 5 CX521 航班維修報告

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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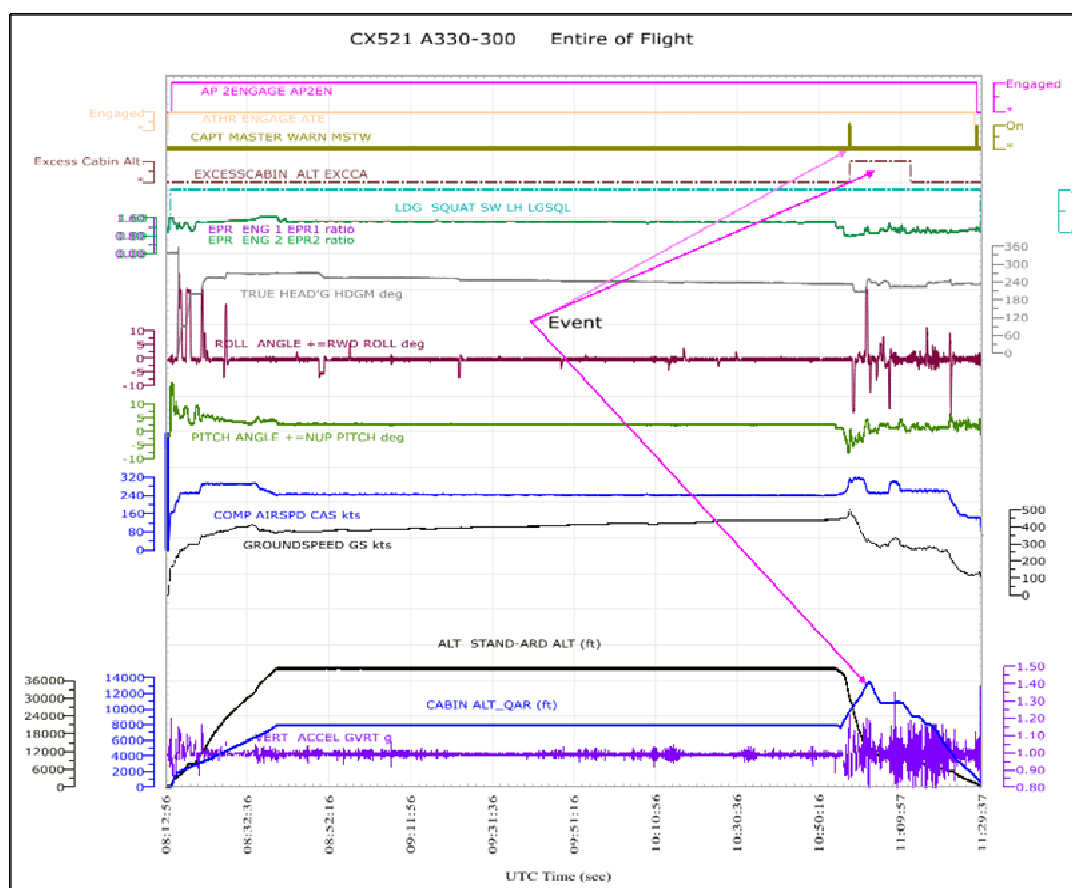
附錄 6 SSFDR data plots

6-1 SSFDR related parameters plot (1)

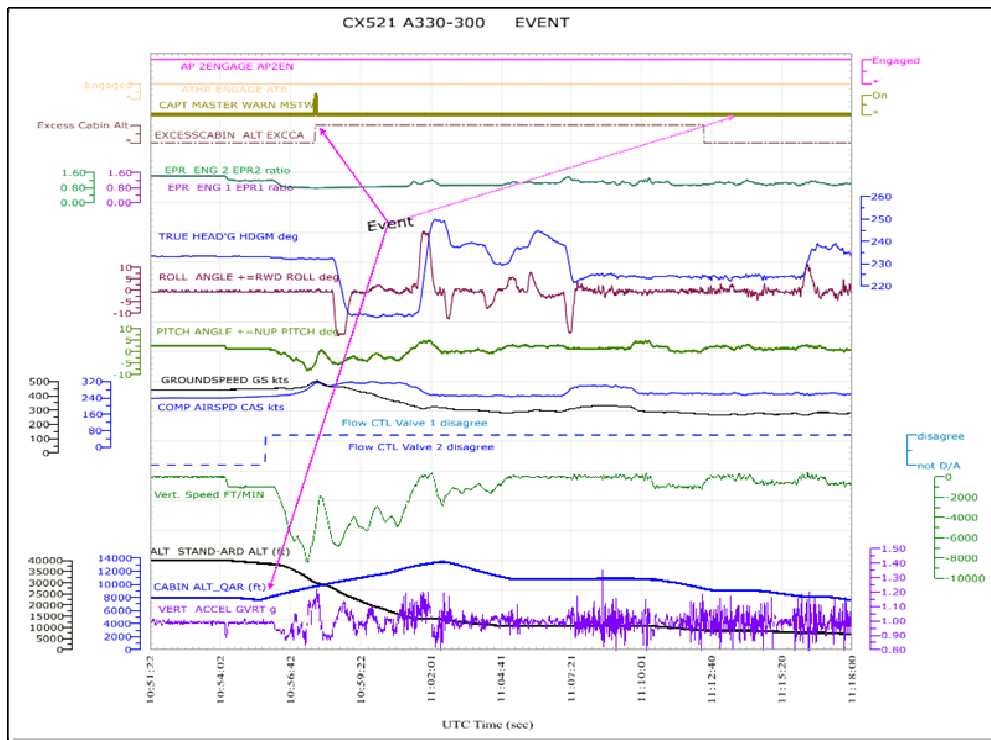
6-2 SSFDR related parameters plot (2)

6-3 SSFDR related parameters plot (3)

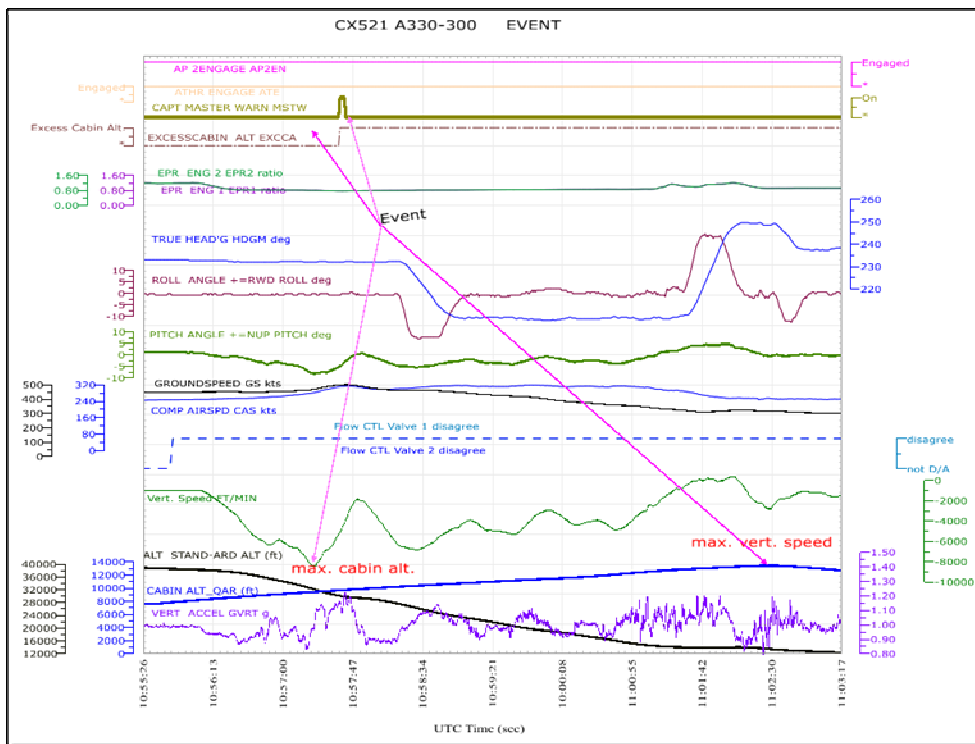
6-4 Superposition of flight path and satellite Map.



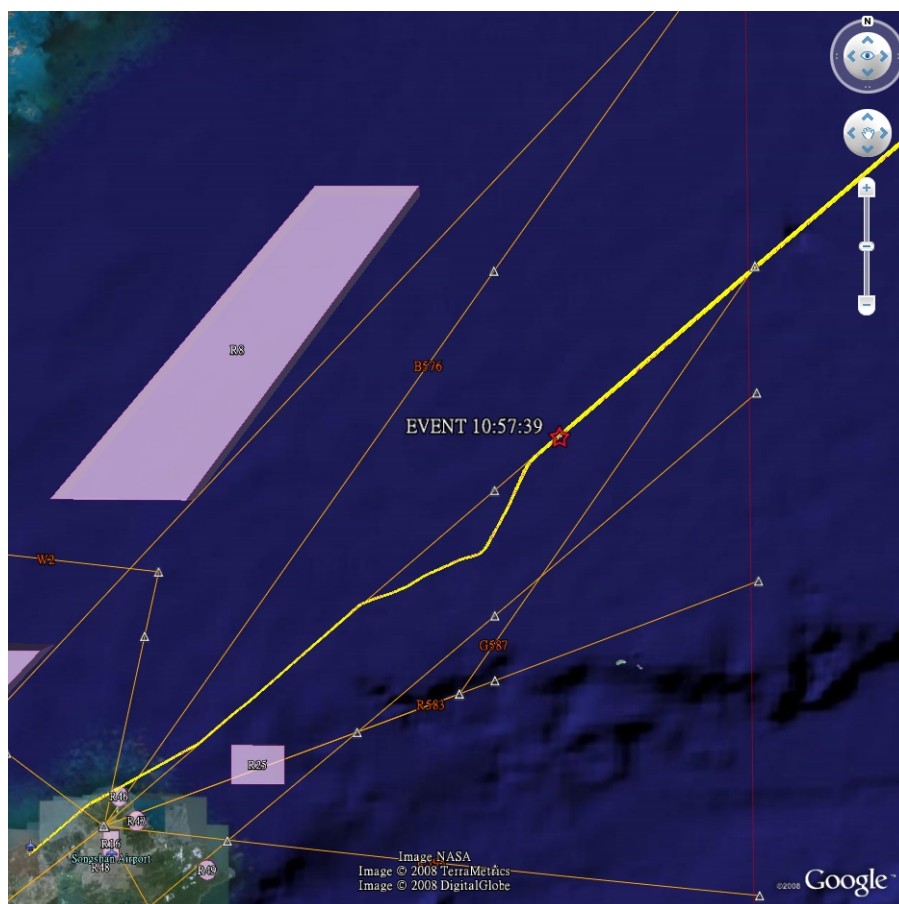
6-1 SSFDR related parameters plot: entire of flight (1)



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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附錄 7 元件測試報告

LIEBHERR-AEROSPACE TOULOUSE S.A.

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

REFERENCE : SC/ST/08-1219
Indice/ Issue : /
Date de l'expertise : 22/10/2008
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COMPTE RENDU D'EXPERTISE / INVESTIGATION REPORT

EMETTEUR / SENDER	Rédigé par / Issued by	Approuvé par / Approved by
Nom / Name Département Téléphone / Phone Fax Date Visa	Technical Support 05-61-35-22-41 05-61-35-29-29 22/10/2008	
PARTICIPANTS / MEMBERS		DIFFUSION / ISSUING
BEA CPA		Participants + : P Graves AI : SEE
AI :EYVT AI :SEE		Mathieu CALLENAERE AI : LR Prog
LTS : Engineering LTS : Engineering LTS : Engineering LTS : Methods LTS : Methods LTS : Laboratory Material	Lloyd Tracy Guillaume Gard Michel Eglen Francis Carla Dominique Loret Philippe Tardieu Claude Rossignol	LTS : Technical Support LTS : Technical Support LTS : Engineering LTS : Engineering LTS : Quality Assurance LTS : Quality Assurance LTS : Laboratory Material
OBJET DE L'EXPERTISE / SUBJECT		
Description Part Number Sérial Number Operator Aircraft Assembly Date Flight hours Removal Date	Thermostat (THC) 398E020000 00163 CPA B-HLH # 1 05/94 TSI 10145 FH TSN 31547 FH 14/09/2008	Fan Air valve (FAV) 6733A030000 00156 CPA B-HLH # 1 10/94 TSI 17305 FH TSN 25203 FH 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.

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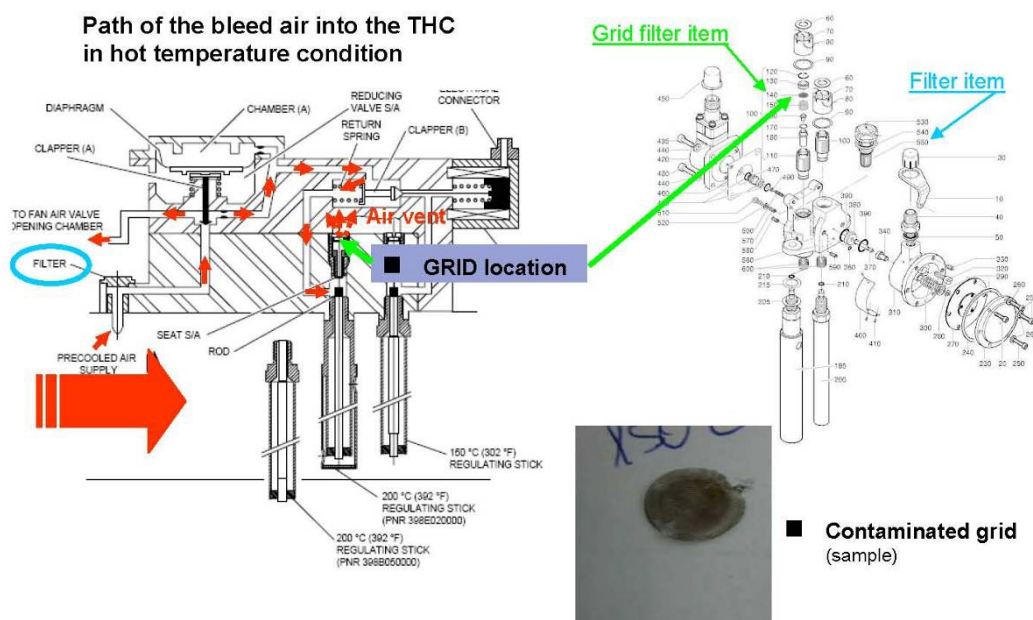
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Final Testing with the grid filter pierced at nominal temperature condition as per CMM requirements has allowed to re-find the value within the tolerances:

-T= 205 °C 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 .



matrice/0992crex ind 1

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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



matrice/

lever wear



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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

titre/titre:

reference:

RO S/N:

TCT

GO-NOGO 398E020000

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

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

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:

Signature: 455 mbar
sous 3 bar - 1850°C = 473 mbar

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APPENDIX 2 : FAV testing

LIEBHERR-AEROSPACE S.A.

Tool & scheduling Data sheet / Fiche de codification de pontic FA

ref RO: 194318	CMM: 36-11-24	Client / Airline: LSZ	Date:	Contrôle final / Final control:
P/N: 6733A030000	Monteur / Operator:			
S/N: 00156				

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

Designation of test	Condition	Nominal value	LRDM code	Value	confirmation
Visual inspection	Check visual inspection		10		
Insulation resistance test					
Apply 50VDC	Check insulation resistance	R ≥ 100 MΩ	20	70000	
Continuity test					
	Measure continuity between bonding points	R ≤ 20 mΩ	20	5 m Ω	
Air functional test on table					
Mini. Opening pressure test					
Valve dosed	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	450	
	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	0.98	
	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

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

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Appendix 3 THC SN 644 SFR and testing

LIEBHERR Liebherr Aerospace Singapore 8 Pandan Avenue Singapore 607564 Your contact : Name : XXXXXXXXXX Tel : + 65 64747315 Fax : + 65 62652657 E-mail : XXXXXXXXXX		LIEBHERR CATHAY PACIFIC AIRWAYS LTD FPM, MAT PLANNING & SUPPLY DE SOUTH TOWER CATHAY PAC CITY 8 SOUTH TOWER LANTAU HONGKONG 95 Repair Order : 317014 Sales Order : 317014 Sheet : 2 of 2 Issue : 0	
SHOP FINDING REPORT INVESTIGATION REPORT CUSTOMER DATA Operator : cathay pacific airways pbb Customer Order : 80180883 Aircraft : A310XRP Aircraft Reg No : B-111-11 Date of receipt : 10/10/2008 Work requested : repair Warranty requested : No Approved date : CMM 36.31.35 Rev3		UNIT RECEIVED DATA Part No : 308F020000 Amendment : - Description : thermocouple Serial No : 00040 Quantity : 1 Manufacture date : 10/08 TSN : 10143.84 TSD : 10143.84 TSN : 17594.24 WORK ORDER / WORK : 1183	
UNIT TO BE DELIVERED / UNIT DELIVERED Part No : 308F020000 Amendment : - Customer ref. : - Serial No : 00040 Quantity : 1 Work performed : repair Warranty applied : Out of Warranty		REASON FOR RETURN : 41 ENG BLEED FAULT MSG (011 A) VISUAL CHECK : Unit received in dirty condition. FINDINGS AND ANALYSIS : reduced pressure (hot air) on 150°c stick out of oil reduced pressure (hot air) on 700°c stick out of oil Incoming filter pressure drop test found: 110 mbar (nom< 100 mbar) Disassembly defects found: Diaphragm 342.4250 aged. Poppet 398-24 worn. Spring S100-6/3, S100-687 & S100-909 tension weak. M/F Reduced pressure 600 (two side) ORIGIN OF DEFECT : Reported defects was due to the faulty pressure reducing v/s (both at low side) WORK PERFORMED : AS PER MANUAL contact 150°c stick / seat cleaned and lapped packing 4407-2-741 A on 140°c stick replaced sealing 140°c stick / seat adjusted (hot air) contact 200°c stick / seat cleaned and lapped packing 4407-2-741 A on 200°c stick replaced sealing 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 : Return justified ? : Yes Reason for return confirmed ? : Yes Name :	

LIEBHERR-AEROSPACE TOULOUSE S.A.

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

LIEBHERR COMPONENT MAINTENANCE MANUAL 398050000 & 398020000 THERMOSTAT

TASK 35-11-35-700-801-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

NR 368E02000	S/N: 00644		
TESTED BY: [REDACTED]	DATE: 22 OCT 2008		
FINAL INSPECTION APPROVAL BY: [REDACTED]	DATE: 22 OCT 2008		
POSITION IN THE CHM:			
MEASUREMENT	NOMINAL VALUE TOL. FRANCE	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 (20-150).	> 100 MΩ	>100 MΩ
Para. 1.D.2b	Electrical continuity test Measure electrical continuity between contact pin(3)(ground) of electrical connector (20-150) and any point of unit.	≤ 20 mΩ	17 mΩ
Para. 1.D.2c	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	P2 valve = ±150 mbar rel.	147 mbar
Para. 1.D.3b	150°C regulating stick energize the solenoid with 17 VDC P1=3 bar rel. ± 0.1 bar rel.	P2 valve = ±150 mbar rel.	147 mbar
Para. 1.D.4g	Hot air test Adjustment of 150°C regulating stick. T1= 161± 2°C, P1=3 ± 0.1 bar rel.	P2 valve = 300 ± 20 mbar	298 mbar
Para. 1.D.4h	Adjustment of 200°C regulating stick. T1= 205 ± 2°C, P1=3 ± 0.1 bar rel.	P2 valve = 300 ± 20 mbar	301 mbar
Para. 1.D.4i	Temperature control T1= 205± 2°C. P1=4 ± 0.1 bar rel. P2 bar rel. P1=3 bar rel. Decrease T1= 181°C	P2 value = 340 ± 15 mbar P2 value = 255 ± 10 mbar P2 value = 303 ± 9 mbar P2 value = 302 ± 15 mbar	338 mbar 263 mbar 300 mbar 298 mbar

IAS/DT226

Rev.1, Dated 09 Sep. 2008

CHM 35-11-35, Rev. 3

LIEBHERR COMPONENT MAINTENANCE MANUAL 398050000 & 398020000 THERMOSTAT

TASK 35-11-35-700-801-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	SIN:	00644
TESTED BY:	Lim Xian Jie <i>lim</i>	DATE:	20 oct 2008
FINAL INSPECTION APPROVAL BY:	<i>Sungu Rajendran</i>	DATE:	20 oct 2008
POSITION IN THE CHM:			
	MEASUREMENT	NOMINAL VALUE TOLERANCE	ACTUAL VALUE UNIT
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 (20-150)	> 100 MΩ	>100 MΩ
Para. 1.D.2b	Electrical continuity test Measure electrical continuity between contact pin(3)(ground) of electrical connector (20-150) and any point of unit.	≤ 20 mΩ	17 mΩ
Para. 1.D.2c	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	P2 valve = ±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 valve = ±150 mbar rel.	147 mbar
Para. 1.D.4g	Hot air test Adjustment of 150°C regulating stick. T1= 161± 2°C, P1=3 ± 0.1 bar rel.	P2 valve = 300 ± 20 mbar	298 mbar
Para. 1.D.4h	Adjustment of 200°C regulating stick. T1= 205 ± 2°C, P1=3 ± 0.1 bar rel.	P2 valve = 300 ± 20 mbar	298 mbar
Para. 1.D.4i	Temperature control T1= 205± 2°C. P1=4 ± 0.1 bar rel. P1=2 bar rel. P1=3 bar rel. Decrease T1= 181°C	P2 valve = 340 ± 15 mbar P2 valve = 255 ± 10 mbar P2 valve = 303 ± 9 mbar P2 valve = 302 ± 15 mbar	338 mbar 260 mbar 300 mbar 298 mbar

IAS/DT226

Rev.1, Dated 09 Sep. 2008

CHM 35-11-35, Rev. 3

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	: /
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COMPTE RENDU D'EXPERTISE / INVESTIGATION REPORT

EMETTEUR / SENDER	Rédigé par / Issued by	Approuvé par / Approved by
Nom / Name Département Téléphone / Phone Fax Date Visa	Technical Support 05-61-35-22-41 05-61-35-29-29 22/10/2008	
PARTICIPANTS / MEMBERS		DIFFUSION / ISSUING
BEA CPA	Participants + : P Graves	AI : SEE
AI : EYVT AI : SEE	Mathieu CALLENAERE	AI : LR Prog
LTS : Engineering LTS : Engineering LTS : Engineering 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 : Engineering LTS : Engineering LTS : Quality Assurance LTS : Quality Assurance LTS : Laboratory Material
OBJET DE L'EXPERTISE / SUBJECT		
Description Part Number Sérial Number Operator Aircraft Assembly Date Flight hours Removal Date	PRV 6764B040000 Amdt A 00573 CPA B-HLH # 2 12/99 TSI 7895 FH 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

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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

Closing indication issue:

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:

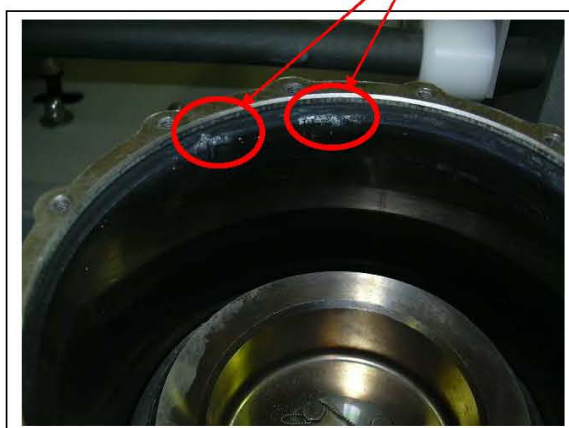
Complementary static tests have been performed and have revealed an external leakage and an actuator piston leakage out of the CMM tolerances:

- 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
B.P. 2010 - 408 av. des Etats-Unis
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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					

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Appendix 2

LIEBHERR AEROSPACE SAS

Fiche d

ref RO : 146359 P/N : 6764B940000 S/N : 00535	CMM : 36-11-23 Client / Airline : CATHAY Monteur / Operator :	Date :	Contrôle final / Final control :
NFF- No fault Found / NFF- Pas de pannes trouvées		1000	

Designation of test	Condition	Nominal value Tolerance	LIROW code	Value	Confirmation
Visual inspection					
Check of butterfly clearance	Check visual inspection		10		
	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	3000	
Continuity test					
	Measure 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	
Additional microswitch test					
Open and close valve	Check switch setting	8 ± 1°	35/6	5.5	
	Check switch hysteresis	≤ 13°	35	20	
Air functional 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	to ≤ 4s	45	3	
	Open valve by obturating vent and check time to open	to ≤ 4s	45/5	4.4	
Test of downstream clapper					
Apply P2= 1 bar rel (14.5 psig)	Verify opening of downstream clapper	open	60	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	2.146	
	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	4.33	
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). P2= 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 thermal					
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 166.6 psig) P2 = 3 ± 0.1 bar rel (42 to 45 psig)	Check value of Q1 leakage rate	Q1 ≤ 750 Nl/min	80/63	850 Nl/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	83/5	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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附錄 8 服務資訊信函

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 'ENG 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).

SIL NUMBER: 36-055
 PAGE: 2 of 4
 DATE: Jun. 28/2004
 REVISION: 01 - 15 Nov. 2006

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 1/2 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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附錄 9 相關航務操作程序

與本次事故相關之操作程序如下：

- 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(yCR/ 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 it 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(s)/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 <4> 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(s)/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.

ONE PACK ONLY IF WAI ON

STATUS

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	TS6067/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	TS6783/TM CWP/REV 45 CP C (25 APR 07)	1.28
	MISCELLANEOUS		

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	TS670XTM CM, (1 FEB 48) G (25 APR 05)	2.21
	PNEUMATIC		
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. • <u>AT, OR BELOW, FL 220:</u> - 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. • <u>AT, OR BELOW, FL 220:</u> - 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.

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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).

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.]

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TS7684/DMLQ/cw]

**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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附錄 10 相關飛航管制操作程序

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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

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- 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

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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) APPROACHES/PRACTICE PRECAUTIONARY APPROACHES, Para 3-10-12.

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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.

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- 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 HLJK (or HJ) to blink in the data block.
- ③ Only nondiscrete Code 7500 will be decoded as the hijack code.

9.2.2

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- 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.

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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.*

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- 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.

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- 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.

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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 NRCC 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 units concerned 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.

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- 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:

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- 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.

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9.2.9

附錄 11 各單位陳述意見之書面說明

香港特別行政區政府民航處提出 10 點陳述意見，本會不同意部份如下所述：

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”.

國泰航空公司提出綜合性 2 點陳述意見，4 項有關飛航操作陳述意見，10 項有關生還因素陳述意見，本會不同意部份如下所述：

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 information 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 filter), 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.

附件清單

- 1 CX521 飛航計畫書
- 2 臺北區域管制中心、臺北近場管制塔臺及臺北機場管制臺管制條
- 3 臺北區域管制中心、臺北近場管制塔臺之航管通訊電路每日測試紀錄表
- 4 航管業務通用手冊第 14 版
- 5 臺北區域管制中心業務手冊第 15 版
- 6 臺北近場管制塔臺業務手冊第 13 版
- 7 飛航管理程序 CHG-1
- 8 臺北飛航情報區飛航指南（事故當日有效版本）
- 9 ICAO Doc. 4444 V15
- 10 事件發生時臺北區域管制中心、臺北近場管制塔臺雷達螢幕顯示紀錄
- 11 B-HLH Certificate of Airworthiness.pdf
- 12 B-HLH Certificate of Registration.pdf
- 13 B-HLH Last letter check records.pdf

- 14 Maintenance record of THC_filter_replacement.pdf
- 15 B-HLH 3 Months Maintenance Logs.xls, B-HLH Tech Logs 01-07-08 to 26-08-08.pdf, B-HLH Tech Logs 26-08-08 to 14-09-08.pdf, B-HLH Cabin log.pdf
- 16 原件測試報告，CPA_DBL_B-HLH_PRV_SN_573.pdf and CPA_DBL_B-HLH_THC_398_SN_163_AND_FAV_6733_SN_156.pdf
- 17 A330 Aircraft Maintenance Manual
- 18 A330 Flight Crew Operations Manual (FCOM), CATHAY PACIFIC AIRWAYS.
- 19 A330 Quick Reference Handbook (QRH), CATHAY PACIFIC AIRWAYS.
- 20 CX521 Cabin Crew and Passenger O2 Mask Deployment
- 21 Decompression AEQ 2009
- 22 A330 MEL 36-11-01/2 / Pneumatic
- 23 A330 MEL 36-11-01/2 / Pneumatic Operational Procedure
- 24 OPERATIONS MANUAL, CATHAY PACIFIC AIRWAYS LTD.

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飛航事故調查報告

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