飛航事故調查報告

ASC-AOR-12-04-001

中華民國100年5月12日
立榮航空公司執行BR 806班機任務
MD-90型機
國籍標誌及登記號碼B-17917
於桃園機場落地時偏離跑道

飛安

飛航安全調查委員會
AVIATION SAFETY COUNCIL

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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爲目的。

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

民國 100 年 5 月 12 日，立榮航空股份有限公司（以下簡稱立榮）一架 MD- 90 型客機，國籍標誌及登記號碼 B-17917，溼租予長榮航空股份有限公司（以下簡稱長榮），執行由澳門機場飛往桃園國際機場（以下簡稱桃園機場）之載客任務，班機號碼 BR806，機上載有飛航組員 2 員、客艙組員 5 員及乘客 127 員。

2036 時[1]該機於桃園機場 06 跑道落地，落地滾行時，於距 06 跑道頭約 3,340 呎處右主輪偏出跑道，後於 5,100 呎處返回跑道。該機經由 S6 滑行道脫離跑道，滑回停機位後檢查，發現航機受輕微損傷，人員無傷亡。

行政院飛航安全委員會（以下簡稱本會）爲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獨立機關，依據飛航事故調查法並參考國際民航公約第 13 號附約（Annex 13 to the Convention on International Civil Aviation）相關內容，於民國 100 年 5 月 12 日接獲我國桃園機場公司航務處之事故通報後，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）、桃園國際機場公司、立榮航空股份有限公司（簡稱長榮）、美國運輸安全委員會及波音公司。

本事故「調查報告草案」依程序於 100 年 12 月 27 日經本會第 151 次送委員會議初審修正後，於 101 年 1 月 12 日函送相關機關（構）提供意見，並再經彙整相關意見修正後，於 101 年 3 月 20 日經本會第 153 次委員會議審議通過。獲通過之調查報告經與相關機關（構）確認並由立榮航空公司於 101 年 4 月 24 日向本會第 154 次委員會陳述意見後，於 101 年 5 月 4 日發布。

[1]本報告時間均採用台北時間，採 24 小時制，以 FDR 時間為參考依據。台北時間=UTC 時間+8 小時。

本事故調查經綜合事實資料及分析結果，獲得之調查發現共計 14 項，改善建議計 19 項，分述如後：

調查發現

與可能肇因有關之調查發現

1. 落地當時自 500 呎至落地期間有約 10 浬/時至 20 浬/時之左側風；飛航組員落地前未獲知風速顯著變化資訊；落地後未能及時伸展地面擾流板，致無法破壞機翼升力，減低地面風對航機右傾之影響；落地後左側風增至最大 18 浬/時，航機左機翼因側風使升力增加使左機翼上揚，操控駕駛員亦未及時向上風邊壓桿，克服左翼上揚現象，因而使航機產生向右坡度之右偏；側風落地時遭遇風標效應，飛航組員未能即時將反推力器回收至慢車減少側向分力，更加劇航機右偏，終致航機短暫偏出跑道。（1.11、2.3.2、2.3.2.1）

與風險有關之發現

1. 飛航組員通知航管完成進場準備時之外型、高度、空速及距離機場距離，未符該公司「交叉檢查執行」及「下降計劃」要求。（1.11.1、 1.11. 2、2.2、2.3.1.3）
2. 飛航組員於航機高度較正常下降計畫高且速度較快時警覺不足；且未能於確認及討論後再執行相關操作。（1.11.1、2.3.3.2）
3. 臺北近場臺桃南席管制員許可 BR806 進場時，該機攔截 ILS 之高度高於下滑道約 1,000 呎，且未提供航空器相關距離資料，增加駕駛員進場操作之風險。（1.9、1.11、2.10）
4. 飛航組員下降前所獲之天氣資料及落地前塔台告知之天氣資料，符合副駕駛員落地操作標準，但此後因天氣變動，致使該機於落地前側風之變化已超出副駕駛員落地標準；落地前飛航組員並未獲知最新之天氣資料。（1.7、1.18.1.、2.3.1.2、2.10）
5. 臺北近場臺桃南席管制員未依「飛航管理程序」確認駕駛員是否收到最新之

ATIS。（1.9、2.10）

6. 塔臺機場席因廣播雷暴警報與能見度，以及其他航機徵詢雷雨天氣資訊，致未能掌握地面風之變化，並提供 BR806 地面風顯著變化之資訊。（1.7.2、1.18.1.、2.10）
7. 該機左右主輪及鼻輪三輪同時著陸，平飄至著陸期間之著陸姿態異常，未符 MD90 標準操作手冊之要求。（1.11.2、2.3.2）
8. 航機落地後出現偏側時正駕駛員未能及時接手。（1.11.1、1.11.2、2.3.2）
9. 該二名飛航組員未能依照立榮航空 MD90 標準操作手冊要求實施呼叫，公司應加強航務自我督察作業。（1.5.1、1.5.2、2.3.1.1、2.3.3.1）
10. 正駕駛於該機落地後，忽略檢查擾流板之狀態，在擾流板未自動展開時以手動方式使其展開。（1.11.1、1.11.2、1.16.2、1.16.3、2.4、2.5）
11. 較可能造成該機落地後擾流板未自動展開之原因，係駕駛員雖有將減速板拉起但未拉至正確備動位置，或遺漏執行拉起減速板手柄至備動位置之動作，且於執行落地檢查時未完成確認。（1.11.1、1.11.2、1.16.2、1.16.3、2.4、2.5）
12. 近場台管制員工作負荷過重，班務督導及協調員未視航行量及工作量變化，主動調配人力，開啓餽給席以分擔桃南席之管制工作。（1.9、2.10）
13. 由近年的事故調查案例中，曾發現 2 次值班管制員未按「飛航管理程序」規定提供航空器重要天氣資料的情況，顯現訓練考核與席位查核作業未能發揮應有之改善機制。（1.18.1、2.10）

其他發現

1. 飛航組員相關飛航資格，符合現行民航法規之規定。（1.5.1、1.5.1.2、2.1）
2. 無證據顯示飛航組員於飛航中曾受任何生理、心理、藥物及酒精影響。（1.5.2.1、1.5.2.2、2.1）
3. 該班機載重平衡在限制範圍內，無證據顯示本次事故與航機之維修及適航有關。（1.6.2、2.1）
4. 該機飛航組員如能參考 ALAR Tool Kit 第 8.6 節內容，將可於飛航中適時獲得

有關風之資訊。(1.18、2.3.3.1)

5. 該機落地時鋪面有發生水飄的條件及環境，但因該機著陸後第 3 秒及第 4 秒左主輪離地，第 6 秒及第 7 秒右主輪離地，之後該機即偏出跑道，本次偏出跑道事故應非水飄現象所致。(2.3.2)
6. 該機無線電高度 200 呎以下至主輪著陸期間，風切危害因子小於 0.1、CVR 及 FDR 資料亦顯示機上風切警告系統（windshear alerting and guiding system）未致動、且當時地面觀測亦無風切警告，故無風切現象。(1.11.2、2.3.2)
7. 該具 FDR 紀錄之「煞車踏板位置」、「煞車壓力」及「地面擾流板位置」三參數，非屬我國現行法規要求紀錄之 32 項必要參數，惟屬於 ICAO 第六號附約第 9 版之標準及建議措施所要求紀錄之 78 項必要參數。(1.11.2、2.6)
8. 民航局航務檢查員於立榮航空部分航務相關主管從缺後，未要求立榮航空確實依航務手冊另行指派。(1.17.4.、2.7.1)
9. 我國民航法規未將民航運輸業之航務主管須具備民航運輸業駕駛員及航務相關督導或管理經驗列爲必要條件。(1.17.1、1.17.2、2.7.2)
10. 桃園機場 06/24 跑道鋪面橫坡度符合「民用機場設計暨運作規範」需求，但若跑道在降雨量大的狀況下仍可能造成跑道鋪面水深變高之現象。(1.10.1、1.10.3、2.8.1、2.8.3)
11. 民航局欠缺機場跑道平坦度檢測指導之相關規定，另桃園機場未執行 06/24 跑道平坦度檢測。(1.12.2、2.8.2)
12. 事故後，桃園機場 06/24 跑道摩擦係數值均高於摩擦係數養護規劃標準及最低抗滑標準。(1.10.2、2.8.4)
13. 「台灣桃園國際機場活動區之巡場與維護作業程序」之不定期巡場程序，未依據「民用機場空側作業應注意事項」建議將惡劣天候狀況之條件（如：強風、大雨、霧或低能見度）加以敘明。(1.10.3、 2.8.5.2)
14. 該機落地後通報塔臺跑道煞車狀況爲「poor」之後，該資訊有加報於後續之 ATIS，但塔臺未將此資訊通知桃園機場公司航務處。(1.11、2.8.5.4)

15. 桃園機場公司未依「民用機場設計暨運作規範」及「民用機場鋪砌道面狀況應注意事項」建議，將需增加特別抗滑檢測之情況納入如「臺灣桃園國際機場跑道鋪面摩擦阻力檢測及維護作業規定」等相關程序中。（1.10.3、2.8.5.4）
16. 桃園機場 06/24 跑道落地之航機多屬高速著陸飛機，且跑道寬 60 公尺，適用「民用機場設計暨運作規範」建議設置跑道中心線燈之條件。（1.10.1、2.9）

飛安改善建議

致立榮航空公司

1. 加強 MD-90 機隊正駕駛員於擔任監控駕駛員時，於發現操控駕駛員操作異常時應及時接手之認知。（ASC-ASR-12-05-001）
2. 加強 MD-90 機隊飛航組員訓練、考核及自我督察項目，其中應包括：（ASC-ASR-12-05-002）
   A. 於側風、跑道濕滑下之落地及操控技巧，包括側風落地遭遇風標效應反推力器之使用；並對航務手冊有關組員資源管理有關狀況警覺及資訊交換之執行。
   B. 有關飛航組員遵守標準操作程序及計畫（包括檢查及標準呼叫），及檢視並考量修訂現行 MD-90 機隊飛航組員於落地前對減速板手柄位置之檢查程序及操作方式，以確保落地後地面擾流板之伸展。
3. 考量參考 ICAO Tool Kit 有關風之相關資訊並有效運用於飛航中。（ASC-ASR-12-05-003）
4. 重新依據航務手冊檢視運航本部航務相關主管之派任。（ASC-ASR-12-05-004）
5. 重新檢視飛航資料紀錄器之年度檢查程序及其感應裝置的校準作業，以確保飛航資料紀錄器所記錄參數之正確性。（ASC-ASR-12-05-005）
6. 檢討現行飛航資料分析系統無法捕捉及分析航空器偏出跑道風險類的關鍵參數原因，研擬強化飛航資料分析系統功能之辦法。（ASC-ASR-12-05-006）

致交通部民用航空局

1. 督導立榮加強 MD-90 機隊正駕駛員於擔任監控駕駛員時，於發現操控駕駛員操作異常時應及時接手之認知。（ASC-ASR-12-05-007）
2. 督導立榮加強 MD-90 機隊飛航組員訓練及考核及自我督察項目，其中應包括：（ASC-ASR-12-05-008）

A.於側風、跑道濕滑下之落地及操控技巧，包括側風落地遭遇風標效應反推力器之使用；並對航務手冊有關組員資源管理有關狀況警覺及資訊交換之執行。

B. 有關飛航組員遵守標準操作程序及計畫（包括檢查及標準呼叫），及檢視並考量修訂現行 MD-90 機隊飛航組員於落地前對減速板手柄位置之檢查程序及操作方式，以確保落地後地面擾流板之伸展。

3. 督導立榮檢視並考量修訂現行 MD-90 機隊飛航組員於落地前對減速板之操作、檢查程序及方式，包括落地前減速板手柄位置之檢查，以確保落地後地面擾流板之伸展。（ASC-ASR-12-05-009）
4. 督導立榮參考 ICAO Tool Kit 有關風之相關資訊，有效運用於飛航中。（ASC-ASR-12-05-010）
5. 督導立榮重新依據航務手冊檢視運航本部航務相關主管之派任。（ASC-ASR-12-05-011）
6. 督導立榮重新檢視飛航資料紀錄器之年度檢查程序及其感應裝置的校準作業，以確保飛航資料紀錄器所記錄參數之正確性。（ASC-ASR-12-05-012）
7. 督導立榮檢討現行飛航資料分析系統無法捕捉及分析航空器偏出跑道風險類的關鍵參數原因，研擬強化飛航資料分析系統功能之辦法。（ASC-ASR-12-05-013）
8. 督導飛航服務總台航管作業，重新檢視並落實飛航服務之管理政策，確保督導席及協調席善盡其席位管制之工作職責。（ASC-ASR-12-05-014）
9. 檢視航管訓練考核及席位查核之規定，並督導航管作業，使訓練考核及席位查核發揮應有之機制，確保航管服務皆能符合規定。（ASC-ASR-12-05-015）

10. 督導飛航服務總台評估管制員工作負荷及工作環境，落實「飛航管理程序」提供氣象資訊之規定。（ASC-ASR-12-05-016）

11. 落實飛航管理程序中塔台若收到跑道煞車狀況報告，應通知機場權責單位之相關規定。（ASC-ASR-12-05-017）
12. 考量增訂機場平坦度檢測之相關指導規定；督導桃園機場公司，增訂不定期巡場作業程序之啓動條件並於駕駛員通報跑道煞車狀況時，增加特別抗滑檢測或其它因應作爲之機制。（ASC-ASR-12-05-018）

致桃園機場公司

1. 增訂不定期巡場作業程序之啓動條件，並於駕駛員通報跑道煞車狀況不好時，增加特別抗滑檢測或其它因應作爲之機制。（ASC-ASR-12-05-019）

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第一章　事實資料

1.1　飛航經過

民國 100 年 5 月 12 日，立榮航空股份有限公司（以下簡稱立榮）一架 MD- 90 型客機，國籍標誌及登記號碼 B-17917，溼租予長榮航空股份有限公司（以下簡稱長榮），執行由澳門機場飛往桃園國際機場（以下簡稱桃園機場）之載客任務，班機號碼 BR806，機上載有飛航組員 2 員、客艙組員 5 員及乘客 127 員。2036 時[2]該機於桃園機場 06 跑道落地，落地滾行時，於距 06 跑道頭約 3,340 呎處右主輪偏出跑道，後於 5,100 呎處返回跑道。該機經由 S6 滑行道脫離跑道，滑回停機位後檢查，發現航機受輕微損傷，人員無傷亡。

綜合現場調查紀錄、人員訪談紀錄、座艙語音紀錄器（Cockpit Voice Recorder, CVR）及飛航資料紀錄器（Flight Data Recorder, FDR）等資料，該機之飛航情況如下：

該機起飛前飛航組員獲知目的地機場能見度良好、下大雨、雲幕高爲 2,500 呎，飛航沿途有雷雨。該機約於 1917 時起飛，正駕駛員坐於駕駛艙左座，擔任監控駕駛員（Pilot Monitoring, PM），副駕駛員坐於駕駛艙右座，擔任操控駕駛員（Pilot Flying, PF）。該機約於 1938 時到達巡航高度 31,000 呎，飛航組員於飛航中聽取桃園機場自動終端資料廣播服務（Automatic Terminal Information Service, ATIS）系統廣播，獲知桃園機場之風向爲 040 度，風速爲 16 浬/時，能見度爲 3,500 公尺，符合副駕駛員操作航機落地標準，正駕駛員於進場提示時決定由副駕駛員於落地時擔任操控駕駛員。

該機約於 2009 時開始下降(飛航軌跡如圖 1.1-1)。約於 2021 時通過高度 20,000 呎，於苗栗附近，機上氣象雷達顯示前方有積雨雲且目視有閃電，因而飛航組員向航管申請往東偏移以躲避雷雨，該機於距機場約 30 浬時，由航管雷達引導進場。

[2]本報告時間均採用台北時間，採 24 小時制，以 FDR 時間為參考依據。台北時間=UTC 時間+8 小時。

飛航組員表示進場過程中沿途都有雷雨。依據座艙語音紀錄器資料，該機於 2032:25 時放下起落架並開始執行落地前檢查，於 2033:04 時，高度約 2,700 呎時，塔臺許可落地，並告知 06 跑道之風向 030 度、風速 10 浬/時、能見度 3,500 公尺。依據座艙語音紀錄器資料，於 2033:30 時飛航組員於落地前檢查中曾報：「spoiler brake armed uh medium flaps slat」。於 2033:39 時，正駕駛員與副駕駛員間曾討論機外天氣爲雷雨，當時該機高度爲 2,248 呎。於 2034:41 時，塔台發布雷暴警報[3]，當時該機高度爲 1,452 呎。

於 2035:52 時，該機通過高度 500 呎時，飛航組員互相確認「Stable」，正駕駛員呼叫：「Approach light insight」，於 2036:06 時，副駕駛員請正駕駛員打開雨刷。該機於 2036:39 時左、右主輪及鼻輪同時著陸，著陸時空速 144 浬/時；於 2036:41 時，左、右反推力器打開，主輪著陸後第 3 秒及第 4 秒，左主輪由「GND」模式轉爲「AIR」模式；主輪著陸後第 6 秒及第 7 秒，右主輪由「GND」模式轉爲「AIR」模式；於 2036:46 時，該機於距 06 跑道頭 3,340 呎，該機航跡向右偏出 06 跑道邊線外；於 2036:49 時，座艙語音紀錄器中出現異常之滾行聲；於 2037:56 時，距 06 跑道頭 5,100 呎，該機重回 06 跑道。飛航資料紀錄器資料顯示，該機於 2036:39 時至 2041:55 時期間，左、右擾流板均處於收回狀態。

依據訪談紀錄，正駕駛員表示，落地前雨勢變大，觸地前跑道上有積水，落地後立刻使用反推力，航機向右偏，正駕駛員使用左舵修正機頭，航機仍向右偏，但之後很快就修正回來。航機於脫離跑道後，飛航組員發現滑行無問題，輪胎亦無不正常指示，於 S6 脫離跑道滑回停機位 C10，於滑行中飛航組員曾告知塔台「Braking action poor」，之後飛航組員請地面人員檢查外型。

地面檢查後發現，航機起落架擋水板變形，1、2、3、4 號主輪刮傷，2 號發動機外部及進氣導片有損傷痕跡，06 跑道右側 4 具跑道邊燈損壞。

[3]當雷暴系統移入機場 3 公里至 8 公里範圍內時，機場氣象單位會立即發布雷暴警報。

圖 1.1-1 飛航軌跡圖

1.2　人員傷害

該機搭載飛航組員 2 人、客艙組員 5 人及乘客 127 人，共計 134 人。人員無傷亡。

1.3　航空器損害

無實質損害。

1.4　其他損害情況

桃園機場 06 跑道右側 4 盞（編號 R19、R22、R23、R24）邊燈燈具受損。

1.5　人員資料

1.5.1　駕駛員

駕駛員基本資料如表 1.5-1。

表 1.5-1 駕駛員基本資料表

項目	正駕駛員	副駕駛員
性別	男	男
事故時年齡	37	46
進入公司日期	民國 89 年	民國 85 年
航空人員類別 檢定證號	飛機民航運輸駕駛員 1025xx	飛機民航運輸駕駛員 3012xx
檢定項目 發證日期 終止日期	DASH-8/MD90 民國 97 年 2 月 21 日 民國 101 年 4 月 21 日	MD-90 F/O 民國 99 年 5 月 3 日 民國 104 年 5 月 8 日
體格檢查種類 終止日期	甲類駕駛員 民國 100 年 7 月 31 日	甲類駕駛員 民國 100 年 8 月 31 日
總飛航時間	10,444 小時	10,556 小時
最近 12 個月飛航時間	789 小時	861 小時
最近 90 日內飛航時間	228 小時	220 小時
最近 30 日內飛航時間	76 小時	68 小時
最近 7 日內飛航時間	25 小時	19 小時
MD-90 飛航時間	1,903 小時	5,082 小時
事故日已飛時間	2 小時 50 分	2 小時 50 分
事故前休息時間	10 小時以上	48 小時以上
附註：本資料時間皆以事故發生日（民國 100 年 5 月 12 日）爲準		

1.5.1.1 正駕駛員

正駕駛員爲中華民國籍，於民國 89 年 3 月進入長榮，爲長榮培訓之機師，於美國加州受訓期間之飛行時間約爲 300 小時。該員持有中華民國交通部民用航空局民用航空人員檢定證，航空人員類別爲：飛機民航運輸駕駛員，檢定項目欄內之註記爲：「DASH-8, MD-90、陸上多發動機 Multi-engine, Land、具有於航空器上無線電操作資格 Privileges for operation of radiotelephone on board an aircraft」，特定說明事項欄內註記爲：「無線電溝通英語專業能力等級五（Y/M/D）Language Proficiency: Level-5 ，Expiry Date 2013/09/20」。

該員曾擔任長榮 B747 型機副駕駛員，民國 94 年轉換立榮 DASH-8 型機，於同年 5 月完成晉升訓練，擔任 DASH-8 型機正駕駛員，民國 96 年 4 月完成 MD-90 型機正駕駛員轉換訓練，兼具 DASH-8 及 MD-90 型機正駕駛員資格。該員總飛航時間爲 10,444 小時，其中 MD-90 型機之飛航時間爲 1,903 小時。最近一次 MD-90 型機之年度檢定時間爲民國 99 年 11 月 7 日，檢定報告建議欄內之註記爲：「Completed and satisfied with briefing」，最近 3 年內之各類訓練及考驗無不正常紀錄。

該員體格檢查種類爲甲類駕駛員，上次體檢日期爲民國 99 年 7 月 13 日，體檢及格證限制欄內相關註記爲：「NONE（無）」。事故後該員於桃園機場航務處，由航務人員執行酒精測試，測試結果：酒精值爲零。

1.5.1.2　副駕駛員

副駕駛員爲中華民國籍，在美國自行學飛取得商業駕駛員證照，民國 85 年 5 月進入台灣航空公司（以下簡稱台航）。持有中華民國交通部民用航空局民用航空人員檢定證，航空人員類別爲：飛機商用駕駛員，檢定項目欄內之註記爲：「MD-90 F/O（First Officer）、陸上，多發動機 Multi-Engine, Land，具有於航空器上無線電操作資格 Privileges for operation of radiotelephone on board an aircraft」，特定說明事項欄內註記爲：「無線電溝通英語專業能力等級五（Y/M/D）Language Proficiency: Level-5，　Expiry Date 2013/08/27」

該員曾於台航擔任 Do-228 型機副駕駛員，台航與立榮合併後，於民國 88 年 3 月完成轉換訓練，擔任 DASH-8 型機副駕駛員。民國 93 年 3 月完成轉換訓練，擔任 MD-90 型機副駕駛員。該員總飛航時間爲 10,556 小時，MD-90 型機之飛航時間爲 5,082 小時。最近一次之年度檢定時間爲民國 100 年 1 月 15 日，檢定報告建議欄內之註記爲：「Completed with satisfactory」，其他 3 年內各類訓練及考驗無異常紀錄。

該員體格檢查種類爲甲類駕駛員，上次體檢日期爲民國 100 年 1 月 11 日，體

檢及格證限制欄內相關註記爲：「NONE（無）」。事故後該員於桃園機場航務處，由航務人員執行酒精測試，測試結果：酒精值爲零。

1.5.2 駕駛員事故前 72 小時活動

1.5.2.1 正駕駛員

5 月 10 日： 在家休假。

5 月 11 日： 約 0800 時起床，1205 時前往機場執行松山飛馬公國內航線任務，來回三趟，於 2100 時落地，2200 時返家休息。

5 月 12 日： 約 0900 時起床，1420 時至機場報到，執行 BR805/806 桃園往返澳門任務，於 1758 時飛抵澳門，1917 時自澳門起飛返回桃園。

1.5.2.2 副駕駛員

5 月 10 日： 在家休假。

5 月 11 日： 在家待命（1230 時至 2200 時）。

5 月 12 日： 約 0800 時起床，1420 時至機場報到執行 BR805/806 桃園往返澳門任務，1758 時飛抵澳門，1917 時自澳門起飛返回桃園。

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。

表 1.6-1 航空器基本資料（統計至民國 100 年 5 月 12 日）

編號	項目	內容
1	機型	MD-90
2	國籍標誌及登記號碼	B-17917
3	製造廠	BOEING
4	製造序號	53572
5	製造日期	民國 87 年 1 月
6	交機日期	民國 87 年 1 月 25 日
7	使用人	長榮航空公司
8	所有人	立榮航空公司
9	最大起飛重量	75,296 公斤
10	適航證號碼/有效期限	100-01-020/民國 101 年 1 月 15 日
11	航空器總飛行時數	26,365.13
12	航空器總落地次數	17,926
13	上次 A 級檢查/完工日期	A02 檢查/民國 100 年 5 月 4 日
14	自上次 A 級檢查後 飛行時數/落地次數	56.33 小時/22 次

該機裝置兩具 International Aero Engines（IAE）公司生產之發動機，其基本資料詳表 1.6-2。

表 1.6-2 發動機基本資料

位置	製造廠	型號	序號	安裝日期	總使用時數	翻修後使用時數	總落地次數
1	International Aero Engines（IAE）	V2500-D5	V20125	05/17/2010	22,110:20	1,919	19,623
2	International Aero Engines （IAE）	V2500-D5	V20108	02/08/2010	19,861:56	2,465	15,965

1.6.2　載重平衡資料

該機重心限制範圍如圖 1.6-1。該機實際之載重與平衡相關資料如表 1.6-3。

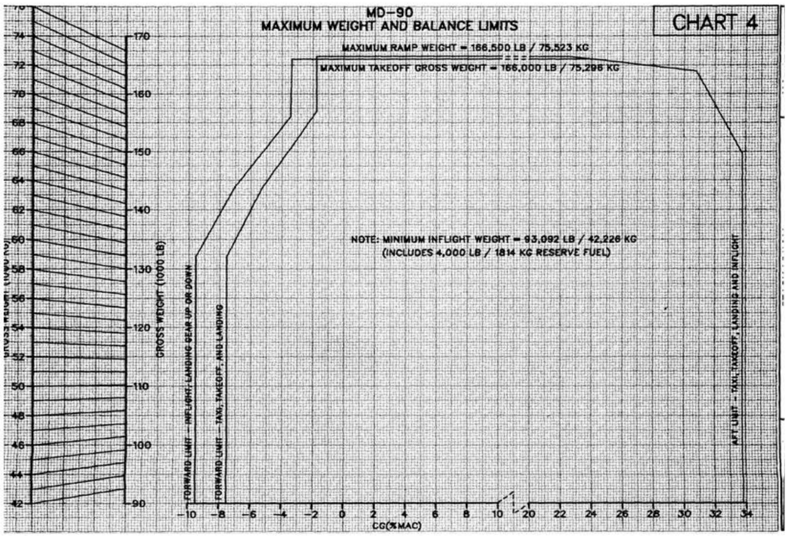

圖 1.6-1 MD-90 型機重心限制範圍

表 1.6-3 載重及平衡相關資料表

最大起飛重量	75,296
最大落地重量	64,410
最大零油重量	59,875
計畫零油重量	55,200
實際零油重量	55,300
計畫起飛總重	62,900
實際起飛總重	62,988
起飛油量	7,690
航行耗油量	3,995
計畫落地總重	58,900
實際落地總重	58,993
起飛重心位置	6.3 % MAC[4]

單位：公斤

1.6.3 維修資料

查閱該機於事故發生前 3 個月內相關維修資料，無與事故有關之系統故障登錄，亦無相關待執行之適航指令。

[4] MAC: Mean Aerodynamics Chord。

事故當日（民國 100 年 5 月 12 日）飛行前檢查單（Preflight Check Sheet）顯示（詳附錄一），1、2、3、4 號主輪及左、右鼻輪胎壓如下：

輪胎編號	1號主輪	2號主輪	3號主輪	4號主輪	左鼻輪	右鼻輪
標準胎壓磅／平方吋（PSI）	180±5	180±5	180±5	180±5	155~160	155~160
量測胎壓磅／平方吋（PSI）	182	181	182	180	156	157

1.6.4　MD-90 地面擾流板操作[5]

1.6.4.1　擾流系統設計

MD-90 擾流系統由左、右機翼上方，襟翼前方之三片擾流板（spoiler panels）所組成。兩片靠近翼尖擾流板爲飛行擾流板，功能除單邊伸展以協助副翼進行左右滾轉動作外，亦具兩邊同時伸展之飛行減速功能，稱之減速板（speed brake），減速板手柄控制兩翼上之擾流板，於減速時對稱展開。另一片擾流板靠近機身，其功能爲地面擾流板（ground spoiler），正常情況下只能於飛機著陸時一齊展開。

MD-90 型機之飛行手冊中說明，襟翼與擾流板禁止於飛行中同時伸放。

1.6.4.2　減速板手柄制鎖

MD-90 型機地面擾流板於飛行時具備有制鎖之機械結構 （MD-90 In-Flight Ground Spoiler Lockout Mechanism），以下簡稱擾流板制鎖機構，當襟翼展開大於 8 度之同時，襟翼之機構件會將減速板機構制鎖，以避免於飛行時不愼被手動移動。當減速板正在伸展時，如果駕駛員又再伸展襟翼，則會致動警報，此時制鎖機構亦會置於備動（armed）位置，如果駕駛員將減速板手柄置於收回位置，制鎖機構亦完成制鎖構型，則該制鎖構型將持續至解鎖輸入或襟翼收回爲止方完成解鎖條件

[5]本章節內容係譯自波音文件，原文請參考波音網站。
http://boeing.com/commercial/aeromagazine/aero_03/textonly/sy02txt.html

（unlock）。

1.6.4.3 制鎖機構解鎖

航空器於落地時伸展地面擾流板，需要輸入下列任何一個獨立解鎖條件，減速板手柄方得解鎖，並伸展地面擾流板（詳附錄二）。

- 自動擾流板致動器伸展（auto spoiler actuator activated）
- 主起落架主輪承重（weight on wheel）
- 鼻輪起落架支柱壓縮（nose gear compressed）

1.6.4.4 自動擾流板致動器伸展

當航機主輪落地後，主輪轉速到達 390RPM（revolution per minutes，轉/分）至 725RPM 時，自動擾流板致動器會輸出解鎖訊號，此時若減速板手柄位置在備動狀態時，則自動擾流板致動器會將地面擾流板伸放至全開位置。

1.6.4.5 主起落架主輪承重

當航機落地，右起落架支柱被壓縮至 2 吋時，支柱中一個電磁閥會將減速板手柄解鎖，如遇主輪轉速或自動擾流板伸展功能皆失效時，駕駛員得於鼻輪支架壓縮前，以手動伸放地面擾流板。

1.6.4.6 鼻輪起落架支柱壓縮

當鼻輪起落架支柱被壓縮時，會輸出一個替代性之訊號，用來致動自動擾流板致動器，此功能如同一個備用的機械式解鎖機構，當自動擾流板致動器與電磁閥皆失效時，可用來解鎖減速板手柄。

MD-90 地面擾流板之詳細之操作說明可參考 MD-90 AIRCRAFT MAINTENANCE MANUAL。

1.7 天氣資料

1.7.1 天氣概述

事故當時有一鋒面，位於台灣東北方海面，向東移動。受此鋒面影響，台灣中部以北地區對流旺盛，台北航空氣象中心當日持續對此區發布雷暴之顯著危害天氣資訊（Significant Meteorological Information，以下簡稱 SIGMET），事故時有效之 SIGMET 如下：

SIGMET 3；有效時間 1730 時[6]至 2130 時；台北飛航情報區，觀測並預測有隱藏的雷暴位於 N2730 E12400、N2400 E12400、N2330 E11730、N2630 E11730 所圍區域，雲頂高度高於 FL400[7]，強度不變，以 20 浬/時的速度向東北方移動。

桃園航空氣象臺於 2035 時發布以下之機場天氣警報：

機場天氣警報 1；有效時間 2035 時至 2135 時；2035 時觀測有雷暴。

2000 時及 2100 時之紅外線衛星雲圖如圖 1.7-1 及 1.7-2。

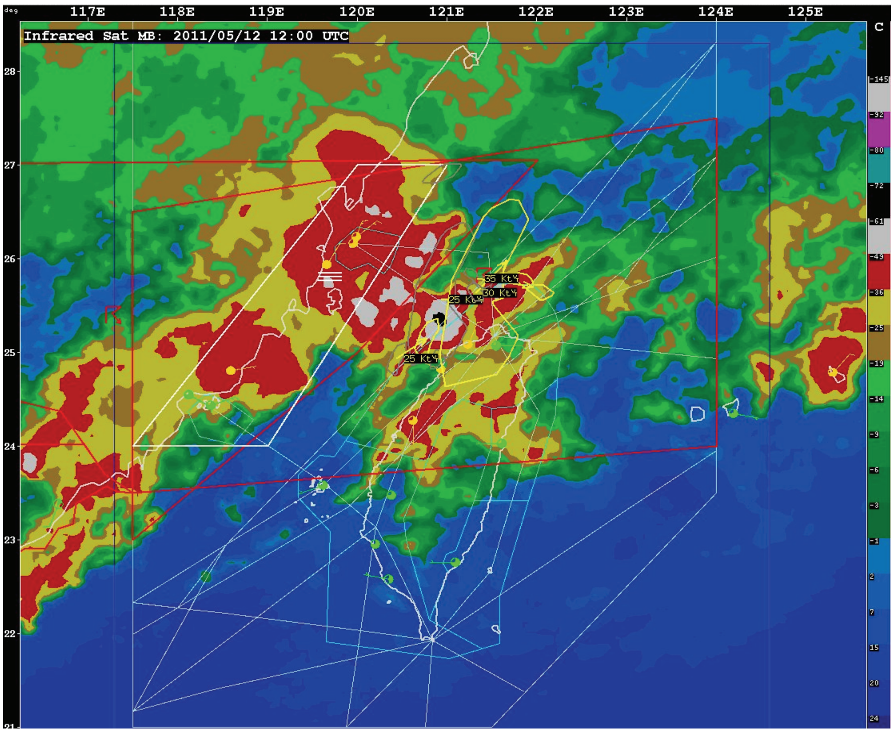

圖 1.7-1　2000 時之紅外線衛星雲圖

[6]第 1.7、1.9、1.18.1.4-6 述及之時間為 ATC 時間，與其他章節所使用以 FDR 為基準之時間，時間差距約 90 秒（ATC 時間+90 秒=FDR 時間）。

[7]高度 40,000 呎。

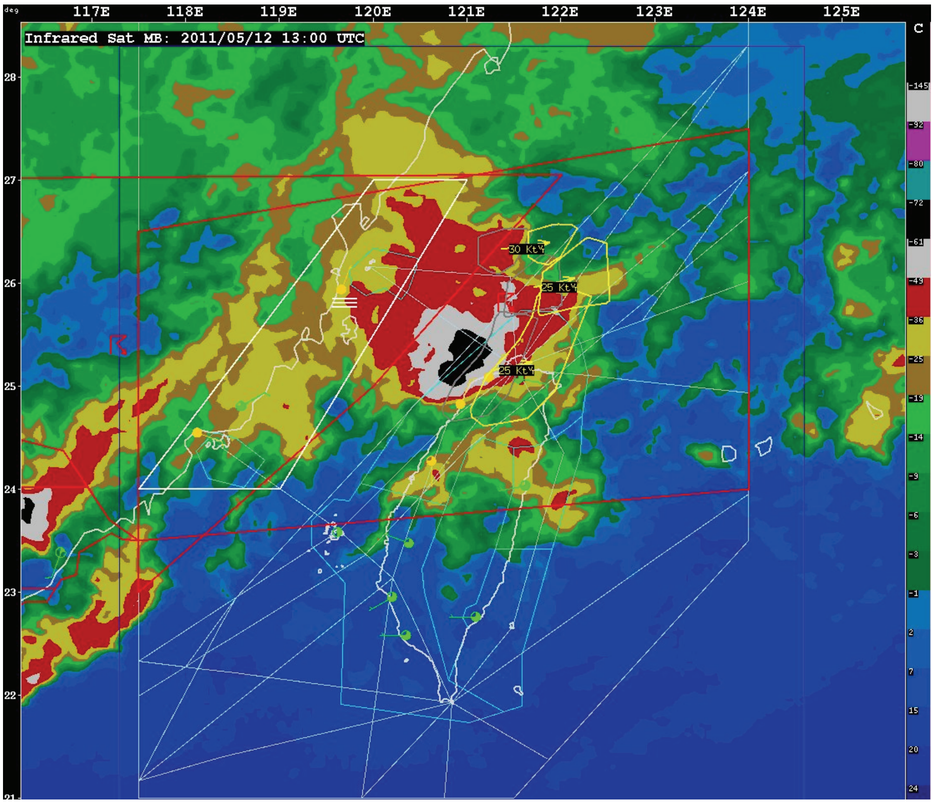

圖 1.7-2　2100 時之紅外線衛星雲圖

1.7.2　地面天氣觀測

桃園國際機場之地面天氣觀測紀錄如下：

2030 時：風向 040 度，風速 16 浬/時；能見度 3,500 公尺；臨近有雷暴、小陣雨；疏雲 400 呎、裂雲 700 呎、積雨雲稀雲 1,000 呎、裂雲 2,200 呎；溫度 24℃，露點 22℃；高度表撥定值 1010 百帕；補充資訊-全部跑道風切；趨勢預報-暫時性變動能見度 3,000 公尺，雷雨；備註-雷暴位於西南方至西北方，向東移動。（ATIS I）

2034 時：風向 020 度，風速 15 浬/時，風向變動範圍 300 度至 060 度；能見度 800 公尺；跑道視程-05 跑道大於 2,000 公尺、06 跑道大於 2,000 公尺；中度雷雨；疏雲 200 呎、裂雲 500 呎、積雨雲疏雲 1,000 呎、裂雲 1,500 呎；溫度 24℃，露點 22℃；高度表撥定值 1011 百帕；補充資訊-全部跑道風切；備註-雷暴位於西南方至西北方，向東移動。（ATIS J）

2035 時：風向 360 度，風速 15 浬/時，陣風 25 浬/時，風向變動範圍 300 度至 060 度；能見度 800 公尺；跑道視程-05 跑道 1,900 公尺，無顯著趨勢變化、06 跑道大於 2,000 公尺；中度雷雨；疏雲 200 呎、裂雲 500 呎、積雨雲疏雲 1,000 呎、裂雲 1,500 呎；溫度 24℃，露點 22℃；高度表撥定值 1012 百帕；補充資訊-全部跑道風切；備註-雷暴當空。（ATIS K）

2041 時：風向 350 度，風速 17 浬/時；能見度 800 公尺；跑道視程-05 跑道 1,900 公尺，趨勢無顯著變化、06 跑道 1,900 公尺，趨勢無顯著變化；大雷雨；疏雲 200 呎、裂雲 500 呎、積雨雲疏雲 1,000 呎、裂雲 1,500 呎；溫度 23℃，露點 22℃；高度表撥定值 1011 百帕；補充資訊-全部跑道風切；備註-雷暴當空。（ATIS L）

桃園機場地面自動氣象觀測系統（Automated Weather Observation Systems, AWOS）及低空風切預警系統（Low Level Wind Shear Alert System, LLWAS）記錄有 2015 時至 2045 時之資料。AWOS 設置 6 個站台，每 1 至 2 秒記錄一次氣象資料；LLWAS 設置 15 個站台，每 10 秒記錄一筆風向風速資料。06/24 跑道 AWOS 之設置地點如圖 1.7-3、06/24 跑道 2034:50 時至 2035:20 時之即時風向風速資料如表 1.7-1、06/24 跑道 2001 時至 2040 時之降雨量資料如表 1.7-2 所示。

圖 1.7-3 06/24 跑道之地面自動氣象觀測系統位置圖

表 1.7-1 06/24 跑道 AWOS 之即時風向風速資料（度、浬/時）

ATC 時間	FDR 時間	AWOS 06	AWOS 06/24	AWOS 24
2034:50	2036:20	330/14	340/17	350/11
2034:51	2036:21	330/13	340/18	350/11
2034:53	2036:23	320/14	330/17	340/10
2034:54	2036:24	330/14	330/18	340/10
2034:56	2036:26	340/18	340/19	330/12
2034:57	2036:27	340/18	340/19	320/12
2034:58	2036:28	330/20	340/18	330/13
2034:59	2036:29	330/22	340/17	330/13
2035:00	2036:30	330/21	340/17	330/16
2035:03	2036:33	330/20	330/14	340/19
2035:04	2036:34	330/19	320/16	340/19
2035:05	2036:35	330/19	330/16	350/19
2035:06	2036:36	330/19	330/16	350/20
2035:07	2036:37	340/17	340/18	350/20
2035:08	2036:38	330/17	330/18	350/19
2035:10	2036:40	330/15	330/17	340/17
2035:11	2036:41	310/15	330/16	340/17
2035:12	2036:42	320/18	330/16	340/16
2035:14	2036:44	320/20	330/15	340/15
2035:15	2036:45	330/22	330/15	340/15
2035:16	2036:46	340/21	330/14	340/15
2035:17	2036:47	300/23	330/14	340/15
2035:18	2036:48	300/23	330/14	340/15
2035:19	2036:49	330/23	320/16	340/17
2035:20	2036:50	300/22	320/18	340/17

表 1.7-2　AWOS 06/24 之 1 小時累積雨量資料（公厘）

ATC 時間	雨量	ATC 時間	雨量	ATC 時間	雨量	ATC 時間	雨量	ATC 時間	雨量
2001	0	2009	0	2017	0	2025	0.2	2033	0.4
2002	0	2010	0	2018	0	2026	0.2	2034	0.4
2003	0	2011	0	2019	0	2027	0.2	2035	0.6
2004	0	2012	0	2020	0	2028	0.2	2036	1.6
2005	0	2013	0	2021	0	2029	0.4	2037	3
2006	0	2014	0	2022	0	2030	0.4	2038	4.2
2007	0	2015	0	2023	0	2031	0.4	2039	5.8
2008	0	2016	0	2024	0	2032	0.4	2040	7.4

1.7.3　低空風切警訊

桃園機場LLWAS在事故當日1930時至2130時之間，曾於2028:09時至2028:59時顯示" 05 跑道進場，風切警示，五邊二浬，風速增量 15 浬/時"之低空風切警示。

桃園機場於 2001 時發布低空風切警報如下：

風切警報 01；有效時間 1955 時至 2155 時；預報 1955 時獲 B747 型機機長報告全跑道有中度風切。

1.8　助、導航設施

無相關議題。

1.9　通信

臺北近場管制塔臺及臺北機場管制臺之機場管制席/地面管制席/資深輔導員分別以 125.1 及 118.7/121.7/121.6 MHz 頻率與 BR806 進行無線電通訊，無通訊不良紀錄。

1.10 場站資料

1.10.1 機場空側[8]基本資料

依據臺北飛航情報區飛航指南，桃園機場位於臺北西方 30.9 公里處，機場標高 106 呎。該機場均為水泥板塊鋪面，鋪面強度 PCN[9] 60/R/B/X/U。06/24 跑道範圍長 3,350 公尺、寬 60 公尺。

06/24 跑道部分設有防滑溝槽，分布如圖 1.10-1 所示。06/24 跑道邊燈總長度 3,350 公尺，間距 60 公尺；均具簡易式高亮度進場燈光指示系統，配有跑道對正指示燈（Simplied Short Approach Lighting System with Runway Alignment Indicator Lights, SSALR），機場圖如 1.10-2 所示。

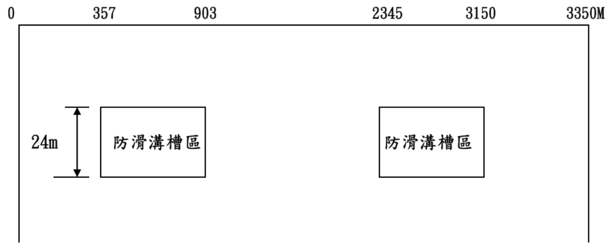

圖 1.10-1　06/24 跑道防滑溝槽分布區

[8] Airside。

[9] 鋪面分類號碼（PCN）/鋪面類別（R:剛性鋪面）/道基強度（B:中強度 K 值介於 60~120MN/m^3）/最大允許胎壓值（X：1.00MPa＜胎壓≦1.50MPa）/評估方法（U: 經驗法）。

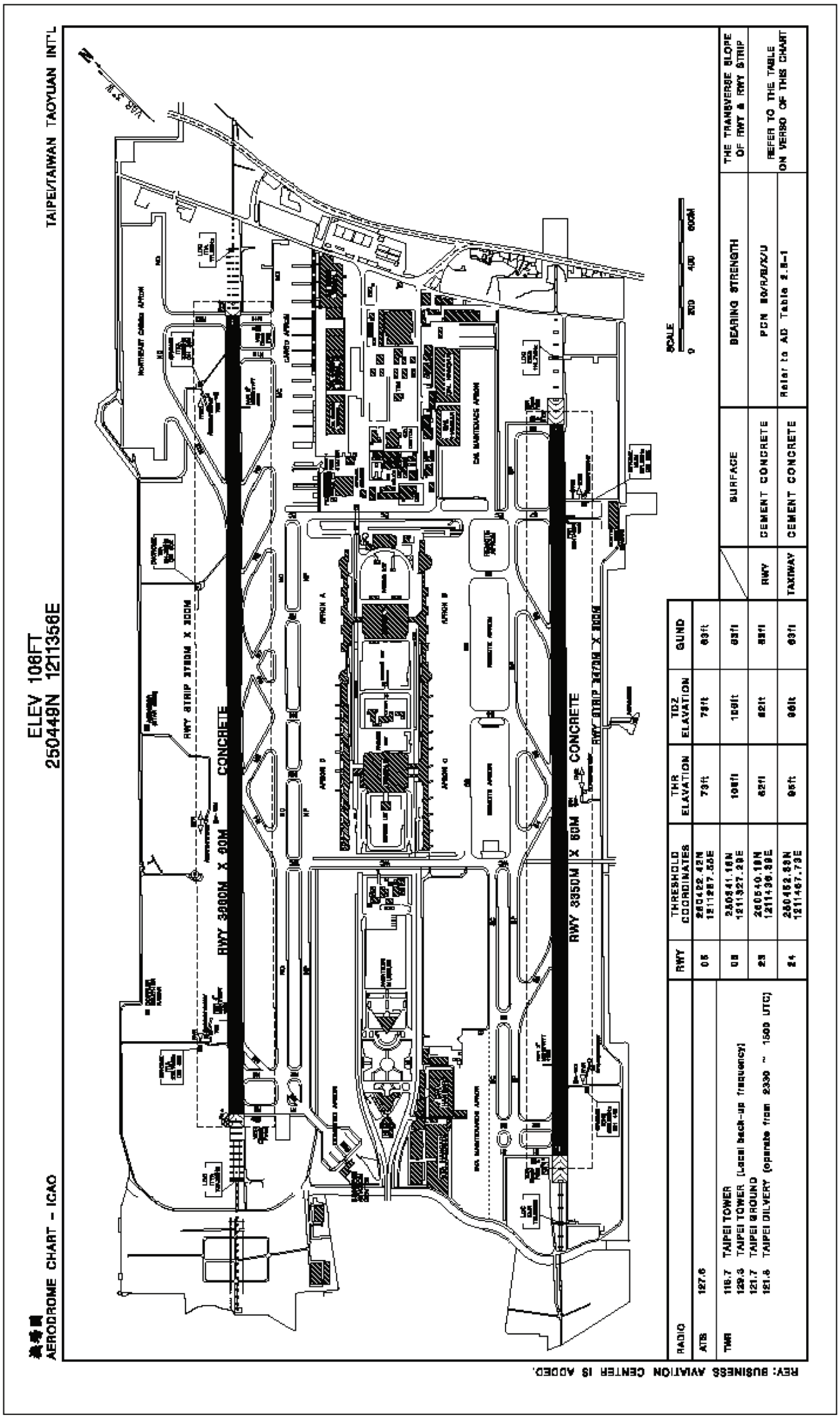

圖 1.10-2　桃園機場機場圖

1.10.2 跑道摩擦係數檢測

桃園機場跑道摩擦係數由機場工程處人員使用國際民航組織（International Civil Aviation Organization, ICAO）核定之標準測試儀器 Runway Friction Tester 進行定期測試，06/24 跑道摩擦係數檢測頻率為每 2 星期測試一次，檢測位置為跑道中心線兩側 5 公尺，檢測時灑水保持鋪面水膜厚 1 公釐，檢測速度為 65 公里/小時及 95 公里/小時。

依據該機場提供資料，民國 100 年 5 月 13 日，06/24 以速度為 65 公里/小時及 95 公里/小時之跑道檢測標準儀器，進行跑道摩擦係數檢測，自 06 跑道頭起算，跑道中心線左右側之 3 分區塊平均值、每 100 公尺之平均值，如表 1.10-1 及 1.10-2 所示，由事故後至此次檢測期間，除緊接著 BR806 之後降落之 CX402 班機，06/24 跑道無航機起降。

表 1.10-1　06/24 跑道 65 公里/小時摩擦係數值彙整表

機場名稱：桃園國際機場
檢測跑道：06/24跑道
檢測儀器：RFT
檢測單位：工程處
檢測人員：
檢測時間：100年5月13日10時00分
天　氣：晴/大氣溫度：--°C/鋪面溫度：--°C
摩擦測試輪更換日期:98年7月17日
跑道長度：3350公尺
檢測位置：跑道中心線兩側5公尺
檢測速率：65公里/小時
水膜厚度：1mm
06跑道檢測起點距端部距離：150公尺
24跑道檢測起點距端部距離：150公尺
三分區塊檢測成果：

跑道	第一個三分區塊	第二個三分區塊	第三個三分區塊	跑道
06	0.73	0.81	0.79	24
	0.75	0.81	0.77	

自06跑道起算每百公尺檢測成果

里程 (公尺)	中心線右側			中心線左側		
	第一次	第二次	平均	第一次	第二次	平均
0 ~ 100	0.87	0.89	0.88	0.81	0.88	0.84
100 ~ 200	0.72	0.79	0.75	0.74	0.69	0.72
200 ~ 300	0.65	0.63	0.64	0.59	0.63	0.61
300 ~ 400	0.63	0.53	0.58	0.54	0.65	0.59
400 ~ 500	0.71	0.62	0.66	0.60	0.67	0.63
500 ~ 600	0.77	0.76	0.77	0.73	0.71	0.72
600 ~ 700	0.84	0.82	0.83	0.75	0.82	0.79
700 ~ 800	0.85	0.83	0.84	0.81	0.88	0.85
800 ~ 900	0.75	0.79	0.77	0.84	0.76	0.80
900 ~ 1000	0.81	0.76	0.79	0.68	0.75	0.71
1000 ~ 1100	0.79	0.83	0.81	0.80	0.86	0.83
1100 ~ 1200	0.77	0.82	0.79	0.81	0.82	0.81
1200 ~ 1300	0.80	0.77	0.78	0.77	0.85	0.81
1300 ~ 1400	0.79	0.82	0.80	0.79	0.78	0.79
1400 ~ 1500	0.83	0.82	0.82	0.78	0.85	0.81
1500 ~ 1600	0.81	0.85	0.83	0.82	0.82	0.82
1600 ~ 1700	0.80	0.85	0.82	0.79	0.85	0.82
1700 ~ 1800	0.78	0.85	0.81	0.81	0.82	0.82
1800 ~ 1900	0.83	0.79	0.81	0.77	0.84	0.80
1900 ~ 2000	0.83	0.82	0.83	0.80	0.85	0.83
2000 ~ 2100	0.83	0.82	0.82	0.80	0.84	0.82
2100 ~ 2200	0.79	0.83	0.81	0.83	0.87	0.85
2200 ~ 2300	0.77	0.81	0.79	0.83	0.84	0.84
2300 ~ 2400	0.70	0.70	0.70	0.74	0.73	0.73
2400 ~ 2500	0.66	0.66	0.66	0.64	0.73	0.69
2500 ~ 2600	0.67	0.66	0.67	0.67	0.72	0.69
2600 ~ 2700	0.67	0.68	0.67	0.66	0.70	0.68
2700 ~ 2800	0.75	0.72	0.73	0.73	0.84	0.78
2800 ~ 2900	0.84	0.82	0.83	0.82	0.86	0.84
2900 ~ 3000	0.91	0.90	0.91	0.89	0.89	0.89

表 1.10-2　06/24 跑道 95 公里/小時摩擦係數值彙整表

機場名稱：桃園國際機場
檢測跑道：06/24跑道
檢測儀器：RFT
檢測單位：工程處
檢測人員：
檢測時間：100年5月13日10時40分
天　　氣：晴/大氣溫度：--°C/鋪面溫度：--°C
摩擦測試輪更換日期:98年7月17日
跑道長度：3350公尺
檢測位置：跑道中心線兩側5公尺
檢測速率：95公里/小時
水膜厚度：1mm
06跑道檢測起點距端部距離：250公尺
24跑道檢測起點距端部距離：250公尺
三分區塊檢測成果：

跑道	第一個三分區塊	第二個三分區塊	第三個三分區塊	跑道
06	0.59	0.73	0.68	24
	0.62	0.73	0.66	

自06跑道起算每百公尺檢測成果

里程	中心線右側			中心線左側		
(公尺)	第一次	第二次	平均	第一次	第二次	平均
0 ~ 100	0.60	0.73	0.67	0.66	0.57	0.61
100 ~ 200	0.50	0.50	0.50	0.47	0.49	0.48
200 ~ 300	0.48	0.45	0.47	0.38	0.49	0.43
300 ~ 400	0.57	0.51	0.54	0.46	0.52	0.49
400 ~ 500	0.66	0.62	0.64	0.61	0.59	0.60
500 ~ 600	0.79	0.76	0.77	0.70	0.73	0.72
600 ~ 700	0.81	0.79	0.80	0.77	0.79	0.78
700 ~ 800	0.48	0.69	0.59	0.74	0.54	0.64
800 ~ 900	0.59	0.54	0.57	0.42	0.52	0.47
900 ~ 1000	0.65	0.69	0.67	0.63	0.73	0.68
1000 ~ 1100	0.62	0.68	0.65	0.72	0.66	0.69
1100 ~ 1200	0.76	0.65	0.71	0.65	0.77	0.71
1200 ~ 1300	0.74	0.75	0.75	0.69	0.74	0.71
1300 ~ 1400	0.76	0.73	0.75	0.72	0.79	0.76
1400 ~ 1500	0.77	0.78	0.77	0.76	0.74	0.75
1500 ~ 1600	0.75	0.76	0.75	0.74	0.78	0.76
1600 ~ 1700	0.65	0.77	0.71	0.76	0.69	0.72
1700 ~ 1800	0.76	0.69	0.72	0.64	0.78	0.71
1800 ~ 1900	0.77	0.75	0.76	0.73	0.79	0.76
1900 ~ 2000	0.77	0.77	0.77	0.73	0.78	0.76
2000 ~ 2100	0.73	0.78	0.75	0.76	0.77	0.76
2100 ~ 2200	0.71	0.71	0.71	0.74	0.76	0.75
2200 ~ 2300	0.55	0.65	0.60	0.66	0.66	0.66
2300 ~ 2400	0.54	0.57	0.56	0.56	0.63	0.59
2400 ~ 2500	0.56	0.52	0.54	0.54	0.63	0.59
2500 ~ 2600	0.52	0.56	0.54	0.50	0.58	0.54
2600 ~ 2700	0.67	0.57	0.62	0.56	0.70	0.63
2700 ~ 2800	0.77	0.78	0.77	0.72	0.82	0.77

1.10.3 跑道鋪面積水狀況之不定期巡場紀錄

依據「臺灣桃園國際機場活動區之巡場與維護作業程序」[10]，跑道鋪面積水狀況之不定期巡場分由航務組、維護組及飛航服務總臺桃園裝修區臺，依據「臺灣桃園國際機場空側設施檢查日報表」執行例行性及不定期巡場。

桃園機場提供民國 99 年 5 月 1 日至民國 100 年 5 月 31 日相關跑道鋪面積水之不定期巡場紀錄共約 152 筆，該內容顯示，機場管理單位視需要不定期巡場，主動依「民用機場鋪砌道面狀況應注意事項」所建議之 4 分類（Damp/Wet/Water Patch/Flooded）目視判斷，而後通報塔台鋪面積水狀況；塔台亦會視需要主動要求機場管理單位提供鋪面積水狀況。

事故前，該機場航務處場面席提供塔台最後一次有關跑道鋪面積水狀況之紀錄爲 1541：19 時，跑道鋪面狀況爲「DAMP」。

1.10.4 機場跑道鋪面抗滑標準及相關規範

依據民航局頒布「民用機場鋪砌道面狀況應注意事項」，表 4-1（詳如表 1.10-3）有關跑道鋪面抗滑標準，其中檢測速度 65 公里/小時，Runway Friction Tester 之摩擦係數養護規劃標準爲 0.6；檢測速度 95 公里/小時，Runway Friction Tester 之摩擦係數養護規劃標準爲 0.54。

[10]版期 2010/07/1。

表 1.10-3 跑道鋪面抗滑標準

檢測儀器	新建跑道道面設計標準*	跑道道面養護規劃標準*	跑道道面最低抗滑標準*	估計供水深度（公釐）	抗滑檢測速度（公里/小時）	檢測輪胎壓（千帕）
Mu-meter						
方法 1	*0.72*	*0.52*	*0.42*	*1.0*	*65*	*70*
	0.66	*0.38*	*0.26*	*1.0*	*95*	*70*
方法 2	*0.68*	*0.47*	*0.42*	*0.5*	*65*	*70*
	0.65	*0.45*	*0.39*	*0.5*	*95*	*70*
Skiddometer	*0.82*	*0.60*	*0.50*	*1.0*	*65*	*210*
	0.74	*0.47*	*0.34*	*1.0*	*95*	*210*
Surface Friction Tester	*0.82*	*0.60*	*0.50*	*1.0*	*65*	*210*
	0.74	*0.47*	*0.34*	*1.0*	*95*	*210*
Runway Friction Tester	*0.82*	*0.60*	*0.50*	*1.0*	*65*	*210*
	0.72	*0.54*	*0.41*	*1.0*	*95*	*210*

**此值為跑道或其中某段之平均值。*

「民用機場鋪砌道面狀況應注意事項」第 4.3 節建議：*跑道中心二分之一寬度範圍出現積水時應提出報告，同時需對積水深度提出評估，為提高跑道狀況描述之準確性，應採用下列定義與相關敘述：微濕（Damp）－道面表面因濕氣而變色。潮濕（Wet）－道面表面濕潤但未出現積水。局部積水（Water patch）－可觀察到局部積水現象。氾濫（Flooded）－可觀察到大範圍積水現象。*

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 L3 Communications 公司，件號及序號分別為 S100-0080-00 及 01480。 該座艙語音紀錄器所記錄之語音資料約 30 分鐘， 4 軌高品質錄音聲源分別來自正駕駛員麥克風、副駕駛員麥克風、座艙區域麥克風及廣播系統麥克風。

座艙語音紀錄器下載情形正常，記錄品質良好，所記錄之語音資料共 30 分 11 秒（2030:28 時~2100:39 時[11]），語音資料包括該機最後進場、落地及事故發生等過程，調查小組製作與事故相關約 9 分鐘之座艙語音紀錄抄件。

該機之時間系統係以飛航資料紀錄器（FDR）之 GMT 參數時間爲基準，經比對 SSCVR 語音資料，以及 FDR 記錄之無線電按鍵（VHF Key）參數與無線電高度（RALT）參數，將 SSCVR 及 FDR 時間同步。經比對航管錄音抄件後，FDR 記錄之 GMT 時間較 ATC 時間約快 90 秒 （ATC Time + 90 秒 = FDR GMT Time），詳表 1.11-1。

表 1.11-1 事故班機之時間同步參考表

SSCVR 時間（hhmm:ss）	FDR 時間（hhmm:ss）	ATC 抄件時間（hhmm:ss）	SSCVR 抄件內容
2032:34.8	2032:35	2031:04 （APP）	eva eight zero six contact tower one eighteen seven good day
2032:55.4	2032:55	-	（不明聲響）
2032:57.4	2032:57	2031:27 （TWR）	taipei tower good evening eva eight zero six runway zero six nine miles final
2033:24.6	2033:25	-	landing check
2034:41.4	2034:41	2033:12 （TWR）	taipei tower broadcasts thunderstorm alert in progress
2036:32.7	2036:33	-	fifty
2036:37.8	2036:38	-	（不明聲響）
2036:49.3	2036:49	-	（異於正常滾行之聲響）
2037:41.7	2037:42	2036:12 （GND）	taipei ground eva eight zero six sierra six
2038:50.0	2038:50	2037:20 （GND）	taipei ground eva eight zero six report braking action is poor
註: APP 代表取自近場台錄音抄件；TWR 代表取自塔台錄音抄件；GND 代表取自地面控制席錄音抄件。			

[11]時間同步後，以 FDR 時間為參考依據。記錄時間為「UTC 時間」，台北時間=UTC 時間+8 小時。

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 Honeywell 公司，件號 S800-3000-00，序號 00528，資料紀錄長度爲 63 小時 20 分鐘 32 秒。事故發生後，本會依據波音公司提供之解讀文件[12]進行解讀，該紀錄器共記錄 87 項參數。

飛航資料紀錄器解讀後，均以其所記錄之世界標準時間參數轉換爲台北時間（UTC+ 8 Hr），BR 806 事故航班之 FDR 紀錄資料解讀結果，著陸期間飛航資料繪圖如圖 1.11-1 至圖 1.11-2，本會另取得該機前三段航班之飛航紀錄器資料供參考比對。BR806 事故航班之 FDR 紀錄資料摘錄如下：

1. 該型飛航資料紀錄器符合民用航空法規彙編之「07-02A 航空器飛航作業管理規則」以及國際民航公約第 6 號附約（Annex 6）第一類（Type I）飛航資料紀錄器規定，符合 32 項必要紀錄參數；
2. 先前航班於主輪著陸後左、右擾流板均會展開，最大達 60 度（註：左、右擾流板均爲飛行擾流板，該機無地面擾流板紀錄。）；
3. 左煞車踏板位置存在固定偏差約 7.7 度，詳圖 1.11-2；
4. 外信標台（OM）及中信標台（MM）訊號，均不會作動；
5. 主警告（Master Warning）訊號，事故航班均未作動；
6. 1909:20 時，FDR 開始記錄，空速 0 浬/時，地速 0 浬/時，磁航向（MHDG）204 度；
7. 1917:24 時，開始推油門加速，磁航向 343 度；
8. 2032:38 時，放下主起落架，航機高度 3390 呎，空速 198 浬/時，地速 208 浬/時，磁航向 19 度，風向 341 度，風速 18 浬/時；
9. 2036:22 時，自動駕駛解除，此時航機高度 184 呎，無線電高度 158.9 呎，空速

[12] 解讀文件【MD-90 DFDAU Interface Control Document, MDC 92K9081, Rev. F, Date: 6 March, 2002】。

142 浬/時，地速 138 浬/時，磁航向 46 度，風向 298 度，風速 18 浬/時；

10. 2036:33 時，無線電高度 49.5 呎，空速 148 浬/時，地速 148 浬/時，磁航向 49 度，風向 345 度，風速 11 浬/時；仰角 0.88 度，滾轉角 0.53 度；左右定位台偏移（LOC） 0.09 dot，方向舵踏板 -1.41 度；左、右襟翼 39.6 度及 39.9 度；左、右發動機壓力比（EPR）均爲 1.19；

11. 2036:39 時，左、右主輪及鼻輪均著陸，無線電高度 0.3 呎，空速 144 浬/時，地速 150 浬/時，磁航向 50 度，風向 308 度，風速 10 浬/時；俯角 1.05 度，滾轉角 0.88 度；左右定位台偏移（LOC） -0.089 dot，方向舵踏板 -1.41 度；左、右襟翼 39.64 度及 39.9 度；左、右發動機壓力比（EPR） 爲 1.08 及 1.03 ；左外擾流板（Spoiler LOB）及右內擾流板（Spoiler RIB） 爲-0.18 度及 0.88 度；
    - 此一秒內垂向加速度之變化爲：1.249、1.022、0.841、0.857、0.841、0.942、0.953、1.01 ；
    - 主輪著陸後第 3 秒及第 4 秒，左主輪由「GND」模式轉爲「AIR」模式，無線電高度由 1.9 呎再降爲 0.3 呎，俯角 2.11 度變爲 1.76 度，滾轉角 1.05 度變爲 0.18 度；(第一次彈跳階段)；
    - 主輪著陸後第 6 秒及第 7 秒，右主輪由「GND」模式轉爲「AIR」模式，無線電高度由 1.1 呎再降爲 0.3 呎，俯角 1.76 度變爲 1.58 度，滾轉角-2.29 度變爲-1.76 度；(第二次彈跳階段)；

12. 2036:41 時，左、右反推力器致動；空速 144 浬/時，地速 146 浬/時，磁航向 50 度，風向 310 度，風速 14 浬/時；俯角 1.05 度，滾轉角 0.88 度；左右定位台偏移（LOC） -0.278 dot，方向舵踏板 6.77 度；左、右發動機壓力比（EPR）均爲 1.02；左外擾流板（Spoiler LOB）及右內擾流板（Spoiler RIB） 0.88 度及 0.88 度；左煞車踏板壓力 72 PSI；

表 1.11-2　該機機頭左偏期間之相關參數列表

時間	空速	地速	航向	偏流角	左副翼	方向舵踏板	左外擾流板	右內擾流板	左右定位台偏移	左煞車踏板壓力	右煞車踏板壓力	左 EPR	右 EPR
sec	kt	kt	deg	deg	deg	deg	deg	deg	dot	Psi	Psi		
42	132	141	48	4.22	-1.58	-2.11		0.88	-0.431	109	0	1.02	1.02
43	132	137	45	5.54	0.48	2.37	-0.7		-0.582	17	28	1.04	1.06
44	133	132	42	6.50	0.62	7.65		0.53	-0.580	95	24	1.10	1.13
45	124	132	40	7.60	1.63	-0.35	-1.23		-0.731	88	0	1.18	1.22
46	118	127	38	8.48	2.51	-3.34		-1.58	-0.880	227	0	1.23	1.26
47	114	117	36	9.32	1.71	14.24	-0.88		-0.920	615	0	1.26	1.29
48	108	111	34	10.41	0.35	-3.16		0.88	-1.066	`936	0	1.28	1.30
49	104	106	31	11.60	-1.49	-8.88	4.22		-1.270	2130	0	1.29	1.29
50	96	101	28	12.17	6.15	-8.61		-7.03	-1.192	1442	0	1.25	1.21
51	92	97	27	12.48	6.86	1.23	-1.58		-1.298	1376	0	1.19	1.15
52	86	92	27	12.00	8.53	-16.08		-8.09	-1.185	1674	0	1.13	1.11
53	88	88	27	11.12	7.95	-13.54	-1.76		-1.296	1437	0	1.11	1.09
54	84	84	28	9.93	8.26	-22.94		-8.61	-1.001	1633	0	1.08	1.07
55	82	81	31	8.04	8.04	-14.50	-1.76		-0.933	1713	33	1.06	1.04
56	80	78	35	5.80	6.86	-7.56		-8.26	-0.819	1996	0	1.04	1.02
57	76	74	39	3.65	4.44	-1.05	-0.88		-0.638	2214	0	1.03	1.02
58	72	71	43	1.76	2.33	5.98		-2.99	-0.497	2173	0	1.02	1.02

13. 2036:39 時至 2041:55 時期間，左、右擾流板均於收回狀態；
14. 2041:55 時，航機停止移動，空速 0 浬/時，地速 0 浬/時，磁航向 322 度；
15. 2103:15 時，FDR 停止紀錄，空速 0 浬/時，地速 1 浬/時，磁航向 319 度；
16. 該機著陸位置係由兩參數決定（主起落架 AIR/GND 及最大垂直加速度之時間點），並與桃園機場 06 跑道儀器進場圖及精密衛星地圖套疊，詳圖 1.11-3（參考 1.11.3 節）及圖 1.11-4 所示。圖 1.11-4 爲雷達高度 130 呎以下之軌跡，其中 FMC 飛航軌跡係爲 FDR 記錄之經度及緯度參數，IRU 飛航軌跡係根據 FDR 記錄參數（時間、地速、磁航向、偏流角、滾轉角、俯仰角）經一次積分後獲得

。

- 2036:31 時至 2036:32 時，該機通過 06 跑道頭上方（圖 1.11-4 標記 a）；
- 2036:39 時，主輪及鼻輪著陸，該機距 06 跑道頭 1,950 呎（圖 1.11-4 標記 b）。
- 2036:46 時，軌跡向右偏出 06 跑道邊線外，距 06 跑道頭 3,340 呎（圖 1.11-4 標記 c）。
- 2037:56 時，軌跡向右偏後並重回 06 跑道，距 06 跑道頭 5,100 呎（圖 1.11-4 標記 d）。

1.11.3 MSTS 雷達資料之時間同步

事故發生後，本會取得民航局飛航服總台提供之多重監視源資料處理系統（Multi Surveillance Tracking System, MSTS）的航跡資料，經比對氣壓高度資料並與其時間系統同步，時間轉換公式如下：

MSTS UTC Time + 89 sec = BR806 FDR GMT

於氣壓高度 5,000 呎以下至著陸期間之飛航軌跡與多重監視源資料處理系統航跡套疊圖（結果詳圖 1.11-3）。

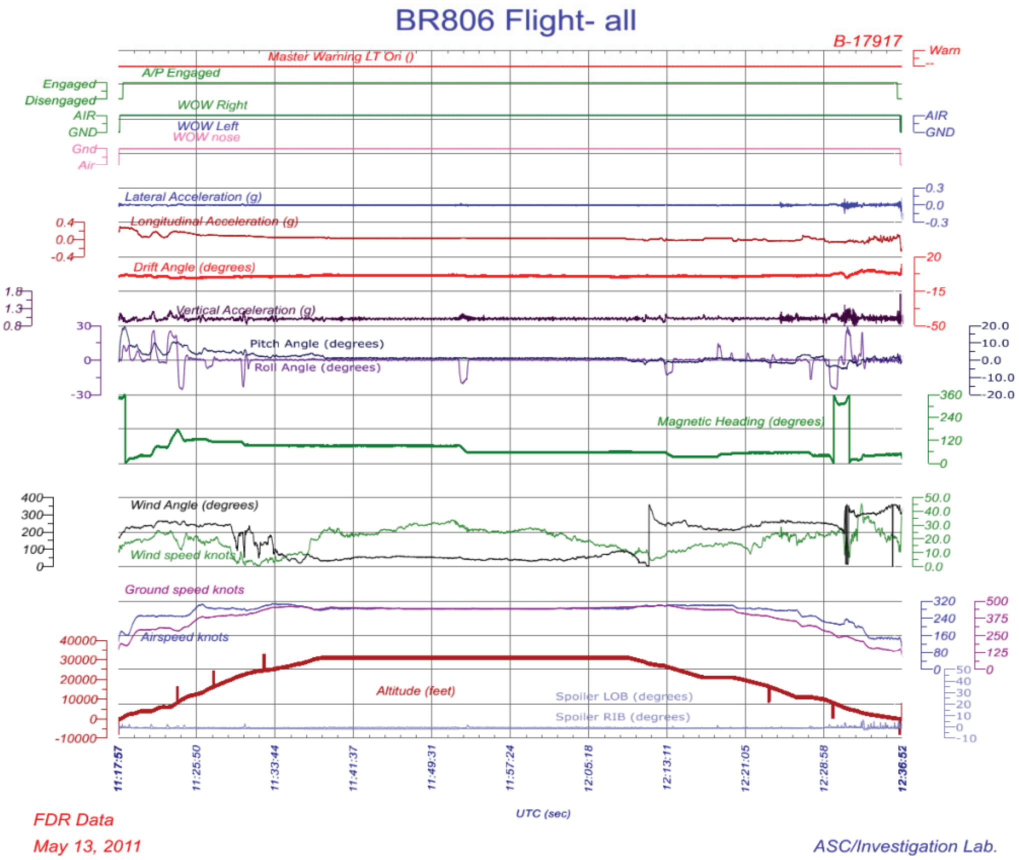

圖 1.11-1 BR806 FDR 資料繪圖

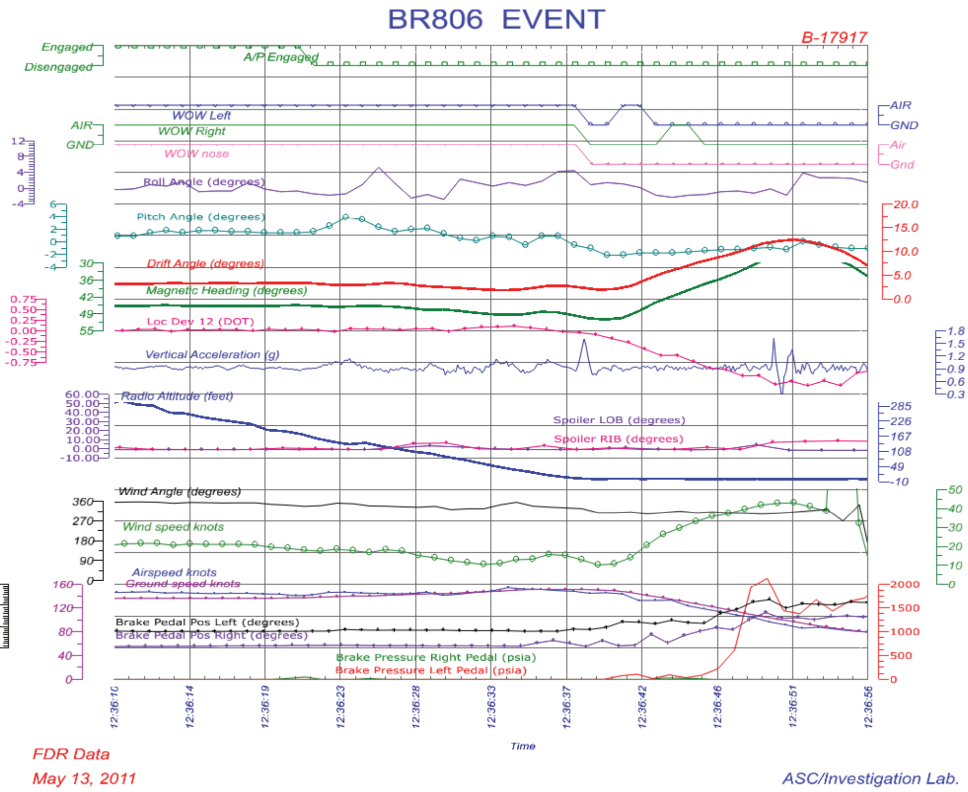

圖 1.11-2　BR806 著陸期間 FDR 資料繪圖

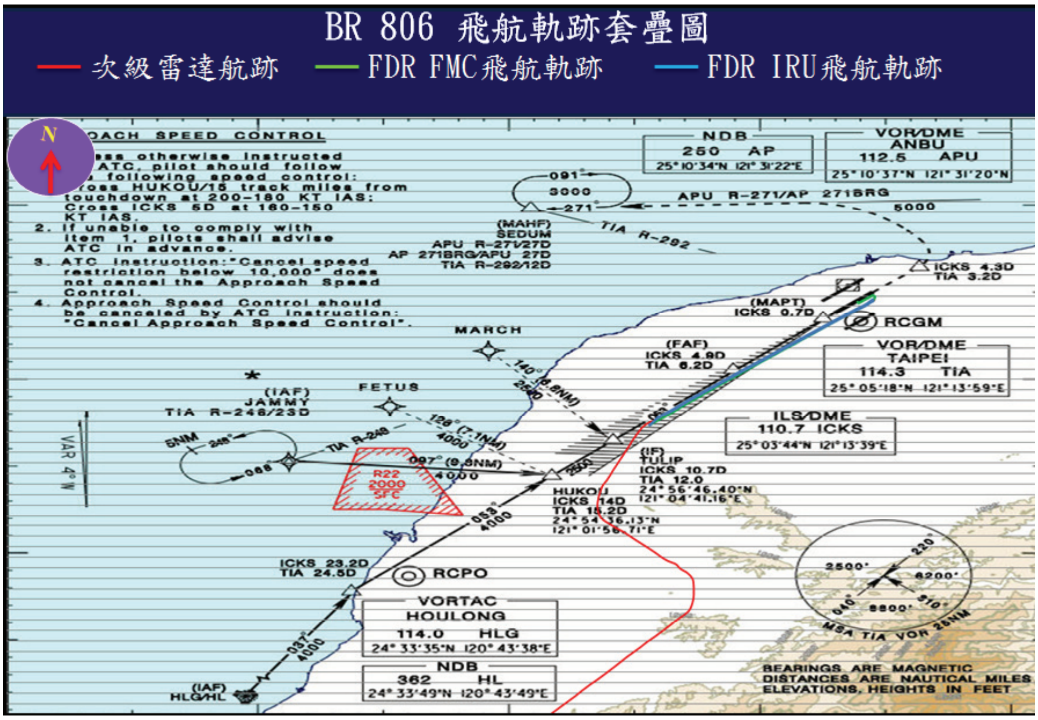

圖 1.11-3 BR806 5,000 呎以下之飛航軌跡與 MSTS 航跡套疊圖

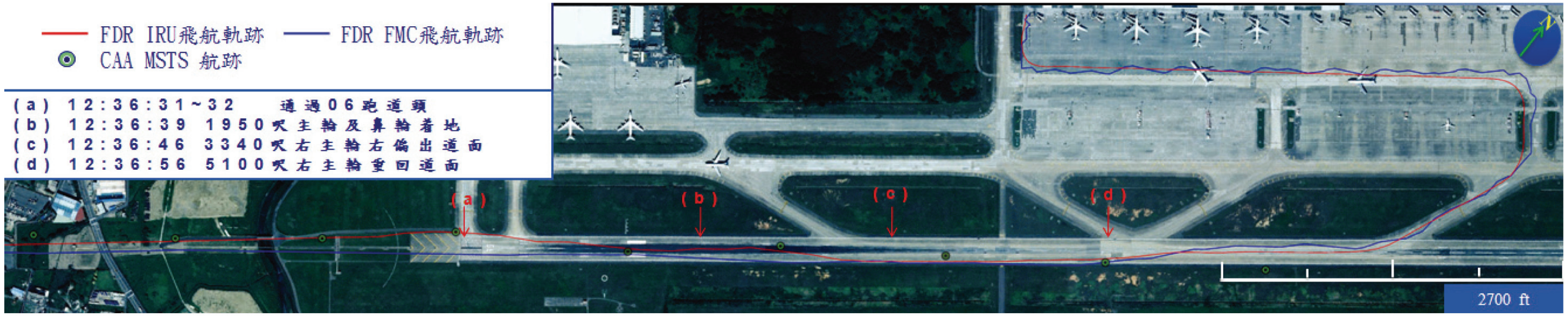

圖 1.11-4　BR806 於 RA 130 呎以下之飛航軌跡（FMC/IRU）套疊圖

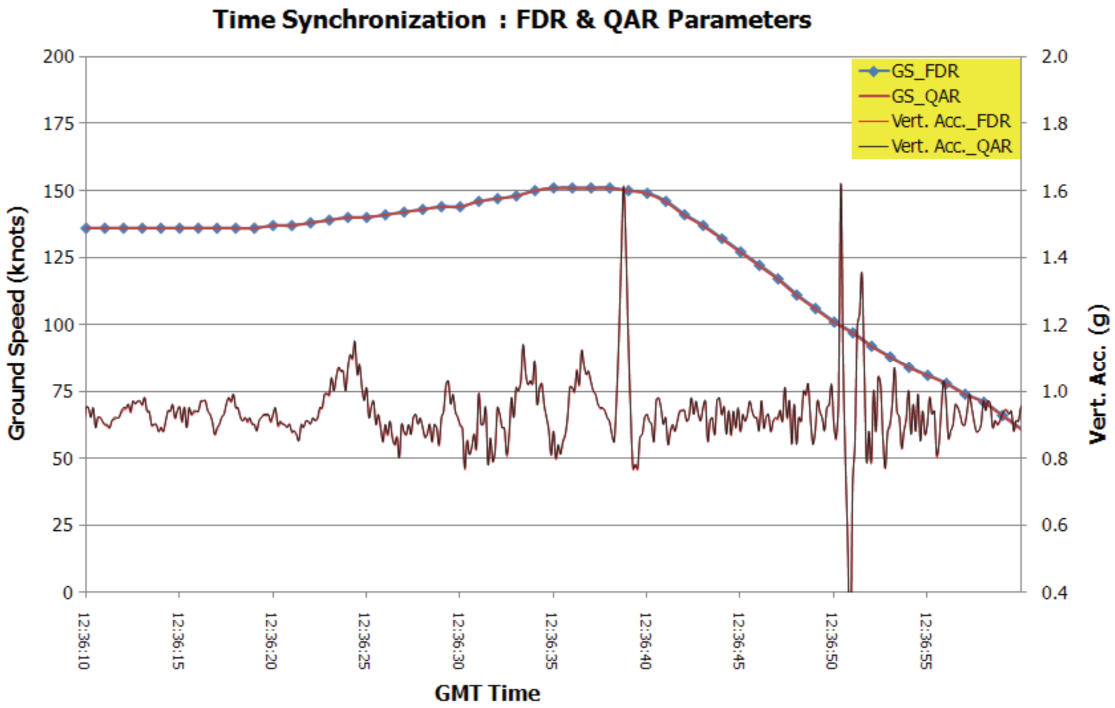

圖 1.11-5　BR806 FDR 及 QAR 資料時間同步套疊圖

1.12　地面量測及航空器撞擊資料

1.12.1　地面量測

本會專案調查小組於民國 100 年 5 月 13 日 0615 時進行 06 跑道現場測量，使用 Trimble PRO XR GPS 接收機，循可辨識之胎痕軌跡進行量測，參考基準爲 06 跑道部分邊線、06 跑道右側部分邊燈及千呎牌，依序量測左、右主輪遺留於 06 跑道之胎痕軌跡及損壞之跑道邊燈，量測項目詳表 1.12-1。量測結果重點摘要如下：

- 於 06 跑道右側，距 06 跑道頭約 3,340 呎及 3,900 呎，分別發現該機主輪偏出跑道之左、右主輪胎痕軌跡；
- 4 具損壞邊燈編號分別爲 R19、R22、R23、R24；圖 1.12-1 爲損壞之 R19 邊燈外觀圖；
- 於 06 跑道右側，距 06 跑道頭約 4,850 呎及 5,100 呎，分別發現該機左、右主輪重返跑道之胎痕軌跡，詳圖 1.12-2 及圖 1.12-3；

- 量測結果與衛星影像及高解析度航拍圖套疊後如圖 1.12-4 至 1.12-6；
- 主輪胎痕軌跡與跑道夾角量測結果如表 1.12-2。

表 1.12-1 事故現場量測項目

項次	量測物	說明	圖例
1.	NO.1 左主輪胎痕	左主輪胎痕外側	綠色
2.	NO.3 右主輪胎痕	右主輪胎痕內側	紅色
3.	NO.4 右主輪胎痕	右主輪胎痕外側	藍色
4.	損壞之跑道邊燈	R19、R22、R23、R24	⊙紅色
5.	跑道邊燈	R20、R27（參考基準）	⊙黃色
6.	千呎牌	千呎牌 9、千呎牌 8、千呎牌 5（參考基準）	紅色
7.	06 跑道邊線	千呎牌 9 附近（參考基準）	黑色

表 1.12-2 胎痕軌跡與跑道夾角測量

項次	與 06 跑道頭距離	胎痕軌跡與跑道夾角	胎痕間距
1	約 2,520 呎	向右約 4 度	（僅一條胎痕）
2	約 3,340 呎	向右約 2.5 度	5.73 公尺
3	約 3,900 呎	向右約 1.5 度	5.10 公尺
4	約 4,850 呎	向左約 3 度	（僅一條胎痕）
5	約 5,100 呎	向左約 5 度	5.60 公尺
6	約 5,630 呎	向左約 6 度	5.89 公尺
7	約 5,880 呎	向左約 3 度	（僅一條胎痕）

圖 1.12-1 損壞之跑道邊燈（編號 R19）

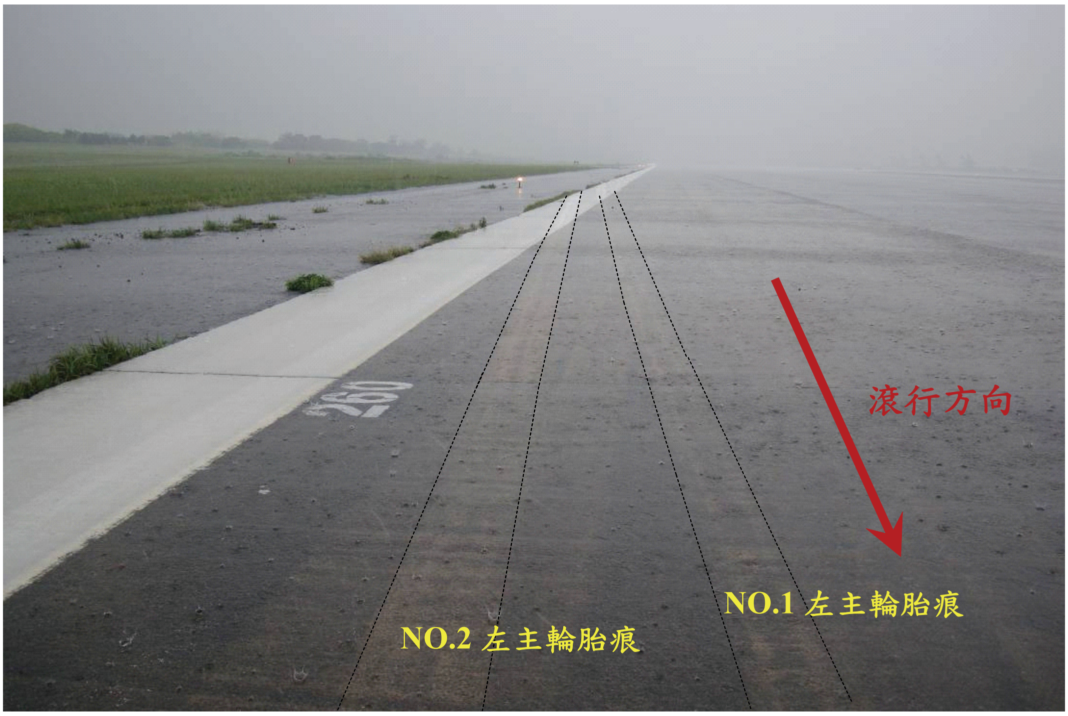

圖 1.12-2 左主輪重返跑道之胎痕（距 06 跑道頭約 4,850 呎）

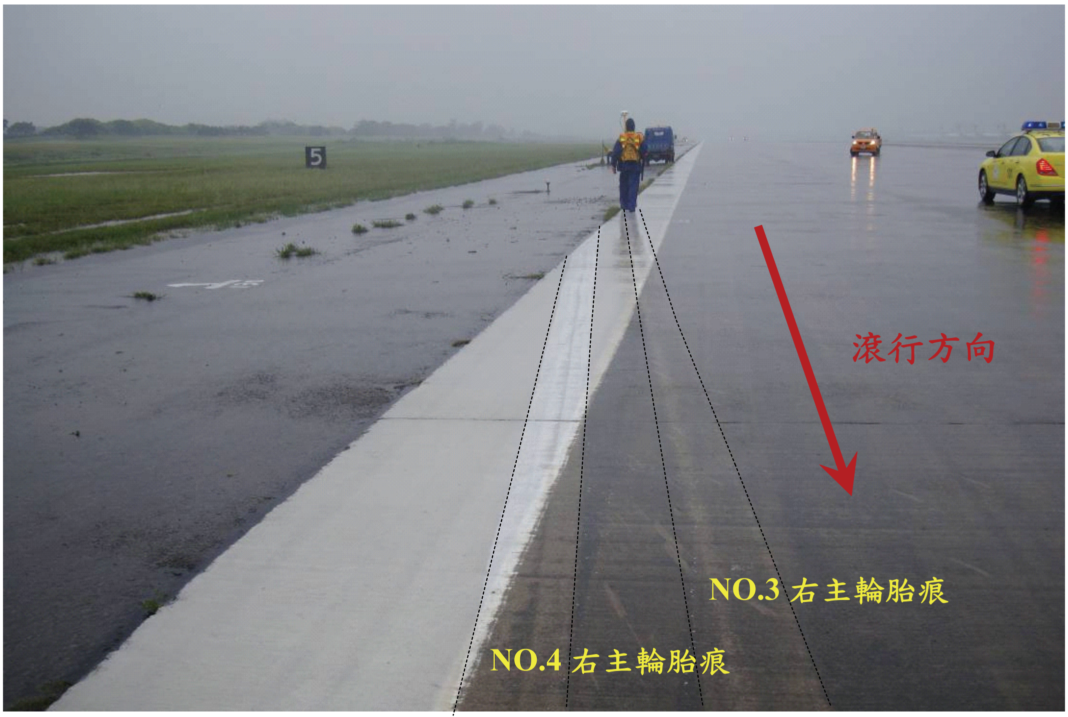

圖 1.12-3 右主輪重返跑道之胎痕（距 06 跑道頭約 5,100 呎）

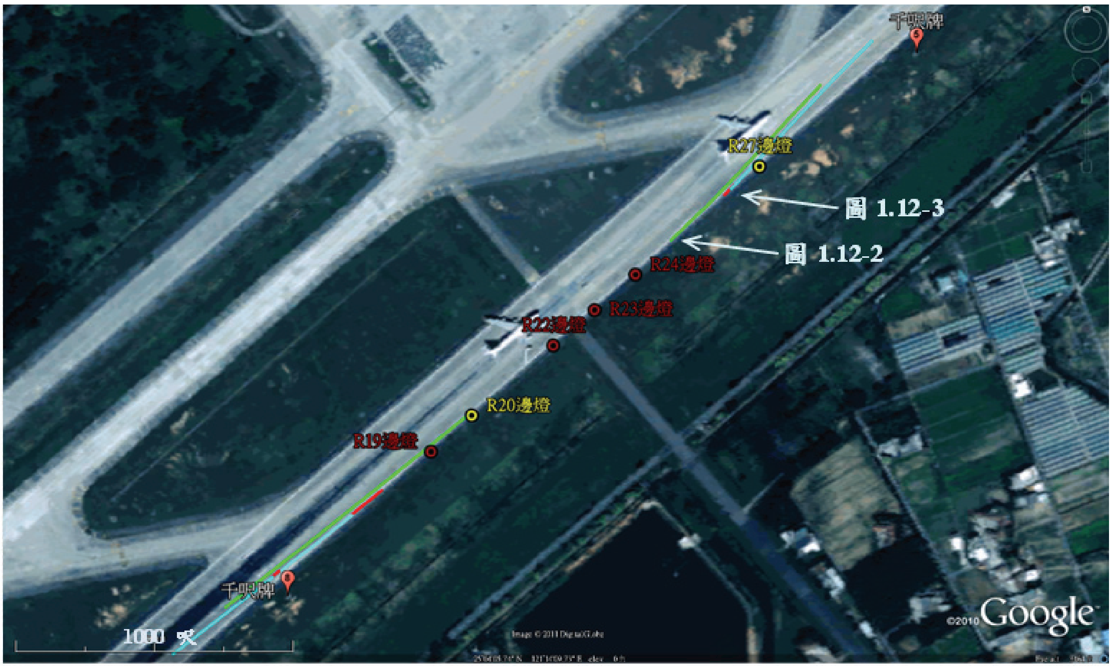

圖 1.12-4 事故現場圖

圖 1.12-5 事故現場近景圖

1.12.2 跑道積水狀況

民國 100 年 5 月 13 日約 0100 時，本會專案調查小組會同民航局、機場公司航務處及立榮人員，進入桃園機場 06 跑道，使用航務處提供之積水水位量測器量測道面積水情況。以 06 跑道中心線爲準，由千呎牌 2 處爲起點向前至千呎牌 3 止，量測中心線右側之積水情況；計取樣 13 量測點，上述量測點積水深度均在 1 公釐以上，其中有 7 處超過 3 公釐，其最小者直徑約爲 1 公尺，最大者直徑約爲 3 公尺。(依據桃園航空氣象臺 AWOS 紀錄，0116 時前 6 分鐘[13]累計 2.6 公釐之降雨量)。

民國 100 年 5 月 13 日上午 0810 時，06 跑道前 6 分鐘累計 2.4 公釐之降雨量，機場分組另依 BR806 軌跡量測 06 跑道右側 2 千呎至 3.5 千呎處，其中有約 1 公釐水深面積約 95%，少部分不平坦區有約 2.5 至 3.0 公釐水深，鋪面積水均爲排水狀

[13]氣象單位以 6 分鐘累積雨量作為降雨強度分類之時間間隔。

態。

1.12.3 航空器損害與撞擊資料

依據立榮事故後檢查提供之航空器損壞評估報告，摘要如下：

1.12.3.1 機身外部損傷

機身外部受外物撞擊損害情形詳圖 1.12-6，1.12-7。

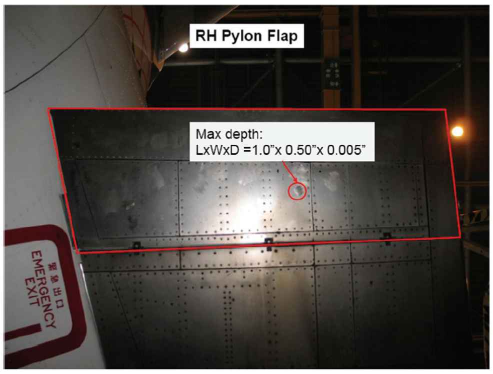

圖 1.12-6　外物撞擊損害（1）

圖 1.12-7　外物撞擊損害（2）

1.12.3.2 起落架損傷

右側起落架擋水板變形，詳圖 1.12-8

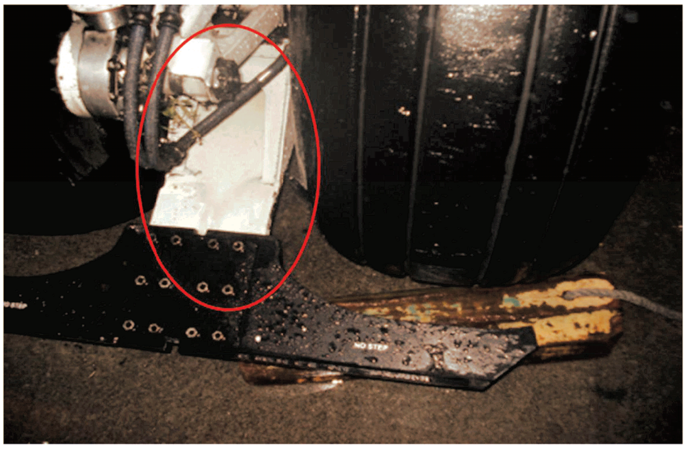

圖 1.12-8　右側起落架擋水板變形

1.12.3.3　2 號發動機外部損傷

右側發動機外部整流罩受外物撞擊，詳圖 1.12-9，1.12-10。

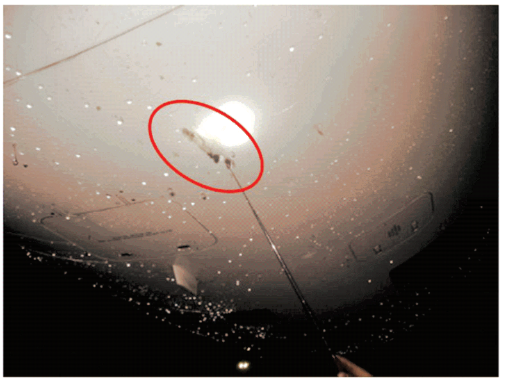

圖 1.12-9　外物撞擊痕跡

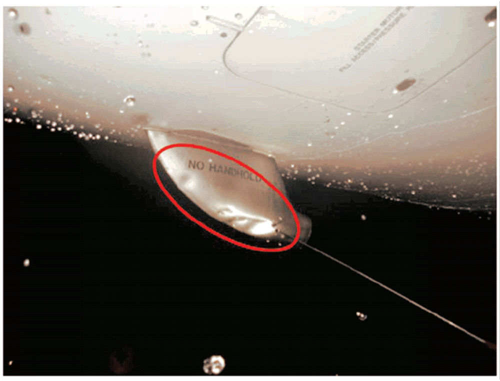

圖 1.12-10　外物撞擊凹痕

1.12.3.4　2 號發動機葉片損傷

風扇葉片損害於目視檢查後結果如表 1.12-3：

表 1.12-3 風扇葉片損害情形

項目	料號	序號	損害情形
1.	6A7654	RGA19669	1. 葉片前緣刮痕，長 0.16" X 深 0.022"， 長 0.13" X 深 0.025"，長 0.1" X 深 0.02" 2. 葉片前緣曲折變形，長 1.1" X 寬 0.5" X 深 0.06"
2.	6A7654	RGA19454	葉片前緣刮痕，曲折變形，長 1.8" X 寬 0.5" X 深 0.04"，長 1.1" X 寬 0.45" X 深 0.05"
3.	6A7654	RGA19508	葉片前緣曲折變形，長 1" X 寬 0.3" X 深 0.03"
4.	6A7654	RGA19628	1. 葉片前緣曲折變形，長 0.7" X 寬 0.33" X 深 0.035" 2. 葉片前緣刮痕，長 0.3" X 深 0.03"
5.	6A7654	RGA19618	1. 葉片前緣刮痕，長 0.2" X 深 0.035"，長 0.1" X 深 0.018"，長 0.1" X 深 0.01" 2. 葉片前緣凹陷，長 0.5" X 深 0.018"
6.	6A7654	RGV13889	1. 葉片前緣裂紋，長 0.15" 2. 葉片前緣凹陷，長 0.7" X D:0.024"
7.	6A7654	RGA19760	1. 葉片前緣刮痕，長 0.5" X 深 0.02" 2. 葉片前緣缺口，長 0.8" X 寬 0.21"
8.	6A7654	RGA19582	1. 葉片前緣缺口，長 0.56" X 寬 0.1" 2. 葉片前緣刮痕，長 0.28" X 深 0.03"
9.	6A7654	RGA19607	葉片前緣曲折變形，長 0.8" X 寬 0.35" X 深 0.03 "

部分風扇葉片前緣有外物撞擊損害，詳圖 1.12-11 至 1.12-14。

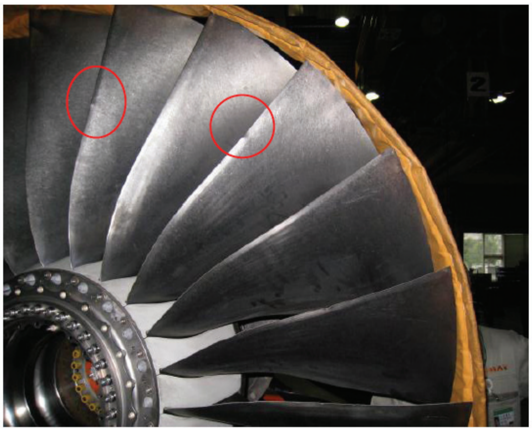

圖 1.12-11　葉片前緣凹陷

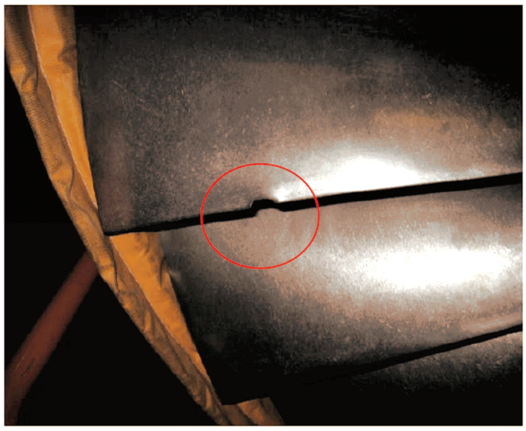

圖 1.12-12　葉片前緣凹陷

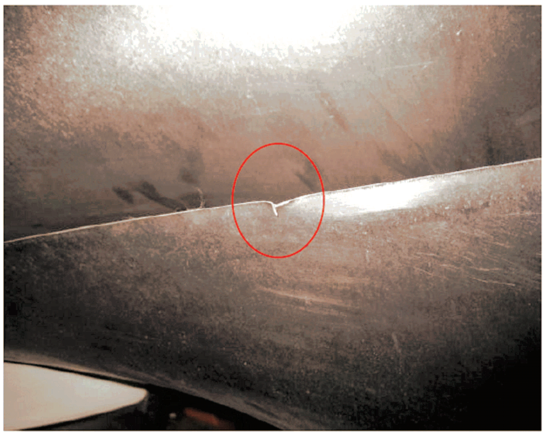

圖 1.12-13　葉片前緣裂紋

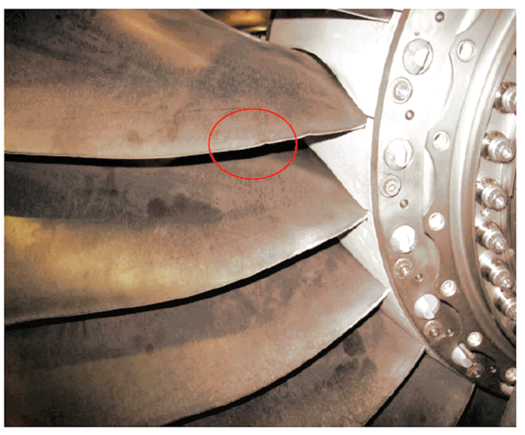

圖 1.12-14　葉片前緣曲折變形

1.12.3.5　空氣進口風罩目視檢查

所有（12 片）隔音板皆受外物撞擊損害，詳圖 1.12-15 至 1.12-20。

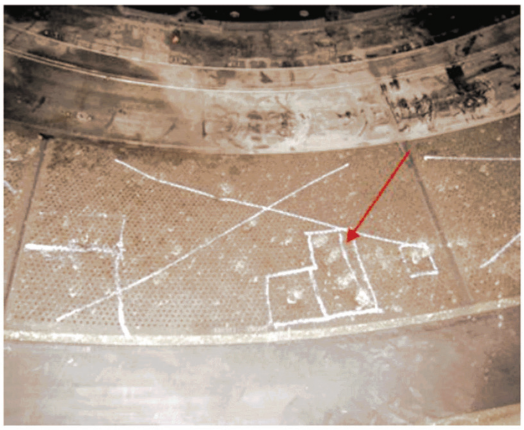

圖 1.12-15 隔音板損害情形（1）

圖 1.12-16 隔音板損害情形（2）

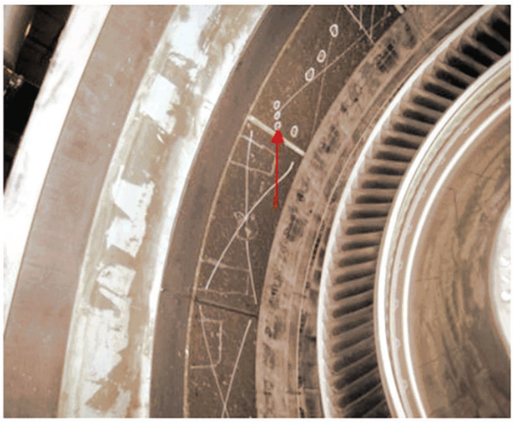

圖 1.12-17 隔音板損害情形（3）

圖 1.12-18 隔音板損害情形（4）

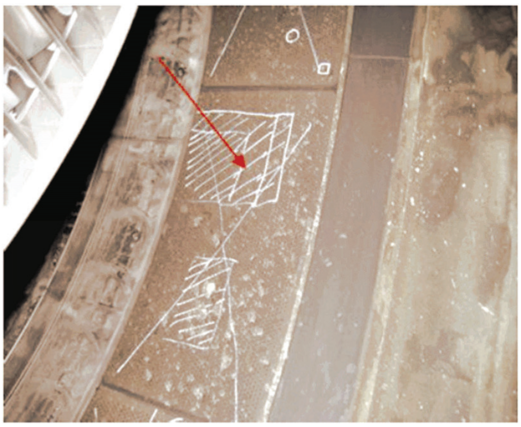

圖 1.12-19 隔音板損害情形（5）

圖 1.12-20 隔音板損害情形（6）

1.12.3.6 輪胎損害

輪胎損害情形詳表 1.12-4：

表 1.12-4 輪胎損害情形

輪胎號碼	序號	胎紋溝深	損害情形
1	SEP96-0434	7 mm	側邊胎皮嚴重剝落一處,胎面刮痕嚴重，深度及寬度超限兩處，輪轂外觀無損傷。(詳圖 1.12-21)
2	MAR98-0872	8 mm	輪胎正面嚴重刮痕一處,輪胎側面大面積刮痕二處，輪轂外觀輕微刮痕。（詳圖 1.12-22）
3	JAN97-0519	5 mm	輪胎側面刮痕一處，輪轂外觀無損傷。（詳圖 1.12-23）
4	JUN98-0960	8 mm	側邊胎皮嚴重剝落兩處，輪轂外觀無損傷。(詳圖 1.12-24)

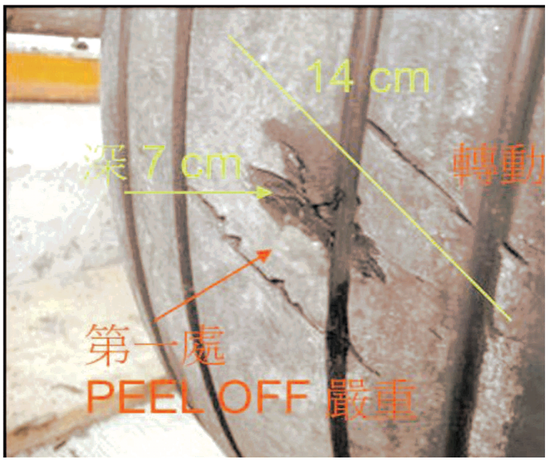

圖 1.12-21 側邊胎皮剝落

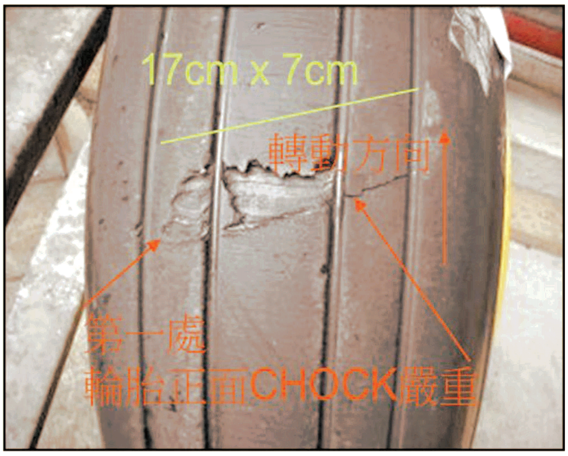

圖 1.12-22 輪胎正面刮痕

圖 1.12-23 輪胎側面刮痕

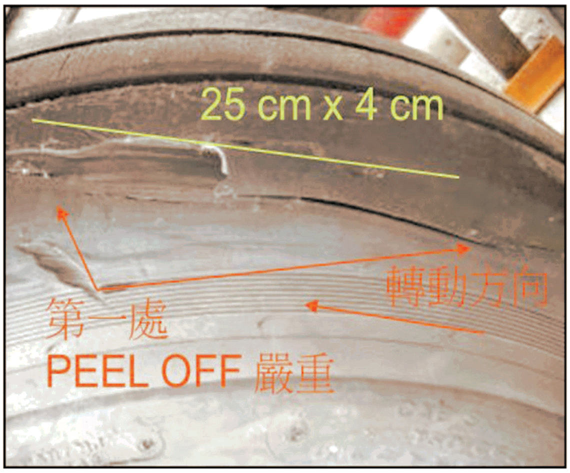

圖 1.12-24 側邊胎皮剝落

1.13　醫學與病理

無相關議題。

1.14　火災

無相關議題。

1.15　生還因素

無相關議題。

1.16　測試與研究

1.16.1　駕駛艙操作觀察

民國 100 年 6 月 11 日專案調查小組於 B7885/B7886 班機執行事故航機駕駛艙內擾流板操作情形觀察。該減速板手柄位於中央控制廊板正駕駛員側前方，觀察包括正/副駕駛員於駕駛艙中之操作動線，及當減速板手柄置於 Armed 位置時，於座艙內有明顯可辨識之聲響，手柄底部會露出一截約 3 至 4 公分之紅色部分。該二航班組員於操作觀察時在落地前對擾流板檢查及操作均依據相關程序，並經交互檢查確認。（如圖 1.16-1）。

圖 1.16-1　駕駛艙中央控制廊板位置及減速板手柄位於置動位置時

1.16.2 航空器系統測試

民國 100 年 5 月 24 日民航局、立榮及飛安會專案調查小組成員於長榮航太公司棚廠，依據 MD-90-30 工作卡號碼 7094M9，針對事故航機進行自動擾流板系統功能測試，測試項目如下：

1. 擾流板自動系統功能測試（Function test of the spoiler automatic system）
2. 擾流板自動系統落地模式功能測試（Function test of the spoiler automatic system landing mode）
3. 自動擾流板操作功能測試（Functional test of the automatic spoiler operation）
4. 擾流板伸展感測器及擾流板伸展燈禁制系統功能測試（Functional test of the spoiler deployed sensors and spoiler deployed light inhibit system）
5. 煞車控制閥功能測試（Functional test of the integrated brake control valve），液壓系統顯示煞車壓力約 3,000PSI（詳圖 1.16-2）。

圖 1.16-2 液壓系統顯示煞車壓力約 3,000PSI

上述 5 項功能測試結果皆無異常。

民國 100 年 6 月 15 日及 16 日，立榮及飛安會專案調查小組成員於立榮公司高

雄棚廠，依據 MD-90-30 工作卡號碼 7095M9，進行擾流板飛行中制鎖功能測試（Functional test of the in-flight spoiler lockout mechanism），並對鼻輪制鎖系統元件之完整性及妥善性進行觀察，擾流板功能測試及鼻輪制鎖系統元件觀察之結果無異常。

民國 100 年 7 月 4 日，立榮及飛安會專案調查小組成員於長榮航太公司桃園棚廠，依據 MD-90-30 工作卡號碼 7094M9，針對事故航機進行自動擾流板致動器(auto spoiler actuator）作動測試，紀錄器分組並錄製自動擾流板致動器所發出之聲音，分別取得自動擾流板致動器由 air mode 轉爲 landing mode；由 landing mode 轉爲 ground mode；spoiler lever armed 及 spoiler lever unarmed 由 air mode 轉爲 ground mode 時之作動聲響。

1.16.3　減速板手柄作動聲之頻譜

依據事故航班 FDR 紀錄參數顯示，該機於著陸期間、偏出道面、重回道面至滑行到 C1 停機坪階段，其擾流板均未展開，詳 1.11.2 節。本案調查小組在立榮的協助下，針對事故航機於落地時之減速板作動（Speed Brake Handle Activation）聲響進行數次地面測試與飛行測試。本節係依據該機 CVR 紀錄及事故後取得同型機之減速板手柄聲音進行比對測試：

1. 6 月 11 日調查小組於立榮兩段載客航班（B7 885 及 B7 886，B-17917 航機）上，以數位攝錄機記錄駕駛艙內之聲響及減速板之備動及作動情形，經後製存取聲音部分後進行頻譜分析（Audio Spectrum Analysis）。
2. 事故後立榮使用數位攝錄裝備側錄三段地面測試影片，包括：手動拉起減速板手柄至備動位置（armed position）、減速板手柄分別由備動位置及收回位置（unarmed position）轉地面模式（ground mode）時之自動作動、手動收回並按下（retract and knockdown）減速板手柄，以及在減速板打開時，藉由推動油門造成減速板手柄自動收回之影片。經後製存取聲音部分後進行分析比對。

上述聲音檔之頻譜分析所使用的軟體可將聲紋視覺化，並顯示其頻率、時間、

波形及訊號強度之特性。結果敘述如下：

1. 兩段載客航班之駕駛艙語音，於航機落地減速板手柄正常作動時，其聲響含有兩部分之音頻特性：先出現一長度約 0.10 秒之寬頻音，再由基礎諧音介於 1,250Hz 與 1,300Hz 間的諧音波所組成。諧音波持續時間較長，約在 0.233 秒至 0.258 秒之間，即減速板手柄作動時間約介於 0.333 秒至 0.358 秒（圖 1.16-4）。
2. 相較於數位攝錄機錄製之聲音檔（圖 1.16-5、圖 1.16-6）， CVR 記錄之聲音，其諧音波之第二、第三諧音部分訊號明顯較弱，原因係駕駛艙內區域麥克風（CAM）之位置較高，以致於高頻訊號散失。
3. 航機在進入地面模式時，減速板手柄於收回位置作動之音頻特性爲近似寬頻音，惟其熱點（hotspots）多集中在 1,250Hz 與 2,500Hz 之頻帶，時間長度約 0.55 秒至 0.60 秒間（圖 1.16-7、圖 1.16-8）。
4. 事故航班落地時 CVR 收錄之不明聲響（UTC 1236:37.8）長度約 0.558 秒；由長度約 0.225 秒之寬頻音開始，且包括持續 0.208 秒 1,300Hz 音波與 0.104 秒的寬頻音。其中諧音波與首先出現的寬頻音時間重疊約 0.1 秒，另諧音波結束後與 0.104 秒之寬頻音起始約 0.121 秒其間並無任何特徵音頻出現（圖 1.16-9）。
5. 前述事故航機落地時之不明聲響寬頻音，熱點多集中在 2,600Hz 以下之頻帶。
6. 地面測試中，藉由推動油門造成減速板手柄自動收回之頻譜特徵音頻特性爲：作動時間持續 0.31 秒，由 0.122 秒之寬頻音開始至另一 0.122 秒之寬頻音結束，兩段寬頻音 0.066 秒間，並無任何特徵音頻出現（圖 1.16-10）。
7. 地面測試影片中，因人爲推油門使減速板手柄自動收回過程中，前 0.188 秒（即第一段寬頻音之 0.122 秒及無特徵音頻之 0.066 秒）爲減速板手柄滑回收回位置（retract）動作，後爲減速板手柄解除作動（disarm）聲響。
8. 以手動拉起減速板手柄至備動位置的音頻特性爲：作動時間約 0.290 秒至 0.7 秒不等，其唯一共有特性爲以一長度約 0.140 秒之寬頻音開始（如圖 1.16-11）。圖 1.16-11 與圖 1.16-12 來源皆爲駕駛艙區域麥克風，其中圖 1.16-12 BR806 事故航班之背景噪音較爲明顯，致該聲響於 3,000 Hz 以下訊號不甚清晰。

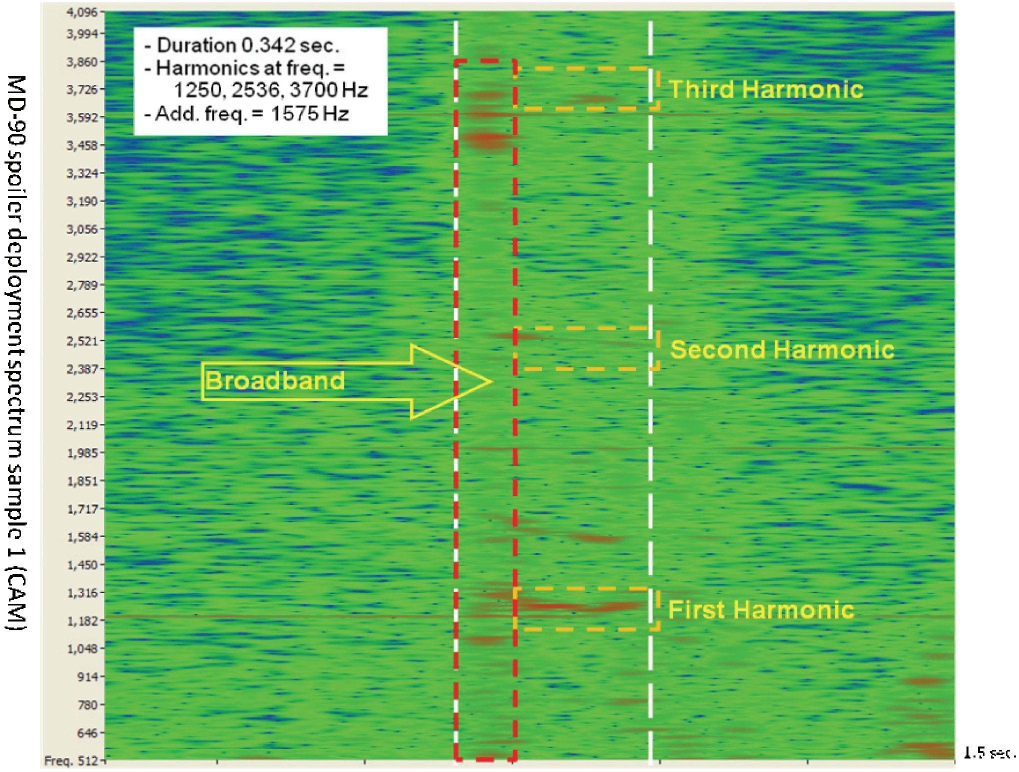

圖 1.16-4　MD-90 正常航班減速板手柄作動之頻譜（CVR）

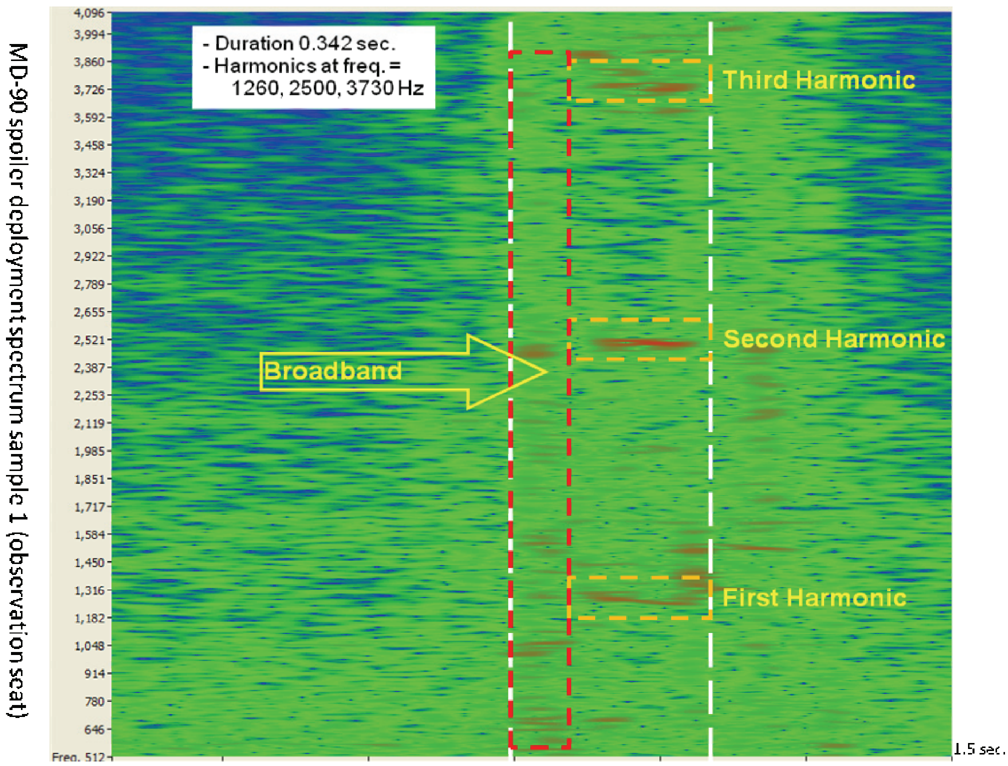

圖 1.16-5　MD-90 正常航班減速板手柄作動之頻譜（DV,1）

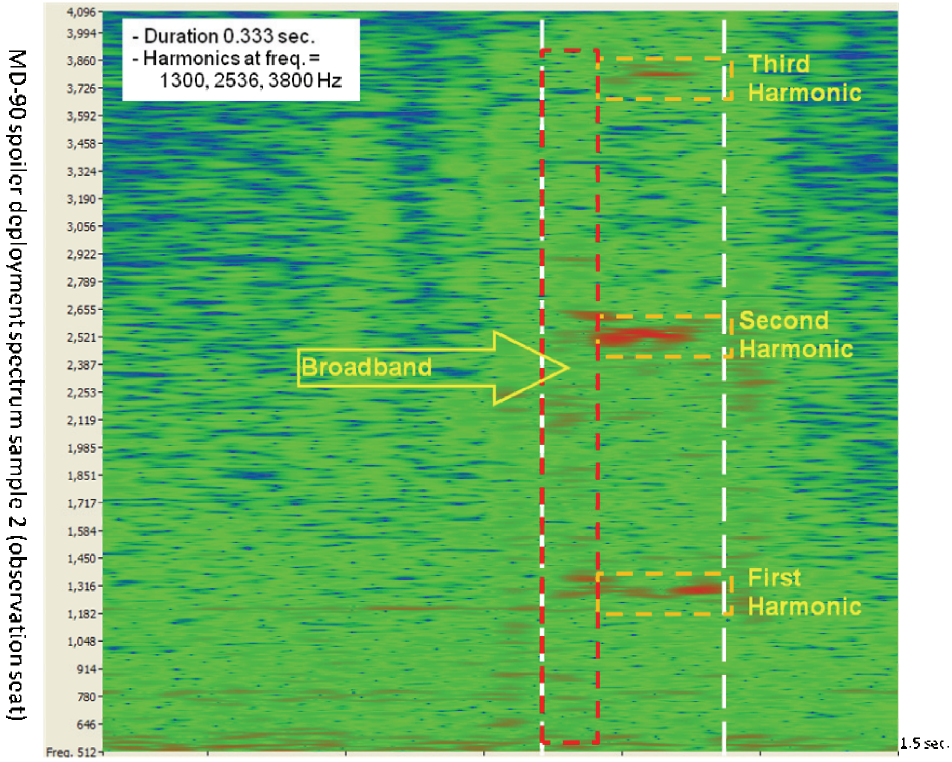

圖 1.16-6　MD-90 正常航班減速板手柄作動之頻譜（DV,2）

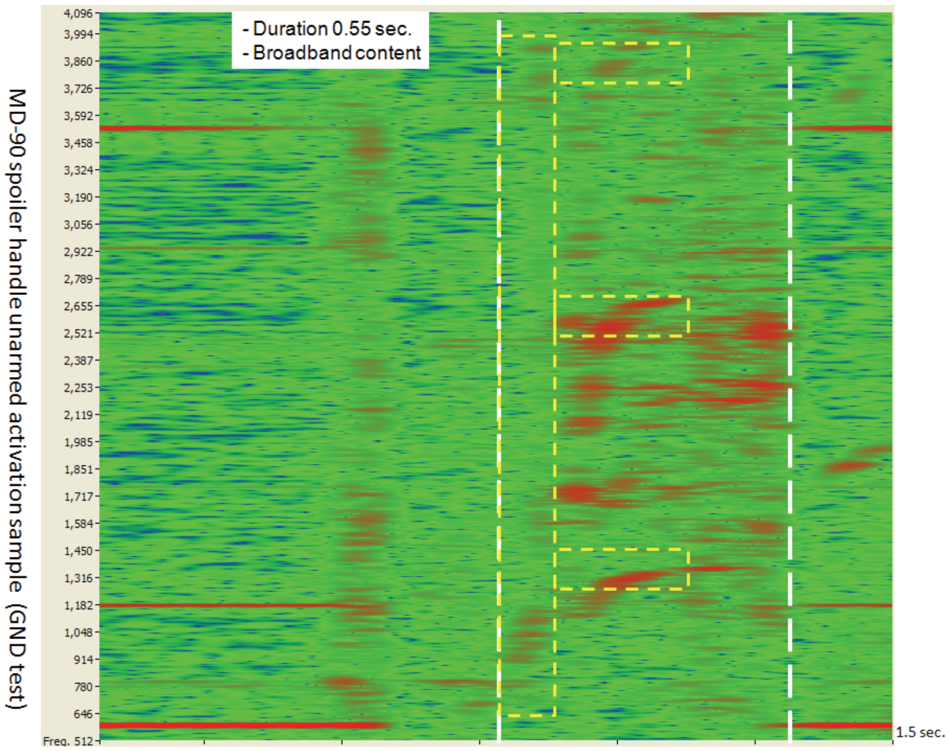

圖 1.16-7 未備動時「AIR-->GND」減速板手柄之頻譜（1）

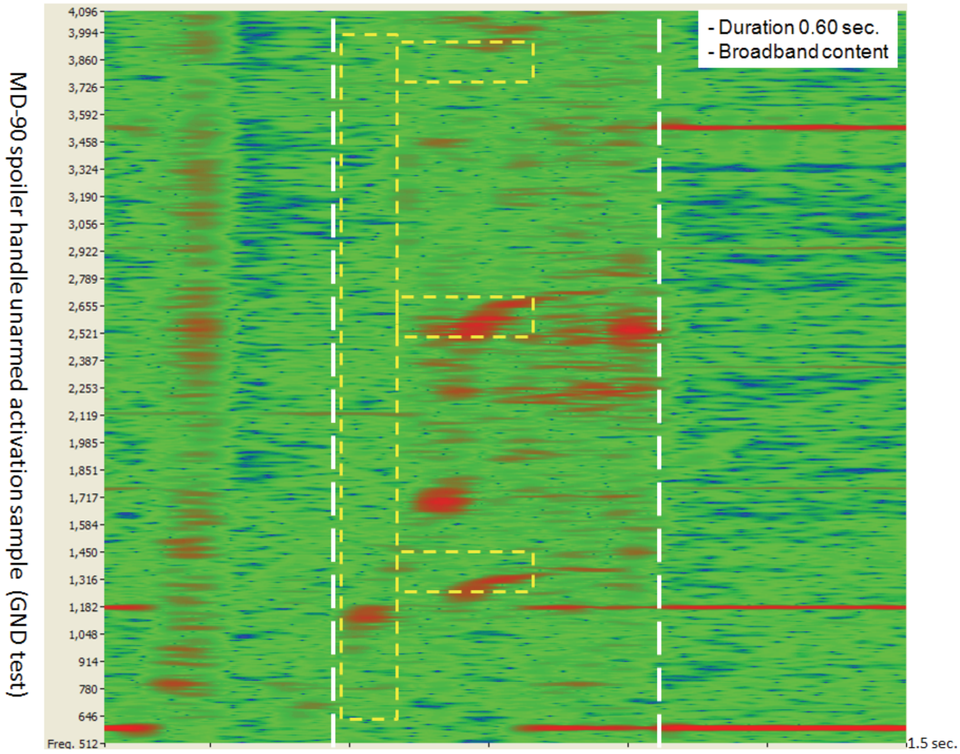

圖 1.16-8　未備動時「AIR-->GND」減速板手柄之頻譜（2）

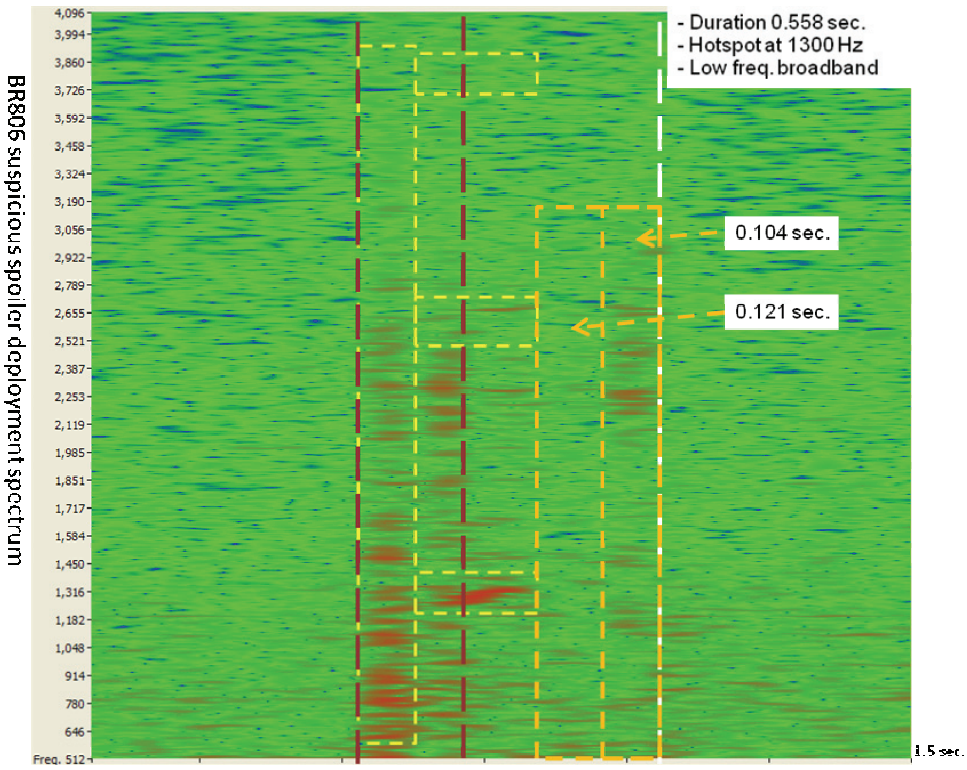

圖 1.16-9　BR806 落地時不明聲響之頻譜

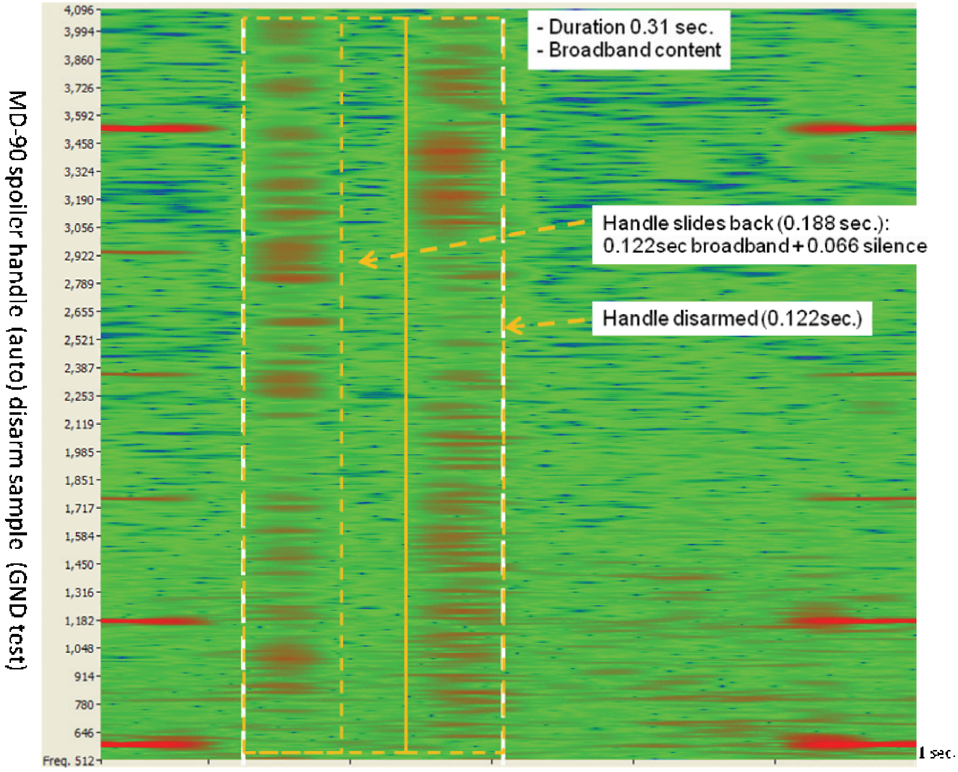

圖 1.16-10　減速板手柄自動收回之頻譜

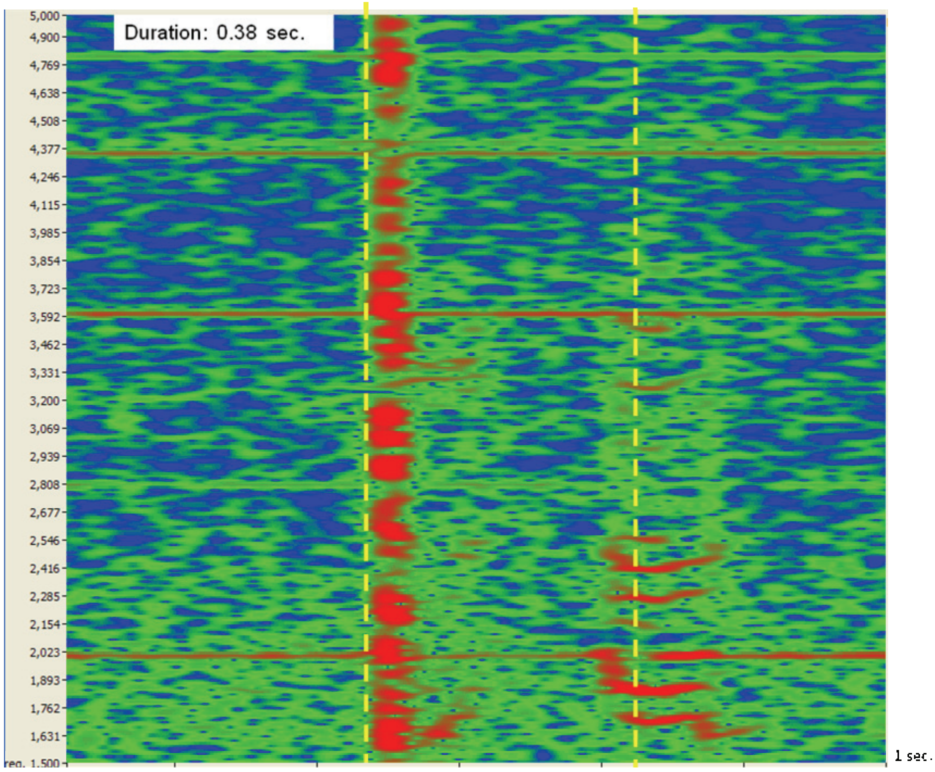

圖 1.16-11　減速板手柄拉至備動位置之頻譜

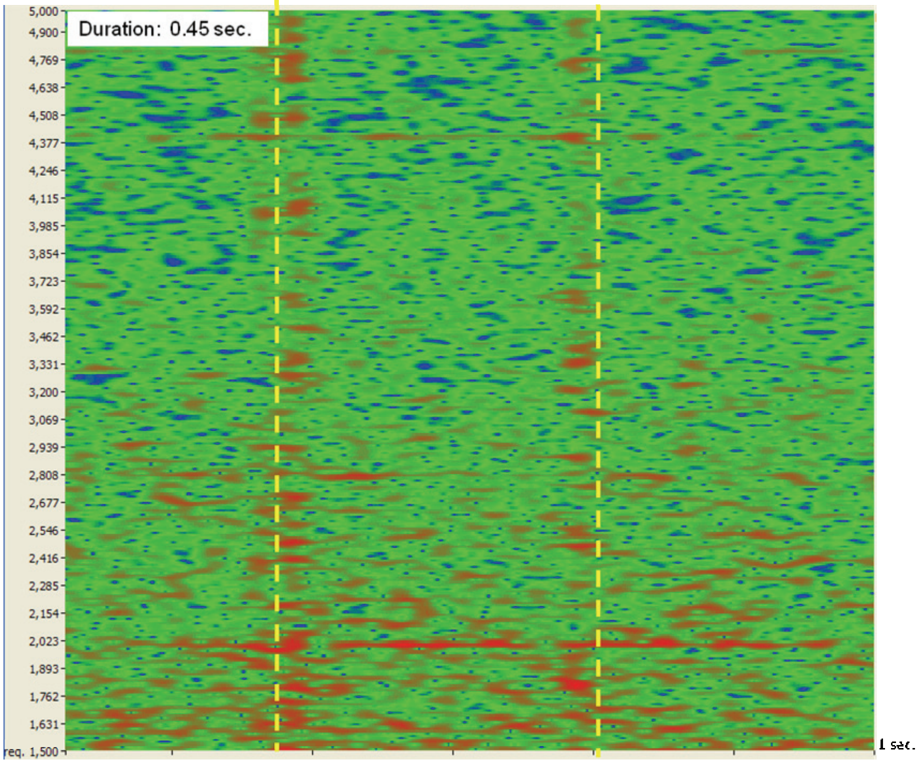

圖 1.16-12　BR806 疑似減速板手柄拉至備動位置之頻譜

1.16.4　跑道鋪面積水深度與磨擦係數

民國 100 年 6 月 25 日，桃園機場工程處人員於 06 跑道鋪面浸濕、無積水、使用 Runway Friction Tester 在不噴灑水膜之狀況下，循 BR806 行經軌跡進行摩擦係數測試。

以 65 公里小時測試之結果：

距 06 跑道頭 550-650 公尺之摩擦係數值爲 0.94；距 06 跑道頭 650 至 750 公尺之摩擦係數值爲 0.92；距 06 跑道頭 750 至 850 公尺之摩擦係數值爲 0.94；距 06 跑道頭 850 至 950 公尺之摩擦係數值爲 0.92；距 06 跑道頭 950 至 1050 公尺之摩擦係數值爲 0.95。

以 95 公里小時測試之結果：

距 06 跑道頭 550 至 650 公尺之摩擦係數值爲 0.49；距 06 跑道頭 650 至 750 公尺之摩擦係數值爲 0.82；距 06 跑道頭 750 至 850 公尺之摩擦係數值爲 0.94；距

06 跑道頭 850 至 950 公尺之摩擦係數值為 0.90；距 06 跑道頭 950 至 1050 公尺之摩擦係數值為 0.80。

桃園機場工程處人員使用 Runway Friction Tester，於民國 100 年 6 月 28 日 1445 時至 1515 時，在下雨不噴灑水膜的狀況下，於 BR806 行經軌跡進行摩擦係數測試。

其間 06/24 跑道 AWOS 雨量計之 1 小時累積雨量（單位公釐），如表 1.16-1 所示。

表 1.16-1 桃園機場 06/24 跑道 28 日 1445 時至 1515 時雨量資料

時間	雨量	時間	雨量	時間	雨量	時間	雨量	時間	雨量
1445	7	1451	7.6	1457	8.4	1503	8.8	1509	9.4
1446	7	1452	7.8	1458	8.4	1504	8.8	1510	9.4
1447	7.2	1453	7.8	1459	8.4	1505	9	1511	9.6
1448	7.2	1454	8	1500	8.6	1506	9	1512	9.6
1449	7.4	1455	8	1501	8.6	1507	9.2	1513	9.6
1450	7.4	1456	8.2	1502	8.6	1508	9.2	1514	9.6

06 跑道沿 BR806 軌跡自距 06 跑道頭 600 公尺至 900 公尺之跑道積水量測資料如表 1.16-2 所示。

表 1.16-2 桃園機場 06/24 跑道 BR806 軌跡跑道積水深度

距 06 跑道頭（公尺）	積水深度（公釐）	距 06 跑道頭（公尺）	積水深度（公釐）	距 06 跑道頭（公尺）	積水深度（公釐）
600	0.1	720	0.2	840	0.5
620	0.1	740	0.1	860	0.1
640	0.5	760	0.5	880	0.1
660	0.1	780	0.5	900	0.5
680	0.1	800	0.1		
700	0.5	820	0.5		

前述摩擦係數測試結果顯示如下：

以 65 公里/小時測試之結果：

距 06 跑道頭 550 至 650 公尺之摩擦係數值爲 0.87；距 06 跑道頭 650 至 750 公尺之摩擦係數值爲 0.85；距 06 跑道頭 750 至 850 公尺之摩擦係數值爲 0.80；距 06 跑道頭 850 至 950 公尺之摩擦係數值爲 0.76；距 06 跑道頭 950 至 1050 公尺之摩擦係數值爲 0.86。

以 95 公里/小時測試之結果：

距 06 跑道頭 550 至 650 公尺之摩擦係數值爲 0.56；距 06 跑道頭 650 至 750 公尺之摩擦係數值爲 0.55；距 06 跑道頭 750 至 850 公尺之摩擦係數值爲 0.53；距 06 跑道頭 850 至 950 公尺之摩擦係數值爲 0.42；距 06 跑道頭 950 至 1050 公尺之摩擦係數值爲 0.35。

1.16.5 波音公司有關落地著陸姿態及系統功能研究

本會於民國 100 年 5 月 12 日致函參與本案之授權代表－美國國家運輸安全委員會（National Transportation Safety Board, NTSB）與波音公司，請其依本案調查小組提供之 FDR，QAR 及減速板作動之聲音頻譜結果，針對 BR806 落地著陸彈跳、地面擾流板功能及煞車效能按項目提供專業意見，波音公司函覆結論如下：

該機以機首略朝下、右翼略傾姿態著陸，擾流板未伸展（自動或手動），有使用反推力器及煞車，煞車使用程度因參數異常以致無法確認。

Summary

Boeing analyzed the Flight Recorder Data from the subject flight. This report focuses on the touchdown, spoilers, and brakes. The airplane touched down in a slightly nose-down pitch attitude with a right-wing-down roll attitude. Spoilers did not deploy, either automatically or manually. Reverse thrust and brakes were used, although anomalies in the parameters prevent a complete confirmation of the actual braking *levels used.*（波音公司回函詳附錄三）

1.17 組織與管理

1.17.1 我國有關航務主管設置與資格之規定

我國係於航空器飛航作業管理規則中，訂定有關民用航空運輸業航空器使用人應設置航務主管及該主管之資格條件相關規定，內容如下：

航空器飛航作業管理規則

第十三條　航空器使用人應設置全職且適任之航務主管、機隊主管、機務主管、品管主管及飛安主管，並報民航局備查。

第十四條　航務主管除應熟悉與其業務相關各類手冊、營運規範及相關民航法規外，並應具備下列條件之一：

一、持有或曾持有民航運輸駕駛員檢定證並擔任大型航空器機長三年以上經驗。

二、擔任使用大型航空器機構之航務主管或航務相關業務三年以上之經驗。

1.17.2 美國聯邦航空法規航務主管設置與資格之規定

我國航空器飛航作業管理規則中有關航務主管設置及資格條件相關規定，係參考美國聯邦航空法規第 119.65 及 119.67 條，該兩條文之部分內容摘錄如下，完整內容詳如附錄四。

119.65 Management personnel required for operations conducted under part 121 of this chapter.

(a) Each certificate holder must have sufficient qualified management and technical personnel to ensure the highest degree of safety in its operations. The certificate holder must have qualified personnel serving full-time in the following or equivalent positions:

(1) Director of Safety.

(2) Director of Operations.

...

119.67　Management personnel: Qualifications for operations conducted under part 121 of this chapter.

(a) To serve as Director of Operations under §119.65(a) a person must-

(1) Hold an airline transport pilot certificate;

(2) Have at least 3 years supervisory or managerial experience within the last 6 years in a position that exercised operational control over any operations conducted with large airplanes under part 121 or part 135 of this chapter, or if the certificate holder uses only small airplanes in its operations, the experience may be obtained in large or small airplanes;

...

1.17.3 立榮航空運航本部組織架構及主管編制

立榮航空運航本部（Operations Division）之組織架構依航務手冊第三章（詳如附錄五）包括有：航行部（Flight Operations Department）、航行管制部（Flight Control Department）及服勤部（Head of Cabin Crew Department），並各設置部主管一名。此外，運航本部下亦包括有執行總機長（Director of Flight Operations）及副執行總機長（Deputy Director of Flight Operations）兩個具民航運輸駕駛員檢定證並曾擔任大型航空器機長三年以上經驗之空勤主管，上述五位主管皆直接對運航本部最高主管（Head of Operations Division）負責。立榮航空係以運航本部最高主管做爲民航法規要求航空器使用人所應設置之航務主管。運航本部組織圖如圖 1.17-1。

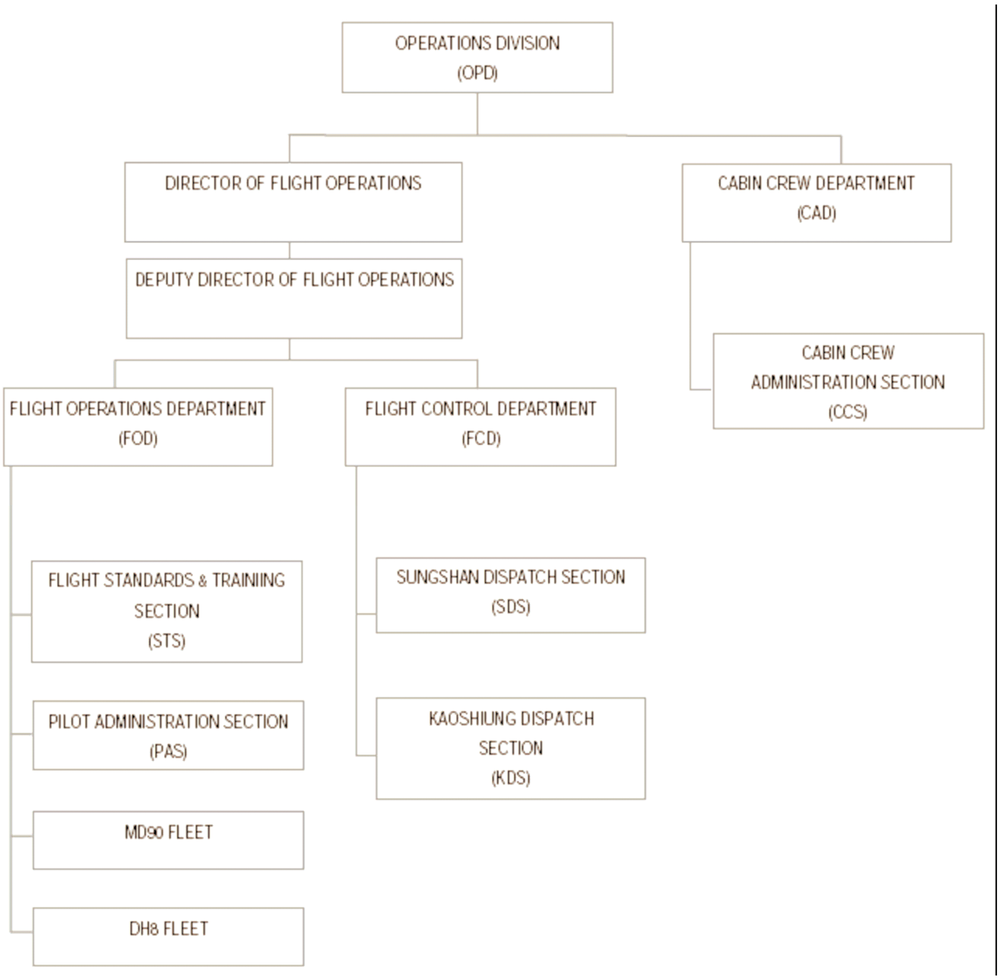

圖 1.17-1　立榮航空運航本部組織圖

1.17.4 立榮航空運航本部主管派任情形

爲瞭解立榮航空運航本部下屬之部級（department）以上主管實際之派任情形，本會訪談立榮航空航務相關主管及民航局之立榮航空主任航務檢查員，訪談摘要如下。

1.17.4.1 立榮航空運航本部代理主管訪談紀錄摘要

該員具簽派員經歷，不具民航駕駛員資歷，由於運航本部協理出國接受飛行訓練，故該員除原擔任之航行管制部經理外，自民國 100 年 5 月 1 日起暫代運航本部

協理之職務，成爲運航本部最高主管，並兼任航行部主管，原航行管制部主管一職，則交航行管制部副理代理。該員雖代理運航本部最高主管，實際運作上長榮航空航行本部主管會協助相關業務。

立榮與長榮航空於民國 98 年起實施合署辦公及資源共享。立榮航空原有人員擔任執行總機長之職務，自民國 97 年 6 月 22 日該執行總機長調任長榮航空後，由當時之副執行總機長代理至民國 99 年 12 月 31 日。民國 100 年 1 月 1 日起因組織調整，立榮航空未再指派人員擔任執行總機長及副執行總機長，該兩職務之功能分別由 MD90 機隊及 DH8 機隊總機長代理，並由長榮航空執行總機長協助。

1.17.4.2 民航局之立榮航空主任航務檢查員訪談紀錄摘要

該員係自民國97年8月15日起被指派擔任民航局之立榮航空主任航務檢查員。其表示知悉該公司航務相關主管實際派任狀況，認爲航務相關主管雖未補實或爲暫代，但功能上皆有人員執行，不認爲其未依據航務手冊執行。

1.18 其他資料

1.18.1 訪談摘要

1.18.1.1 正駕駛員訪談摘要

受訪者表示，事故當日下午由台北飛澳門，2034 時起飛，落地約 2158 時，沿途天氣雷雨，航路上爲躲避雲層，由原計畫飛航高度 32,000 呎下降至 30,000 呎，並請求偏離航路。於澳門落地時天氣尚可，但預報有雷雨胞。回程前看台北天氣有雷雨，但是天氣預報爲小雨。約於距台北 200 多浬時開始 approach briefing，進場時監看雷達發現雷雨很多，與副駕駛員討論後向東偏移，聽 ATIS 播報之風向風速約爲 040/16，能見度爲 3,500 公尺，符合副駕駛操作要求，於是決定由副駕駛擔任 PF 繼續進場。當時雲較低，雨很大，但進場階段大都符合穩定進場狀況，目視跑道後，約於 200 呎前解掉自動駕駛，航機於跑道中心線觸地，檢查擾流板有起來，拉反推力器手柄，沒多久感覺航機彈了一下，發現航機有向右偏，即使用左舵修正機頭，但航機仍持續向右，當時不覺得有壓到東西，認爲只是主輪側滑，之後航機

就回到跑道中心線。受訪者表示當時因爲使用煞車造成航機側滑。落地前煞車設定置於「Auto medium」，有關自動煞車設定公司並無硬性規定，雨天當然是愈大愈好。

正駕駛員表示於落地後感覺一個力量使飛機右偏，像一陣很大的風或是水漂，當時檢查航機機翼是正常的，幫副駕駛使用了一些舵。飛機著陸地點約爲 2,000 呎，副駕駛員嘗試 positive control，較 firm 之著陸姿態。感覺下降率正常，著陸亦正常，落地後馬上使用反推力器至全開，發現航機偏側時，已無法再重飛。

落地過程中唯一覺得不尋常的是當時航機彈了一下，脫離跑道後，煞車及滑行情況還好，滑行中檢查輪胎溫度正常，不到 300℃。到停機位後請地面檢查 Parking Brake 情況，地面回報輪胎胎皮剝落，立刻通知塔台請求檢查道面狀況。

正駕駛員表示，進場過程中是穩定進場，至於落地偏出之原因有可能是觸地時有側風或水漂。正駕駛覺得副駕駛員落地正常，在中心線落地， bank 也是 wing level，落地前雨變大，覺得觸地前跑道上有積水，因爲落地燈照到跑道上有一層白花花的水花。

1.18.1.2 副駕駛員訪談摘要

副駕駛員表示，飛航中聽取之 ATIS 資料與起飛前獲得之天氣資料差不多。到台中苗栗附近時，從雷達上看到有雷雨，並目視閃電，請求向右偏約 10 浬，距機場約 30 浬時，保持 11,000 呎由雷達引導進場，於距機場約 20 浬到進場都有雷雨。進場簡報時包括外型、自動煞車使用，襟翼使用及時機，攔截角、高度、速度等都有提到，如天氣不好，就在 Jimmy hold。之後航管允許繼續進場。final fix 前已做好放起落架及落地準備，當時風向不穩定，告知機長使用 Vref 約爲 142 浬/時，到達高度 1,000 呎時雨很大，高度 500 呎時 stable，告知機長說目視地面，並繼續進場。之後有其他航機問當時之天氣情況，塔台告知現在有航機進場，請該航機不要干擾，之後獲塔台許可落地，未接獲塔台其他任何天氣資訊，到 minimum 時解除自動駕駛，報出 runway approach light ahead in sight ，參照跑道邊燈落地，於高

度 50 呎時已將油門收完，因當時專心看外面，並沒檢查速度。航機在跑道中心線觸地，突然感覺好像有一陣很強的雨跟風，並覺得跑道上水很厚，之後擾流板有出來，有使用反推力，感覺航機往右偏，呼叫正駕駛協助使用舵向左控制，速度到 80 浬/時收回反推力，但可能較晚收回，感覺輪胎有側滑之剖剖...的聲音，航機很快回到中心線，與正駕駛員討論後，覺得可能碰到跑道邊燈，當時正駕駛員也不能確定，未發現滑行有問題，輪胎也無不正常情形，於滑行中曾告知塔台"Brake action Poor"。於 S6 脫離滑回 C10，之後請地面人員檢查外型，發現輪胎有 5 公分損傷，於是告知塔台請地面人員上跑道檢查。

進場前簡報內容依航管給的定向 Tonga 規劃，06 進場之外型 Flap/Brake 等，之後開始躲天氣，天氣簡報包括風向風速，因 ATIS 未提及有下雨情況，所以簡報時沒提到跑道有水及雨之問題。

副駕駛員表示這次航機進場狀況穩定，對正跑道及落地均無問題，幾乎沒有平飄，約在跑道端 1,500 至 2,000 呎間觸地，落地後擾流板有起來，也使用了反推力器。副駕駛員覺得此次落地偏右可能是大側風、雨及跑道積水情形造成，因落地時有非常大的雨，落地燈光照到跑道道面白白的，但無法確認跑道積水多少，但感覺當時水像潑下來一樣。落地後發現右偏，盡量使用舵，但並未使用煞車，落地後一直用自動煞車，速度到 60 浬後才把自動煞車解掉。當時並未使用不對稱煞車（differential brake），因擔心航機會立即偏滑或發生不確定之狀況。

副駕駛員表示航務手冊中說明落地積水過深不宜落地，或落地時使用 Flap 40 並用 medium 以上之自動煞車，如航機落地後偏移可將自動煞車關閉後使用不對稱煞車，但此次爲雨天落地，如使用不對稱煞車可能更不安全。此次反推力器於 80 浬/時前均在全馬力位置。有關反推力器操作之手冊規定，如感覺方向不好操作，應收回一下，這次因發生太快，所以來不及。

1.18.1.3 國泰航空 CX402 班機駕駛員訪談摘要

受訪者表示該機於事故當日 2038 時於 06 跑道落地，進場前獲得機場附近有大

雷雨及風切現象之天氣報告，機場能見度爲 5,000 公尺，風向風速爲 040 度 14 浬/時。航機於 5 邊、高度約 400 呎時可清楚目視進場燈、跑道邊燈及跑道頭，當時雨勢爲中度到大雨，跑道爲濕滑狀態，使用自動駕駛落地、自動煞車設定爲 3，觸地後使用全馬力反推力，操控正常，約於 70 浬/時解除自動煞車，落地後至脫離跑道均未發生異常操控問題。

1.18.1.4 臺北機場管制臺機場管制席

該員當天值 1900 時[14]至隔日 0900 時夜班，1955 時至 2056 時輪值機場管制席。輪值該席位時航行量及工作負荷正常，約 30 分後因天氣有變壞的情形，提供氣象資訊的工作量增加。

接班時天氣良好能見度大於 10 公里，2016 時能見度降至 5,000 公尺，2020 時之後注意到有陣雨的情形，2034 時能見度降至 800 公尺，廣播告知航機。之後持續注意到能見度變差的情形，下席位前能見度稍有好轉，但還有雷雨胞。

該機於 2031 時與該員通聯，管制過程正常，之後地面管制席通知該機，他航報告有 braking action poor 的情形，便通知後續航機此情況。該機落地後，緊接著有 CX402 班機接著降落，其後有一班機於短五邊時重飛，近場臺告知重飛之原因爲看不到跑道。LLWAS 在事故前數分鐘曾發出 05 跑道之風切警示，事故時無風切警示。下席位前尚未接獲該機滑出跑道之報告。

1.18.1.5 臺北機場管制臺資深輔導員

該員爲夜班之班務負責人，當天自 1900 時值班後，便發現許多近場臺管制的航機執行天氣避讓程序，有積雨雲，而塔臺工作負荷與平常差不多。該機進場及落地時該員正於機場管制席、地面管制席及飛航資料席之間進行協助。2059 時該機進停機坪後向地面管制席報告疑似偏出跑道，飛航資料席便通知航務處上跑道巡

[14] 1.18.1.4 至 6 述及之時間為航管（ATC）時間，與其他章節所使用之 FDR 時間差距約 90 秒（ATC 時間+90 秒=FDR 時間）。

視，該員則先協助機場管制席暫停航機離場，關閉 06 跑道並指示五邊之飛機重飛，隨後協助地面管制席連絡航務處及管制車輛。約半小時後，2136 時航務處通知確認該機偏出跑道，邊燈損壞。

當晚 2030 時至 2400 時天氣驟變後有四架飛機重飛，皆於該機落地之後，其中兩架爲能見度不佳、一架爲滑降台訊號不穩，另一架爲上述關閉 06 跑道時管制員指示重飛之航機。

1.18.1.6 桃園航空氣象臺天氣觀測席

該員當天值 1400 時至隔日 0800 時中、夜 2 班，夜班有 2 位觀測員共同值班。當晚天氣變化劇烈，需隨時觀測是否有最新變化，以及監看儀器、LLWAS、雷達回波等，兩位值班人員工作較繁重。

當天中班接班時氣象雷達已有回波，下午回波在北面、西北面，1930 時後向南移動，較偏向西邊，且回波開始增強。接近 2000 時天氣系統靠近機場，聽到雷聲；2016 時開始下雨，能見度降低。2030 雷雨接近機場，2034 時忽然開始下大雨，2035 時雷雨在機場上空，雷雨胞一波一波，共持續 6 個小時。

1955 時塔臺通知一架 B747 飛機於 06 跑道落地時，在 300 呎高度遭遇低空風切，遂發布 2 小時風切警報與機場特別天氣報告。2028 時 LLWAS 曾偵測到低空風切。

當天 1955 時至 2155 時發布一次風切警報，另外自 2035 時起發布 4 次雷雨警報共計 6 小時。

1.18.2 飛航操作相關資料

1.18.2.1 航務手冊

立榮第 20 版之航務手冊（Flight Operations Manual, FOM）於民國 100 年 4 月 15 日修定生效，內容共計 16 章；該手冊第五章爲組員資源管理（Chapter 5 - Crew Resource Management, CRM），其內容概爲 CRM 之原理、策略、技巧、自動控制

原理、威脅與疏失管理等（詳如附錄六）。第六章 飛航派遣及操作限度（Chapter 6 - Flight dispatch, Operating Minima），內容重點計有進場授權、進場及落地最低操作限度、自動落地限制等（如附錄七）。第七章 標準操作政策（Chapter 7 - Standard Operating Policy），內容重點計有進場提示、自動進場及落地系統之使用、重飛等（如附錄八）。第八章 不良天候之操作（Adverse weather Operations），內容重點計有雷雨、亂流、風切、寒冷天候及濕滑結冰跑道之操作等（如附錄九）。

1.18.2.2 MD-90 飛航組員訓練手冊

立榮航空第2版之MD-90型機飛航組員訓練手冊(Flight Crew Training Manual, FCTM)，於民國99年7月1日修定生效，內容共計10章；其中第五章爲進場及迷失進場（Chapter 5 - Approach and Missed Approach），敘述進場之種類、低能見度進場及迷失進場等。第六章爲落地（Chapter 6 -Landing ），敘述落地技巧、側風落地等內容。

1.18.2.3 MD-90 飛航組員操作手冊

美國波音公司之MD-90型機飛航組員操作手冊(Flight Crew Operations Manual, FCOM)第44版，於民國99年12月15日由立榮修定生效，其中NP.70.4至 NP.70.9頁（附錄十）之內容爲落地前檢查（Before Landing）、NP.80.1至NP.80.3頁（附錄十一）之內容爲落地及落地後檢查（Landing & After Landing）。

1.18.3 立榮 MD-90 機隊 Ground Spoiler 之異常操作紀錄

爲了解地面擾流板（Ground Spoiler）在Auto mode未作動狀況專案調查小組及立榮去函波音洽詢可能原因。波音回函稱未曾接獲立榮相關之通報或訊息，立榮公司亦函復稱MD-90機隊Ground Spoiler System當使用AUTO及MANUAL操作均可正常作動地面擾流板，如auto ground spoiler系統異常未作動，故障訊息皆會顯示於駕駛艙，立榮MD-90機隊迄今未曾發生過Ground Spoiler Auto Mode無法作動之紀錄。

第二章　分析

2.1 概述

該機兩位飛航組員飛航資格符合現行民航法規，事故前 72 小時內休息及活動正常，無證據顯示飛航組員於飛航中曾受任何生理、心理、藥物及酒精影響。該班機載重平衡在限制範圍內，無證據顯示本次事故與航機維修及適航相關。

本事故之分析概以飛航軌跡分析、飛航操作（飛航組員相關飛航操作程序、偏出跑道可能原因、CRM 相關議題）、擾流板落地後未展開之原因分析、CVR 頻譜分析、飛航資料紀錄器之適航檢查、航務主管之設置及相關法規、跑道鋪面抗滑影響因素、跑道中心線燈、提供航空器天氣資訊之航管相關作業等分述如下。

2.2 飛航軌跡分析

本節係依 1.11 節飛航紀錄器（CVR 及 FDR）及 1.12 節地面量測軌跡等事實資料，分析該機於最後進場至偏出期間飛航軌跡，計算結果詳圖 2.2-1 及圖 2.2-2。圖 2.2-2 紅色線飛航軌跡[15]，係將 FDR 記錄之地速、航向、偏流角、飛航參數經積分後，參考多重監視源資料處理系統（MSTS）航跡；綠色線飛航軌跡爲 IRU 與左右定位台偏移參數（Localizer Deviation, LOC DEV），計算航機垂直尾翼及航機重心之橫向偏移量[16]。IRU 計算飛航軌跡因 FDR 記錄飛航參數精度不足，造成通過 06 跑道頭及主輪著陸期間，偏離 06 跑道中心線現象，本報告採用之飛航軌跡係以 IRU 與左右定位台偏移參數計算（綠線），分析細節詳附錄十六。

依據本事故之事實資料，該機係由副駕駛員擔任 PF，約於 2032:38 時（FDR 時間）放妥起落架，開始執行落地前檢查。依 CVR 抄件約於 2033:03 時，塔臺許可該機落地，告知 06 跑道風向爲 030、風速爲 10 浬/時、能見度爲 3,500 公尺；依

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[15]因 FDR 記錄飛航參數精度不足，造成通過 06 跑道頭及主輪著陸期間，偏離 06 跑道中心線現象。

[16]航機橫向偏移量計算：△Y=△X x tan（LOC DEV *SA） △X: 航機與 06 跑道頭末端之左右定位台相對距離；SA；LOC 轉換成左右定位台前視扇區之比例； △Ycg=△Y x [72 ft x tan（△Ψ）]；△Ψ；航機與跑道中心線之夾角。

CVR 抄件塔台約於 2034:41 時廣播本場有雷雨，該機約於 2035 時通過 1,000 呎，之後正駕駛員呼叫目視跑道；FDR 資料顯示於 2036:22 時該機解除自動駕駛至 2036:32 時該機通過 6 跑道頭上空期間，該機空速維持於 143+/-3 浬/時，航機保持於 06 跑道中心線左側約 4 呎至 20 呎，此期間左側風約 10 至 18 浬/時。

依 FDR 資料，該機於 2036:33 至 2036:39 時平飄至著陸期間，空速維持於 149+/-5 浬/時。該機主輪於 2036:39 觸地，機首方向爲 050，空速爲 144 浬/時，地速爲 150 浬/時；3 秒後左主輪離地（Weight on wheel 訊號由 Ground Mode 變成 Air Mode）約 2 秒[17]，6 秒後右主輪離地約 2 秒[18]；此期間航跡前進之方向右偏，機頭持續向左；7 秒後（2036:46 時），航機右主輪偏出跑道，當時之機首方向爲 038，地速 117 浬/時；2036:56 時航機重回道面，地速 78 浬/時。總計航機偏出跑道之時間爲 10 秒，相關之航跡資料如圖 2.2-2 及 2.2-3。

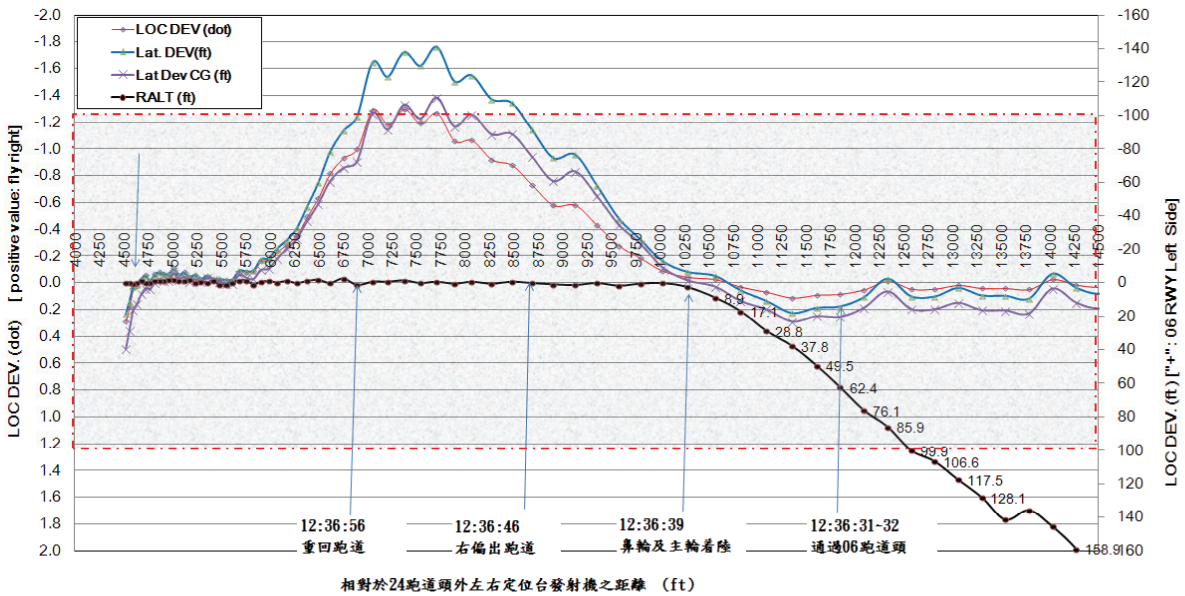
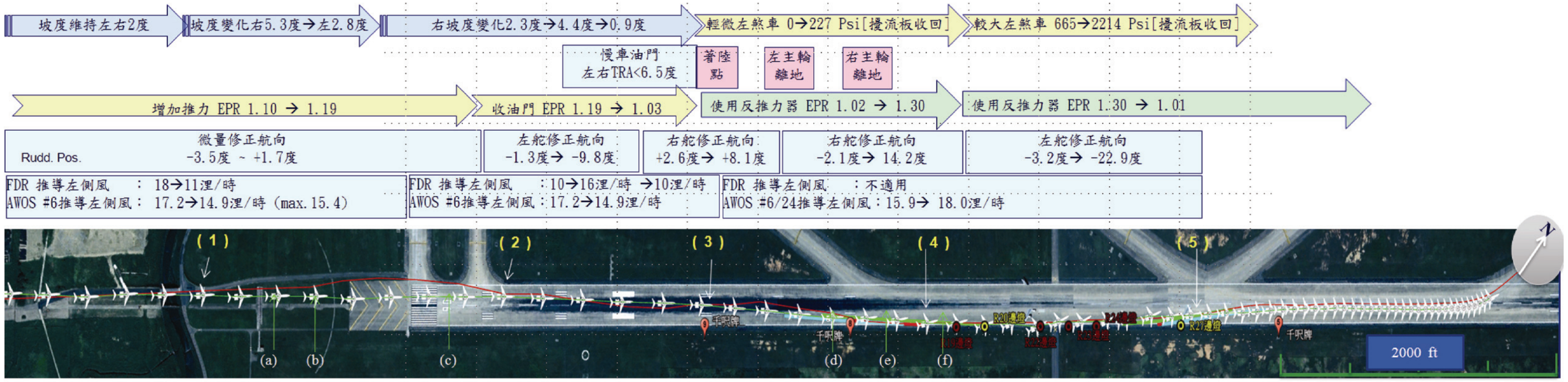


圖 2.2-1 該機 200 呎高度以下至偏出期間之航跡左右偏移量

17 WOW 轉為 AIR, RALT 由 0.7 呎→1.9 呎→0.3 呎

18 WOW 轉為 AIR, RALT 由 1.5 呎→1.1 呎→0.3 呎



參考時間	來源	CVR抄件
(a) 12:36:28.2	CAM-2	幫我check centerline
(b) 12:36:29.0	CAM	one hundred
(c) 12:36:32.7	CAM	Fifty
(d) 12:36:43.1	CAM-2	喂幫我注意一下rudder rudder rudder
(e) 12:36:44.5	CAM-1	rudder rudder rudder rudder
(f) 12:36:46.5	CAM-1	reverse先關掉

參考距離	參考時間	
(1)	20:36:26	右坡度5.27度；RA 128.1呎；空速144浬/時；
(2)	20:36:34	右坡度1.41度；RA 37.8呎；空速154浬/時；由仰角轉俯角
(3) 1,950呎	20:36:39	主輪及鼻輪著地；右坡度0.88度；空速144浬/時
(4) 3,340呎 3,900呎	20:36:46 20:36:47	右主輪右偏出道面 左主輪右偏出道面
(5) 4,850呎 5,100呎	20:36:54 20:36:56	左主輪重回道面 右主輪重回道面

圖 2.2-2 該機最後進場、平飄、落地軌跡分析圖

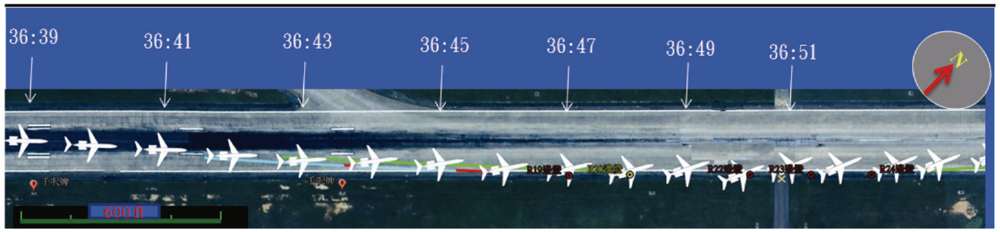


圖 2.2-3 該機最後進場、平飄、落地軌跡分析圖 2

2.3 飛航操作

本節係參考 2.2 節飛航軌跡、FDR 紀錄之飛航資料。

本節就飛航操作程序（標準操作程序、駕駛員操作限制、下降計劃與執行)、偏出跑道可能原因及 CRM 等因素分析如下。

2.3.1 相關飛航操作程序

2.3.1.1 標準操作程序

立榮飛航組員操作手冊下降進場及標準落地操作程序項目包括：計算進場速度、依不同階段施放襟翼、起落架伸放、減速板及煞車設定、速度/高度檢查、標準呼叫及交互檢查等。

飛航組員操作手冊中要求飛航組員於進場落地期間，對任何 FGCP 改變均需依 MD-90 Flight Crew Operations Manual FGCP 章節 NP.00.7 頁實施及執行標準呼叫：例如（SPEED 200 SET、HEADING 180 SET、FIVE THOUSAND FEET SET AND ARM、SET SPEED 250、SET HEADING 180、SET FLIGHT LEVEL 320、ARM ILS、ARM NAV）。

經檢視 CVR/FDR 資料並對照相關操作程序之要求，飛航組員於進場落地期間，對大部份 FGCP[19]改變時未實施及執行標準呼叫；另飛航組員間對於 Approach Check、Landing Check、SLAT/FLAP 和 LANDING GEAR 收放之呼叫、ILS Approach CAT-I 實施及外型（構型）收放之呼叫、AUTOCALL "TWENTY-FIVE HUNDRED"之 RESPONSE 及有關 FMA 改變未完整呼叫，另未對地面擾流板實施呼叫。

檢視該機飛航組員之訓練及考核紀錄無異常，依 AC120-002A 航務自我督察作業要求，督察系統之基本範圍包括能檢視偏離正常、標準操作或一般運作習慣之時

[19] FGCP.（Flight Control Guidance Panel）

間、頻率並應對缺失根本原因訂定改善計劃及複查改善情形，公司應加強航務自我督察作業。

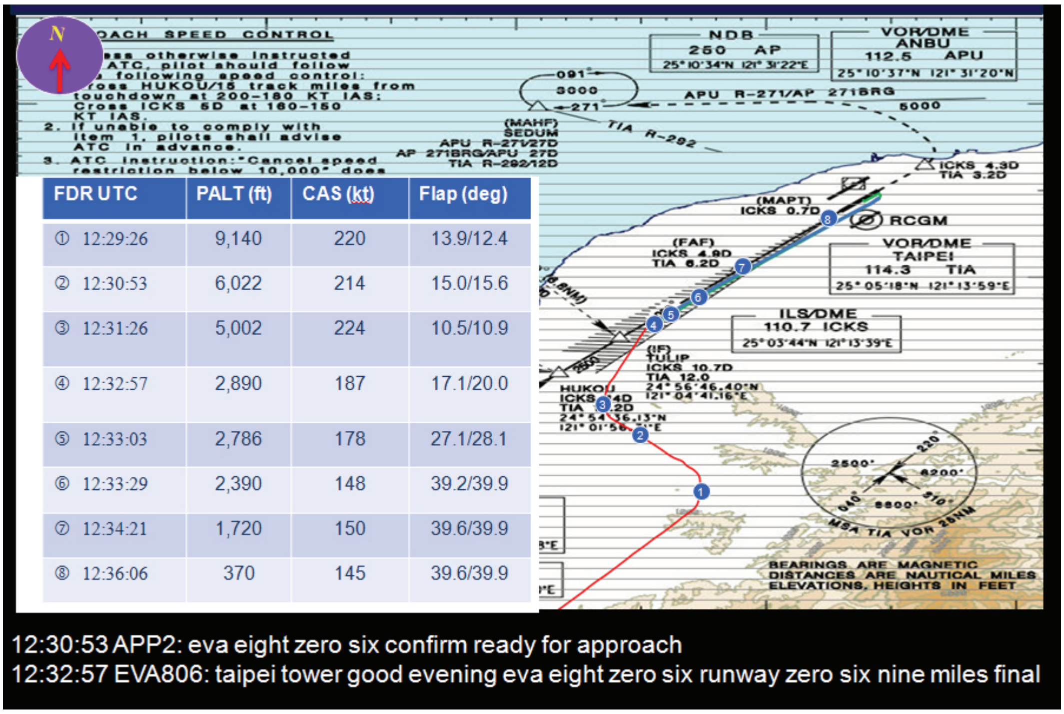
2.3.1.2 駕駛員操作限制

立榮航務手冊第 6.12 節，如落地時之能見度低於 3,000 公尺，或側風（含陣風）超過 15 浬/時，副駕駛員不得執行落地操作。該節並提及任何時間發生或預期有風切產生，應由正駕駛員操作航機。另依該型機落地側風之限制，於 MD-90 快速檢查手冊（QRH）內容律定，於乾跑道側風落地限制爲 30 浬/時，濕（wet）跑道側風落地限制爲 22 浬/時。

飛航組員下降前所獲之天氣資料及落地前塔台告知之天氣資料，符合副駕駛員落地操作標準，但此後因天氣資料變動，致使該機於落地前側風之變化已超出副駕駛員落地標準。依飛航管理程序第 2.9.2 節內容，管制員應確定駕駛員已收到現行之氣象資料，並於資料有變化時盡速提供最新資料。落地前飛航組員並未獲知上述訊息。

2.3.1.3 下降計畫與執行

該機於下降通過後龍，高度約 17,000 呎時，因前方遭遇雷雨，向航管請求東偏 10 浬躲避雷雨，航管同意其繼續下降，高度保持 11,000 呎，並通知該機於中間進場定位點 TULIP（06 跑道進場航道，距機場西南約 11 浬）附近有雷雨；另依 FDR 資料及次級雷達軌跡圖（詳圖 2.3-1），於 ATC 時間 1227:19 時，BR806 通知航管「ready for approach」時，該機尚未放外型，高度爲 10,070 呎，空速爲 227 浬/時，距離機場大約爲 22 track miles，依該公司訓練手冊 4.3 節 Descent4-17 頁：*A good crosscheck is to be at 10,000 feet AAL, 40 miles from the airport, at 250 knots.*所述「交叉檢查執行」及 4-15 頁所述「下降計劃」：*Proper descent planning is necessary to arrive at the desired altitude and at the proper speed and configuration. The distance required for the descent is approximately 3.3 NM/1000 feet altitude loss for no wind conditions using ECON speed* 之要求，該機當時之高度應爲約 6,600 呎。



FDR UTC	PALT (ft)	CAS (kt)	Flap (deg)
① 12:29:26	9,140	220	13.9/12.4
② 12:30:53	6,022	214	15.0/15.6
③ 12:31:26	5,002	224	10.5/10.9
④ 12:32:57	2,890	187	17.1/20.0
⑤ 12:33:03	2,786	178	27.1/28.1
⑥ 12:33:29	2,390	148	39.2/39.9
⑦ 12:34:21	1,720	150	39.6/39.9
⑧ 12:36:06	370	145	39.6/39.9

圖 2.3-1 該機進場航跡圖

2.3.2 偏出跑道可能原因

本節分別就偏出跑道可能有關之風切、水飄、落地姿態、地面擾流板、反推力器、側風等因素分析如下：

風切

根據 1.11.2 節內容，該型機之 FDR 紀錄之（水平）風場資料爲每 1 秒一組風向及風速，爲分析該機最後進場階段之立體風場變化，本會採用數值分析方法[20] 以估算此期間每一秒的三軸風場，並評估是否遭遇風切 進而影響其飛航性能，重點摘要如下：

該機無線電高度 200 呎下降至 100 呎期間，航機坡度正常；此期間左側風約 16 至 18 浬/時，頂風變化 7 浬/時至 3 浬/時；方向舵位置約左舵 0.8 度至右舵 3.5

[20]擴展式卡爾曼濾波（Extended Kalman Filter）：以 FDR 紀錄之三軸加速度、風速、風向、地速及磁航向為觀測量，去除雜訊後來估算三軸的每秒風速。

度；航機重心位置位於 06 跑道中心延長線左側約 10 呎至 18 呎，磁航向 47 度，亦即與 06 跑道磁航向呈現左偏 6 度。

該機無線電高度 100 呎下降至 50 呎期間，航機坡度正常；此期間左側風約 14 浬/時減爲 11 浬/時，頂風變化 0 浬/時至 4 浬/時；此期間方向舵位置約左舵 3.2 度至右舵 1.8 度；航機重心位置位於 06 跑道中心延長線左側約 15 呎至 20 呎，磁航向由 47 度增爲 49 度，亦即與 06 跑道磁航向呈現左偏 4 度至 6 度。

該機無線電高度 50 呎以下至著陸期間，航機坡度均爲右坡度且最大爲 4.4 度；此期間左側風約 11 增爲至 16 浬/時至減爲 10 浬/時，由頂風變化 7 浬/時轉爲尾風 3 浬/時；此期間方向舵位置約左舵 1.3 度至右舵 6.8 度；航機重心位置由 06 跑道中心延長線左側約 23 呎改爲右側約 9 呎，磁航向由 49 度增爲 50 度，亦即與 06 跑道磁航向約左偏 3 度。詳圖 2.3-2。

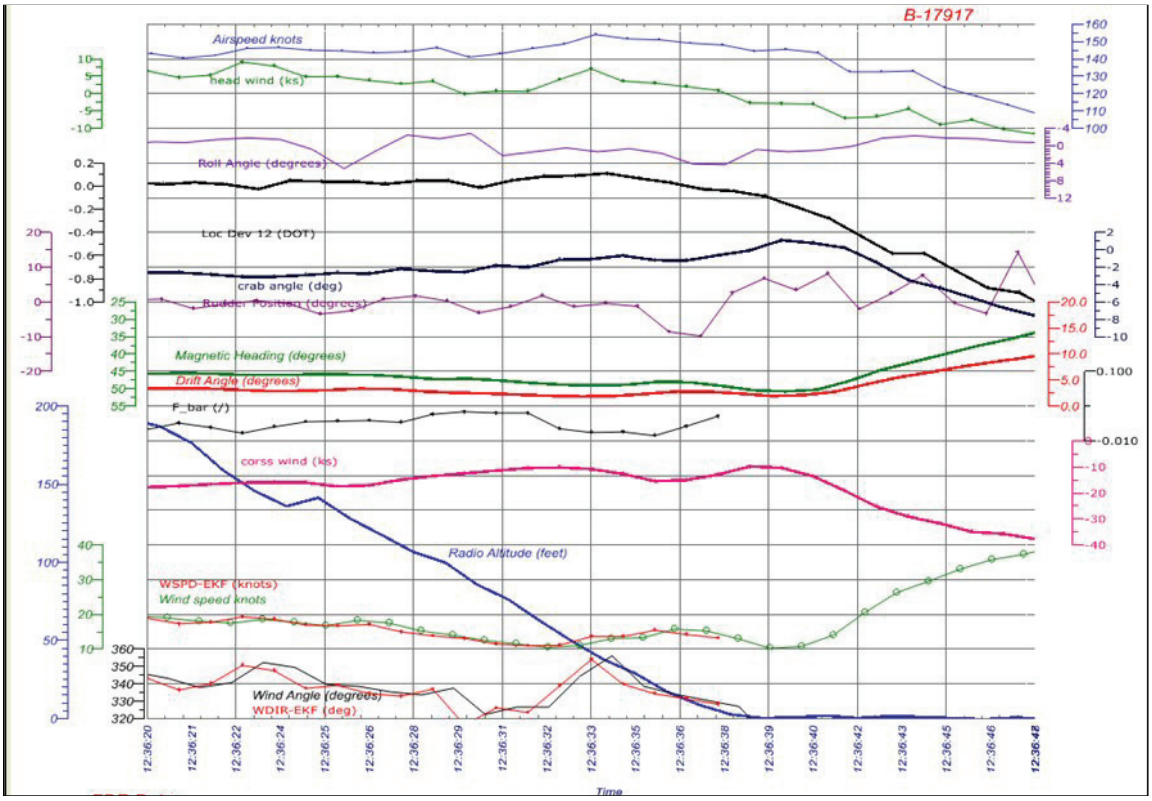


圖 2.3-2 BR806 200 呎高度以下至偏出期間相關參數繪圖

該機無線電高度 200 呎以下至主輪著陸期間，FDR 紀錄風場資料與數值分析方法之趨勢相近。此期間由頂風 7 浬/時轉爲尾風 3 浬/時，空速維持於 149±5 浬/時，其風切危害因子（F-factor）[21]均小於 0.1。

綜上所述風切危害因子小於 0.1、CVR 及 FDR 資料均顯示機上風切警告系統（windshear alerting and guiding system）亦未致動、且當時地面觀測亦無風切警告，故無風切現象。

水飄

航空器於溼滑跑道起降，鋪面上之水分於機輪排水時受到胎面擠壓，產生之水壓可能將部分機輪舉離鋪面，導致機輪與鋪面間之摩擦力大幅降低，此種現象稱爲水飄（Hydroplaning）。水飄發生時，航空器之減速及方向操控效能將因受其影響而降低。

水飄依其發生之特性可區分爲三種：動力水飄（dynamic hydroplaning）、黏滞水飄（viscous hydroplaning）[22]及膠面還原水飄（reverted rubber hydroplaning）[23]等。

黏滞水飄發生時，航機之地速介於中速至高速之間；鋪面狀況爲微濕或潮濕情況，並可能光滑或受油污、灰塵、胎屑等汙染；輪胎則是處於轉動狀態。該機進場落地階段有陣雨發生，故鋪面狀況符合潮濕情況。主輪著陸至左翼輪偏出邊線期間，地速介於 146 浬/時至 124 浬/時，因屬落地滾行初期階段，故應爲高速狀態。另依本報告第 2.8.4 節分析結果，06/24 跑道鋪面摩擦係數檢測結果符合相關規範，現場勘驗結果亦未發現主輪著陸至左翼輪偏出邊線區域之鋪面有受到油污、灰塵、

[21]風切危害因子（F-factor）：量化航機受力之變化，係為飛機位置及速度的函數。當 F 值為正時代表能量減少，F 值為負代表能量增加。FAA 規範的機載都卜勒雷達 F 值，以 0.1 為危險門檻值，0.13 為風切。

[22]黏滞水漂係於濕滑道面情況下，可能發生在較低的地速，當輪胎處於很小的水膜厚度上滑行(約小於 0.3mm)，且輪胎未完全被抬起，此狀況亦會發生於平坦的道面。

[23]膠面還原水飄係於濕滑道面情況下，當輪胎未能正常滾動且部分胎紋因磨擦生熱，致與道面接觸的胎膠呈現黏軟/切銷狀況。

胎屑等汙染情況。該機自主輪著陸至左翼輪偏出邊線期間，鋪面狀況爲潮濕情況，然當時之地速較高、跑道鋪面符合相關規範、未受汙染等現象不完全吻合黏滯水飄發生之條件，故無法積極證明該機遭遇黏滯水飄；動力水飄發生於積水氾濫之鋪面，對舊胎而言積水深度須高於 2.5 公釐，對新胎而言積水深度須高於 7.6 公釐。該機自主輪著陸至左翼輪偏出邊線期間，地速雖高於動力水飄發生之最小臨界速度，但以 06/24 跑道橫坡度降坡符合規範及本會估算當時之積水深度略高於 1 公釐研判，事故當時跑道鋪面應未達積水氾濫程度，動力水飄之發生應可排除；膠融水飄發生時，如機輪與鋪面間之摩擦時間夠久，產生足夠之高熱，則輪胎胎面之橡膠將因高溫而融化爲軟黏之橡膠原料，跑道鋪面上亦將留下兩側呈黑色、中央呈灰色或白色之胎印痕跡。調查中未發現上述現象之情況研判，本次事故應可排除膠融水飄之發生。

綜上所述本會認爲：該機落地時鋪面有發生水飄的條件與環境，但因該機著陸後第 3 秒及第 4 秒左主輪離地，第 6 秒及第 7 秒右主輪離地，之後該機即偏出跑道，本次偏出跑道事故應非水飄現象所致。有關跑道鋪面抗滑影響因素詳 2.8 節分析。

飛航操作

依 FDR 資料，該機於高度 1000 呎時，空速爲 148 浬，油門爲 1.06EPR，位於跑道中心延長線及下滑道且外型放妥，符合立榮航空穩定進場標準。

MD-90 操作手冊 RD 10.3/10.4 頁 FLAP 40 落地前之機身仰角爲 3.05 至 4.75 度（如圖 2.3-1，係 MD-90 ILS FLAP 40 最後進場姿態圖），於反轉及平飄後正常落地機身仰角大約爲 5 至 7 度（如圖 2.3-3 MD-90 落地姿態圖）。

操控駕駛員於著陸前 4 秒及 2 秒兩次輸入較大的推桿及拉桿的俯仰操控，平飄至著陸期間（36:33 時至 36:39 時），無線電高度 50 呎以下，飛機姿態由 0.88 度仰角轉爲 1.05 度俯角，左右主輪及鼻輪同時著陸，導致三輪著陸後並接續發生左右主輪分別短暫離地現象（36:41 時至 36:42 時左主輪離地、36:44 時至 36:45 時右主輪離地）。

監控駕駛員於 CVR 抄件 2036:44 時及 2036:46 時曾提醒操控駕駛員使用方向舵及反推力器，但監控駕駛員未及時接手。

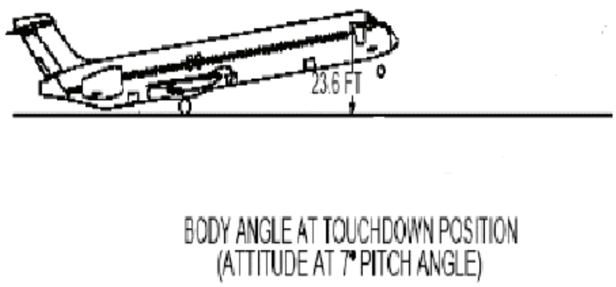


圖 2.3-3 MD-90 落地姿態圖

參考 1.6 事實資料，地面擾流板展開主要功能爲破壞機翼升力，減低地面風對航機操控之影響，同時增加飛機施於輪胎及道面之重量，以增進輪胎循跡效應（Cornering Effect）及煞車性能。

依據 FDR 解讀結果（詳如 1.11.2 節），該機於 2036:39 時著陸後，擾流板全程未展開。依 MD-90 飛航組員操作手冊 NP.80.1（詳附錄十一），航機落地階段，操控駕駛員應先確定油門手柄在慢車位置，於主輪著陸後，監控駕駛員應檢查擾流板之狀態，若擾流板正常展開，應呼叫「spoiler up」，若未正常展開，則呼叫「no spoiler」。當擾流板未正常展開時，正駕駛員（監控駕駛員）亦應依正常程序手動將減速板手柄移至「EXT」位置，以使該機擾流板展開；另依據 CVR 抄件（詳如 1.11.1 節），該機於 2036:39 時著陸後，駕駛員未有任何有關擾流板狀態之呼叫，另 CVR 抄件顯示，航機著陸後，正駕駛員於 2036:43.1 時起，連續呼叫四次「rudder」，接者呼叫「reverse 先關掉」。

綜上所述：正駕駛員於該機落地後，忽略檢查擾流板之狀態，未在擾流板自動展開時以手動方式使其展開。

參考立榮 MD-90 飛航組員訓練手冊第 6.2 節（詳附錄十二），航機於側風落地時會遭遇風標效應[24]（即機首向上風邊而機尾向下風邊），反推力之側向分力會將航機推向下風邊，此時應將反推力器回收至慢車，以減少側向分力，並使用方向舵及煞車以維持航機於跑道中心線上。

事故機落地後，左側風約爲 15 浬/時，操控駕駛員隨即拉反推力器至最大，直至該機偏出跑道。由此段時間該機航向變化由 050 至偏出跑道時之 038 得知，當時航機發生風標效應，飛航組員亦表示落地後感覺一股力量使飛機右偏，應係當時之側風及反推力產生之側向分力，將航機推向下風邊所致。

綜上所述：事故班機落地後遭遇風標效應，飛航組員未能即時將反推力器回收至慢車，並適量使用方向舵維持航機前進方向，以降低航機偏離跑道之風險。

落地後操控駕駛員應向側風邊壓桿，以維持航機正確滾行方向。依據 FDR 資料，落地當時自 500 呎至落地期間有約 10 浬/時至 20 浬/時之左側風，主輪著陸後左側風約維持於 15 浬/時。側風使航機左翼上揚，操控駕駛員未使用副翼修正，因而使航機產生向右之坡度，導致航機右偏；著陸後左右主輪分別短暫離地期間飛航組員仍用右舵修正航跡，更加劇航機右傾，且因左側風增至最大 18 浬/時，左機翼因側風使升力增加，操控駕駛員亦未向上風邊壓桿，克服左翼上揚現象，致使左主輪短暫離地 2 秒，之後操控駕駛員可能試圖改正航機右傾現象，使用副翼向左改正，造成右機翼上揚，使右主輪短暫離地 2 秒。

2.3.3　偏出跑道可能原因小結

落地當時自 500 呎至落地期間有約 10 浬/時至 20 浬/時之左側風；飛航組員落地前未獲知風速顯著變化資訊；落地後未能及時伸展地面擾流板，致無法破壞機翼升力，減低地面風對航機右傾之影響；落地後左側風增至最大 18 浬/時，航機左機

[24] FAA Airplane Flying Handbook: “Characteristically, an airplane has a greater profile or side area, behind the main landing gear than forward of it does. With the main wheels acting as a pivot point and the greater surface area exposed to the crosswind behind that pivot point, the airplane will tend to turn or weathervane into the wind.”

翼因側風使升力增加使左機翼上揚，操控駕駛員亦未及時向上風邊壓桿，克服左翼上揚現象，因而使航機產生向右坡度之右偏；側風落地時遭遇風標效應，飛航組員未能即時將反推力器回收至慢車減少側向分力，更加劇航機右偏，終致航機短暫偏出跑道。

2.3.4 組員資源管理

立榮航務手冊第 5.3 節敘述飛航組員間之溝通及狀況警覺，強調對飛航操作環境中過去、現在及未來之狀況相互交換資訊，保持警覺以及預測狀況發展的重要性，如準備、規劃、注意、工作負荷分配、避免分心等。於飛航中應隨時注意飛航操作環境中最新狀況，相互提醒、討論並做出決策，同時對必要之措施預作準備及反應。

該機下降於苗栗附近通過高度 20,000 呎，機上氣象雷達顯示前方有積雨雲且目視有閃電，飛航組員曾向航管申請往東偏移以躲避雷雨。飛航組員於 CVR 記錄抄件及訪談時均表示進場過程中沿途都有雷雨，航路上爲躲避雲層，由原計畫飛航高度 32,000 呎下降至 30,000 呎，並請求偏離航路，CVR 抄件 2033:39 時正駕駛說「你看一片紅喔」2034:37 時副駕駛說「甚麼 light rain 這是 heavy rain 好不好」。依駕駛員訪談，落地前雨勢變大，觸地前跑道上有積水，因爲落地燈照到跑道上有一層白花花的水花；到達高度 1,000 呎時雨很大，落地燈光照到跑道道面白白的，但無法確認跑道積水多少，但感覺當時水像潑下來一樣，落地當時有其他航機問塔台當時之天氣情況。

該機於三輪著陸後並接續發生左右主輪分別短暫離地現象，2046:43 時正副駕駛曾分別喊出「rudder rudder rudder」，以上資料顯示飛航組員已預知進場過程中天氣變化，於完成落地前檢查程序後，曾考量能見度不高而複習重飛程序，同時收聽到塔台本場有雷雨之廣播後，警覺當時雨勢大之狀況需調整雨刷速度及注意能見度之變化，正駕駛員亦告知副駕駛員如操作有狀況，將由正駕駛員接手等準備；惟副駕駛表示進場前天氣簡報包括風向風速，但因 ATIS 未提及有下雨情況，所以簡報

時沒提到跑道有水及雨之問題，飛航組員間未先行討論遭遇側風狀況之處置。

飛航組員對飛航操作環境之天氣變化狀況警覺不足，未能保持警覺以及預測最新狀況發展，並妥善準備、規劃及相互提醒、討論並考量於落地積水過深時做出重飛決策，同時對必要之措施預作準備及反應，並於平飄至著陸期間發現風向風速驟變前由正駕駛接手。

另依 CVR 抄件，航管於 1230:53 時曾質疑 BR806 是否已完成進場準備（ready for approach），該機當時高度為 6,022 呎，空速為 214 浬/時，加速中，外型為 Flap 15, 距離機場大約為 16 track miles。此時航機高度較正常下降計畫高且速度較快，CVR 抄件中未發現監控駕駛員曾與操控駕駛員討論，即肯定回答是的（affirm）；另於 1231:02 時，監控駕駛員發現飛機速度太快，接近當時飛機外型 Flap 15 之速限，監控駕駛員未得到操控駕駛員之指令，即將 Flap 收到 10 之位置。參照 CVR 抄件，監控駕駛員於 1231:15 時向操控駕駛員提及放回 Flap，CVR 抄件中未見飛航組員間有任何進一步之討論及標準呼叫， FDR 資料顯示於 1231:59 時，Flap 已放置 Flap 15，於 1232:23 時，操控駕駛員再次指示監控駕駛員 Flap15。

上述資料顯示，飛航組員未能警覺航機高度較正常下降計畫高且速度較快且未能於確認及討論後再執行相關操作。

國際民航組織為降低可控飛行撞地（CFIT）及進場及降落階段之事故，於 1993 成立降低 CFIT 與進場與落地事故（ALAR）之任務編組；包含 ICAO、各國監理機關、IATA、飛機製造商、航空公司、飛行員協會及國際飛安基金會代表，完成一降低進場與落地事故之工具書（ALAR Tool Kit），並逐年修訂（如附錄十三）。依據最新修訂之版本第 8.6 節有關風之資訊，內容中述及自動終端廣播系統或塔台提供風之資訊為兩分鐘內之平均值，陣風為 10 分鐘內之最大值，而航機上 IRS（Inertial Reference System）及 FMS（Flight Management System）計算出有關風之計算為幾近即時資訊或 30 秒內之平均值，較自動終端廣播系統或塔台提供之資訊準確，並強調於不同飛航階段應適切選用機上有關風之資訊。飛航組員應妥善運用

上述相關風之資訊，以降低落地及進場時發生事故之風險。

ICAO 於 2004 年第 35 次年會有關討論防制 CFIT 及 ALAR 之進度會議，其中工作成效部份爲 ICAO 曾發函（信函編號：A33-16）各會員國（如附錄十四）：重申有關執行防制 CFIT 與 ALAR 計劃之必要性，可見此計劃之重要性。駕駛艙內之 ND（Navigation Display）及 FMS（Flight Management System）之 MCDU（Multipurpose Control and Display Unit）Progress page 上具有顯示有關風之資訊，如圖 2.3-4、圖 2.3-5，但立榮航空相關操作手冊中，無使用此資訊之操作程序，以利飛航組員獲得空中實際風之資訊，飛航組員間如能先行討論遭遇側風狀況之處置並使用此資訊，應可降低航機偏出跑道之風險。

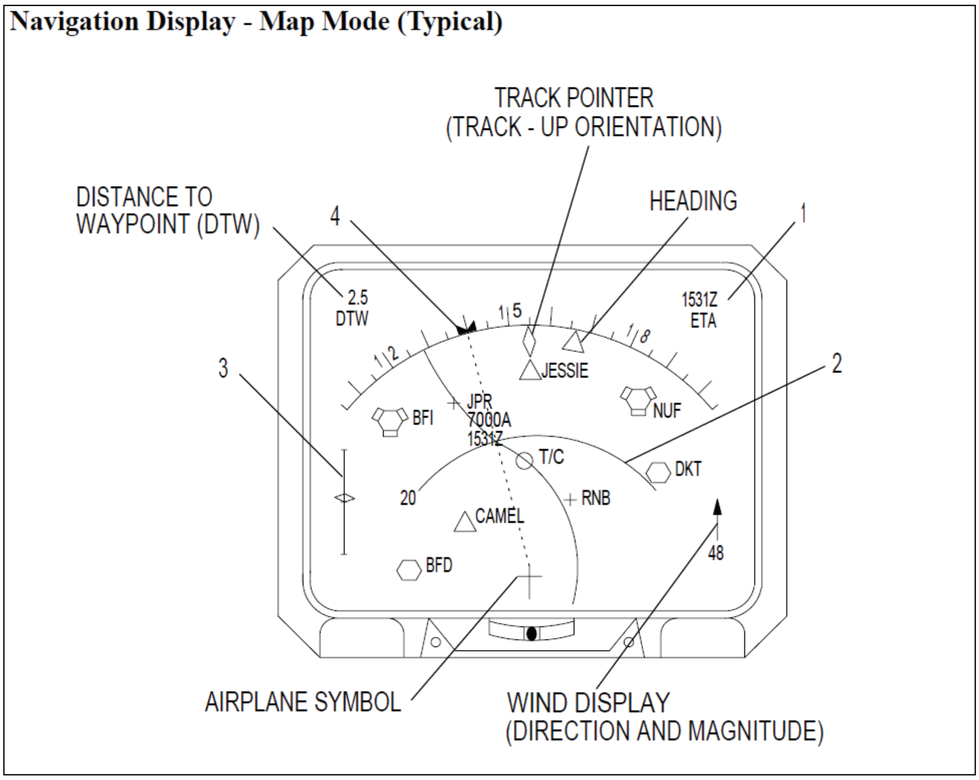


圖 2.3-4 MD-90 Navigation Display

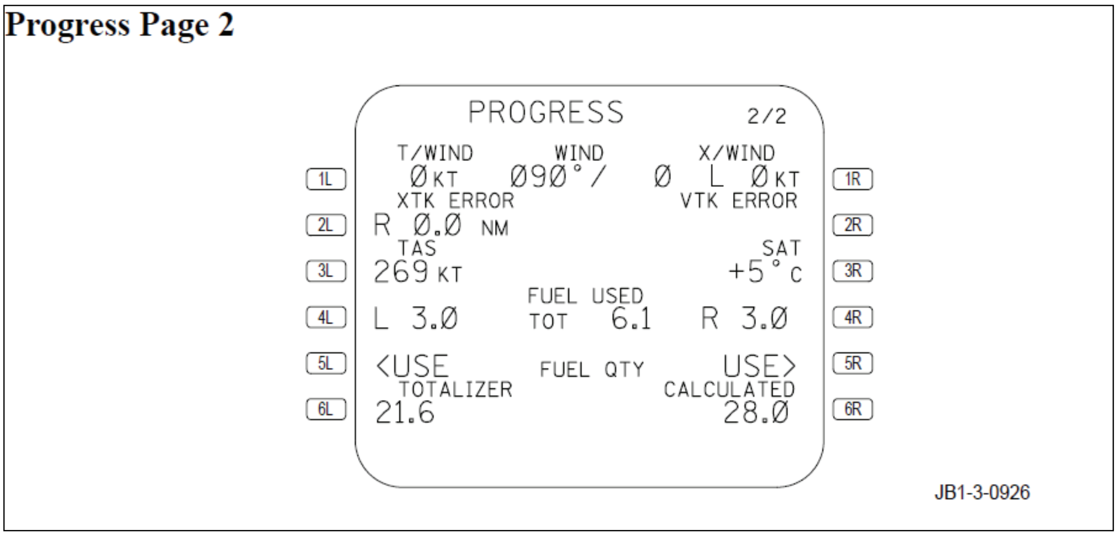


圖 2.3-5 MD-90 FMS MCDU Progress Page 2

2.4　擾流板落地後未自動展開之原因分析

依據 FDR 解讀結果（詳如 1.11.2 節），該機落地至停止移動間，飛行擾流板均無展開之紀錄。由於飛行擾流板及地面擾流板於落地後係連動展開或收回，故可佐證地面擾流板於落地後未展開。為瞭解該機落地後擾流板未自動展開之原因，相關分析如後。

2.4.1　擾流板系統故障可能性評估

1.6.4 節擾流板之操作說明指出，減速板手柄置於備動位置，係航機著陸後擾流板自動展開之必要條件。依 1.16.2 節事故後該機之地面擾流板功能測試結果顯示，該機減速板手柄制鎖機構功能正常且未發現異常零件磨損、變形或斷裂等現象。因此，若當時減速板手柄確實置於備動位置，地面擾流板應會自動展開。據此該機非因系統故障致落地後擾流板未展開，較可能之原因係落地時減速板手柄未置於備動位置。

2.4.2　減速板手柄落地時未備動可能性評估

依據 1.11.1 節及 1.16.3 節數次地面測試與飛行測試收錄之聲頻分析（詳如 2.5 節），從聲頻分析之聲音頻譜及時間長度分析結果顯示，BR806 班機落地前減速板

手柄未在「備動」狀態，故主輪落地期間減速板不會自動伸展。本節分析該機落地時減速板手柄未置於備動位置可能原因如下：

2.4.2.1　駕駛員誤觸減速板手柄可能性評估

依據事故後駕駛艙觀摩操作結果及立榮航空提供之影片顯示，減速板手柄置於備動位置後，駕駛員若意圖解除，需於手柄上方下壓，過程中亦會發出機械聲響；此外，駕駛員正常操作動線亦不會有自手柄上方下壓的動作。據此，無具體證據支持駕駛員誤觸減速板手柄致其跳脫且未被發現。

2.4.2.2　駕駛員對減速板手柄之操作及檢查

MD-90 飛航組員操作手冊 NP.70.6（詳如附錄十）指出，落地前階段，襟翼展開角度達 15 度後，駕駛員應將起落架手柄放下，並待 3 個起落架指示燈皆爲綠燈後，拉起減速板手柄至備動位置。依據 CVR 抄件，副駕駛員指示放下起落架至開始執行落地前檢查止，CVR 記錄有 6 個聲響，經聲頻分析比對後（詳如 2.5 節），皆無法研判係屬減速板手柄至備動位置之聲響，無法佐證該機駕駛員有確實將減速板手柄置於備動位置。綜合考慮各項因素後，本會認爲，落地時減速板手柄未備動之較可能原因係駕駛員放下起落架手柄後，雖有將減速板拉起但未拉至正確備動位置或遺漏執行拉起減速板手至備動位置之動作。

依據 CVR 抄件，該機駕駛員在天氣不佳、進場高度及速度皆高之影響下，有關航機落地外型之準備、速度與高度之操控及各項檢查作業之執行，已出現有別於正常進場之情形，例如：進場前檢查延遲、空速度增大導致襟翼放下 15 度又收回等，正駕駛員有可能在此等狀況影響下，工作負荷過重，未能將減速板手柄置於備動位置之可能性相對變高。

依據正常程序，駕駛員完成落地準備後，應執行落地前檢查（landing check），包含確定減速板手柄已置於備動位置。此時應由正駕駛員呼叫檢查項目「spoilers」，並執行檢查，若確實置於備動位置，則呼叫「arm」。減速板手柄置於備動位置時，手柄會高於未備動時，底部會有一截約 3 至 4 公分的紅色部分，駕駛員主要據

此執行目視檢查。該機進場之高度及速度偏高，且過程中有雷雨，增加駕駛員之工作負荷。CVR 抄件顯示，正駕駛員於落地前檢查時，雖有呼叫「spolier arm」 及「auto break medium」 但卻遺漏呼叫「landing check completed」，且自 2033:33.6 時起，駕駛員間出現有關航機速度、氣象雷達顯示狀況、速度控制、能見度狀況之談話，直至 2033:46.5 時，副駕駛員向正駕駛員詢問落地檢查是否已完成，正駕駛員始回答「好」。以上顯示在天氣不佳、航機進場高且速度快之影響下，正駕駛員可能未投入適當之注意力於落地前檢查，致未發現減速板手柄未置於備動位置；另落地前檢查執行時係約夜間 2033 時，相較於日間，駕駛員需投入更多注意力執行手柄位置之目視檢查，亦可能爲影響因素之一。另減速板手柄位置之檢查除目視檢查外，如考慮以手動方式再拉動手柄一次，或許更能確保手柄已位於備動位置。

2.4.3　小結

綜合上述之分析，顯示較可能造成該機落地後擾流板未自動展開之原因，係駕駛員雖有將減速板拉起但未拉至正確備動位置或遺漏執行拉起減速板手至備動位置之動作，且於執行落地檢查時未完成確認。

2.5　CVR 頻譜分析

頻譜分析可探討人耳無法區分差異之特徵頻率及精確作動時間。本節即嘗試使用頻譜分析找出 CVR 抄件中不明聲響之可能肇因。

2.5.1 CVR 不明聲響

本會調查人員於製作 CVR 抄件過程中發現，BR806 班機於進場至著陸期間，其駕駛艙區域麥克風（CAM）收錄到數個駕駛艙儀器開關或旋鈕的聲響，這些聲響頻繁地出現在駕駛艙錄音中，惟該型機 FDR 對於旋鈕及按鈕的紀錄參數不多，造成識別困難。

本節係針對 CVR 抄件中不明聲響，經比對 FDR 襟翼位置及 Landing Check 來研判，結果詳表 2.5-1。

表 2.5-1 BR806 班機於進場至著陸期間 CVR 抄件不明聲響比對

編號	時間	CVR 抄件內容	聲響之可能來源
1	2031:12.6	不明聲響	Flap lever 扳動聲響 （FDR：flap 15 度→10 度 ）
2	2031:14.6	不明聲響	
3	2032:26.5	不明聲響	無法研判
4	2032:55.4	不明聲響	無法研判 （2032:55 ~2033:03 時 FDR: flap 16 度→28 度 駕駛員扳動 flap lever）
5	2033:00.0	不明聲響	
6	2033:02.6	不明聲響	
7	2033:18.2	不明聲響	Flap lever 扳動聲響 （FDR：flap 28 度→40 度 ）
8	2033:19.7	不明聲響	
2033:24.6 CM2 called landing check			
9	2035:18.1	不明聲響	無法研判 （RA 約 909 呎）
10	2036:34.5	不明聲響	無法研判 （RA 約 30 呎）
11	2036:37.8	不明聲響	自動擾流板致動器作動聲響 （手柄未在備動狀態下）

根據附錄十五之 CVR 抄件，2032:55 時，CVR 的錄音存在「不明聲響」。將該聲響頻譜與手動拉起減速板手柄之聲響頻譜比較後顯示，兩者音頻特徵中僅可確認在一開始之寬頻音特性相符，且因手動拉起該手柄的時間特性範圍變化甚大，故無法研判事故機飛航組員是否有拉起減速板手柄並確實置於「備動」模式。

2.5.2 落地期間減速板手柄是否自動伸展

依據 1.11.1 節及 1.16.3 節之事實資料，數次地面測試與飛行測試收錄之聲頻分析獲知，如減速板手柄於「備動」狀態時，則航空器主輪落地期間手柄自動「作動伸展」時產生之聲響時間長度約在 0.333 秒至 0.358 秒間；如航空器最後進場階段其減速板手柄未「備動」，則航空器主輪落地期間其手柄下連接之自動擾流板致動器亦有動作（但手柄不會自動「作動伸展」），其動作時之聲響時間長度約在 0.550 秒至 0.600 秒間。

BR806 班機主輪落地期間，CVR 收錄之疑似減速板手柄作動聲響時間長度爲 0.558 秒，此聲響時間長度比較接近減速板手柄未「備動」時自動擾流板致動器所發出聲音之長度。BR806 班機於主輪落地期間 CVR 2036:37 時收錄之聲響爲減速板手柄未在「備動」狀態下時自動擾流板致動器作動之聲音。據此，落地前減速板手柄應未在「備動」狀態，主輪落地期間減速板手柄不會自動伸展。

2.6 飛航資料紀錄器之適航及檢查

依據 1.11.2 節事實資料，該型飛航資料紀錄器（SSFDR）符合民用航空法規彙編之「07-02A 航空器飛航作業管理規則」以及國際民航公約第 6 號附約（Annex 6）第一類（Type I）飛航資料紀錄器 32 項必要紀錄參數規定。

本事故中地面擾流板及煞車相關參數，係爲分析該機落地至偏出期間減速及飛航操控之重要依據。本會調查人員於 6 月 11 日駕駛艙觀摩的兩航班（航班代號 885 及 886，航機爲 B-17917）QAR 資料亦發現：「左煞車踏板位置」偏差及「右煞車壓力」異常錯誤。相關參數繪圖詳圖 2.6-1 及圖 2.6-2。該機偏出跑道期間，左右煞車踏板位置均輸入約 8 度至 21.6 度，惟右煞車壓力均爲 0 PSI（此發現亦見於波音公司函覆本會分析報告中，詳附錄三）。

該機 SSFDR 僅記錄左右擾流板，均爲飛行擾流板，無地面擾流板紀錄；該機 FDR 記錄左右兩側的飛行擾流板位置與 32 項必要紀錄參數，煞車踏板位置不屬於 32 項必要紀錄參數；FDR 有記錄左右兩側的飛行擾流板位置，可根據該型機之主輪地空模式參數（WOW）來推斷地面擾流板是否與飛行擾流板連動展開；該型飛航資料紀錄器左煞車踏板位置存在約 7.7 度固定偏差，其中第 13 項參數-地面擾流板/減速板選擇（ground spoiler/speed brake selection）之規範略爲不同。

無證據顯示立榮航空公司於本事故發生前，於飛航資料分析系統定期檢驗及校準程序時，已發現 FDR 紀錄之「左煞車踏板位置」偏差及「右煞車壓力」異常之錯誤，並採取相關檢驗及校準程序。

交通部民用航空局頒布之「飛安0七-0二A航空器飛航作業管理規則[25]」第一百十一條規範我國民用航空器飛航紀錄器之適航及其檢測：*航空器使用人應於航空器上裝置飛航紀錄器，以記錄供航空器失事調查使用之必要飛航資料，航空器飛航作業管理規則附件十二對於飛航資料紀錄器詳細規範：紀錄器必須至少能記錄附表一中32 個參數[26]，其他參數可因飛機型式及紀錄裝置特性而替換之參數及附加資料：11.2 規範所裝置之紀錄器其測量範圍、記錄週期及參數正確性必須以適當之檢定機關所核准之方法加以驗證。*

航空器飛航作業管理規則附件十二另規範飛航資料紀錄器及座艙通話紀錄器系統之檢查：*取自飛航資料紀錄器一完整航次之所有記錄之參數應以工程單位（engineering units）評估以確認其有效性，尤其應特別注意專屬飛航資料紀錄器之感應裝置；取自機上匯電排系統之參數之可用性可由機上其他系統檢測者，不須再作檢查確認；飛航資料紀錄器每五年須至少重新校準一次，以判斷主要參數在例行工程轉換（engineering conversion）之任何差異，及確認被記錄之參數在校準容許誤差範圍內。*

2010年7月ICAO頒布的Annex 6 Part I第九版第二節飛航資料紀錄器「2.2.2.6 Type IA FDR. This FDR shall be capable of recording as appropriate to the aeroplane, at least the 78 parameters in Table A8-1.」，此78項必要紀錄參數中「34. Brakes（left and right brake pressure, left and right brake pedal position）」，「煞車踏板位置」參數已屬必要參數。

[25] 中華民國98年12月30日交通部交航字第0980085065號令修正部分條文及附件二、附件五、附件六、附件八、附件十二、附件十五、附件十九、附件二十、附件二十之一、附件二十之二、附件三十三、附件十九、附件二十、附件二十之一、附件二十之二、附件三十三。

[26] 32 項必要紀錄參數，包括：時間、壓力高度、指示空速、航向、垂直軸加速度、俯仰姿態、滾轉姿態、無線電傳送記錄、每具發動機推力、後緣襟翼或駕駛艙控制選擇、前緣襟翼或駕駛艙控制選擇、反向推力器位置、地面擾流板/減速板選擇、外界空氣溫度、自動駕駛/自動推力AFCS及作用狀態、縱向加速度、橫向加速度、飛行員輸入及/或控制面位置–主操縱面位置（俯仰、滾行、側偏） 俯仰配平位置、無線電高度、下滑路徑上下偏差角度、下滑路徑左右偏差角度、通過信標台信號、主警告訊號、NAV 1 及 2 頻率選擇、DME 1 及 2 距離、起落架蹲踞電門情況、接近地面警告系統、攻角、液壓、導航數據（經、緯度，地速及偏流角）、起落架或起落架手柄選擇位置。

本事故發生前，立榮航空公司已建立 MD-90 機隊之飛航資料分析及異常事件監控作業，針對穩定進場之相關監控參數，包括：進場速度、進場下降率、不同進場高度之仰角及坡度、落地時垂向加速度，以及落地滾行期間航機與跑道夾角等，惟該文件未規範與衝出跑道有關的重要參數，如：進場至落地期間之橫向偏移（含 Localizer Deviation）、50 呎高度至主輪著陸時間、落地距離[27]、左右反推力[28]、自動煞車作動，以及擾流板伸展等。

飛航資料分析計畫爲安全管理系統（SMS）[29]的一部分，確保飛航資料紀錄內容之完整性及正確性，係爲飛航資料紀錄器適航及其年度檢查的重要工作。事故機 FDR 紀錄之「煞車踏板位置」、「煞車壓力」及「地面擾流板位置」三參數，非屬我國現行法規要求紀錄之 32 項必要參數，惟第 9 版國際民航組織第 6 號附約之標準及建議措施所要求紀錄之 78 項必要參數已納入上述「煞車踏板位置」、「煞車壓力」及「地面擾流板位置」三參數。我國民航監理機關若能參照 ICAO 第六號附約第 9 版之標準及建議措施（SARPs），將 32 項必要紀錄參數增加爲 78 項（TYPE 1A），國內民航業者的飛航資料分析計畫將有更多參數可用以監控及預防起降階段可能發生的飛安異常事件，例如：航機著陸期間與跑道夾角、彈跳落地、著陸點/著陸距離、不對稱或過大反推力、不對稱煞車、主輪及鼻輪間之著陸時間、著陸後使用煞車操控（煞車踏板、煞車壓力、各主輪轉速）等，亦有助於本會衝偏出跑道飛航事故調查。

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[27]一般而言，Localizer Deviation 之監控門檻為 1 dots、50 呎高度至主輪着陸時間之監控門檻介於 10~12 秒、落地距離之監控門檻介於 1,500~2,000 呎。

[28]1996 年 2 月，美國波音麥道公司曾發布飛安資訊給 MD-80 機隊，該資料強調於溼滑跑道情況下，當反推力高於 1.3 % EPR 時，其空氣動力效應將會干擾並可能降低垂直安定面及方向舵之橫向操控能力。該公司 FCOM Vol II 「Cold Weather Procedures 中 亦有 CAUTION: If difficulty in maintaining directional control is experienced during reverse thrust operation, reduce reverse thrust to reverse idle (or forward idle thrust, if required), regain directional control, and reapply reverse thrust as necessary. Do not attempt to maintain directional control by using asymmetric reverse thrust.」

[29]航空器飛航作業管理規則第二章 民用航空運輸業/第九條　航空器使用人應建立安全管理系統並經報請民航局備查後，於中華民國九十八年一月一日起實施，該系統應具有下列功能：...., 航空器使用人對最大起飛重量超過二萬七千公斤之飛機，應建立飛航資料。

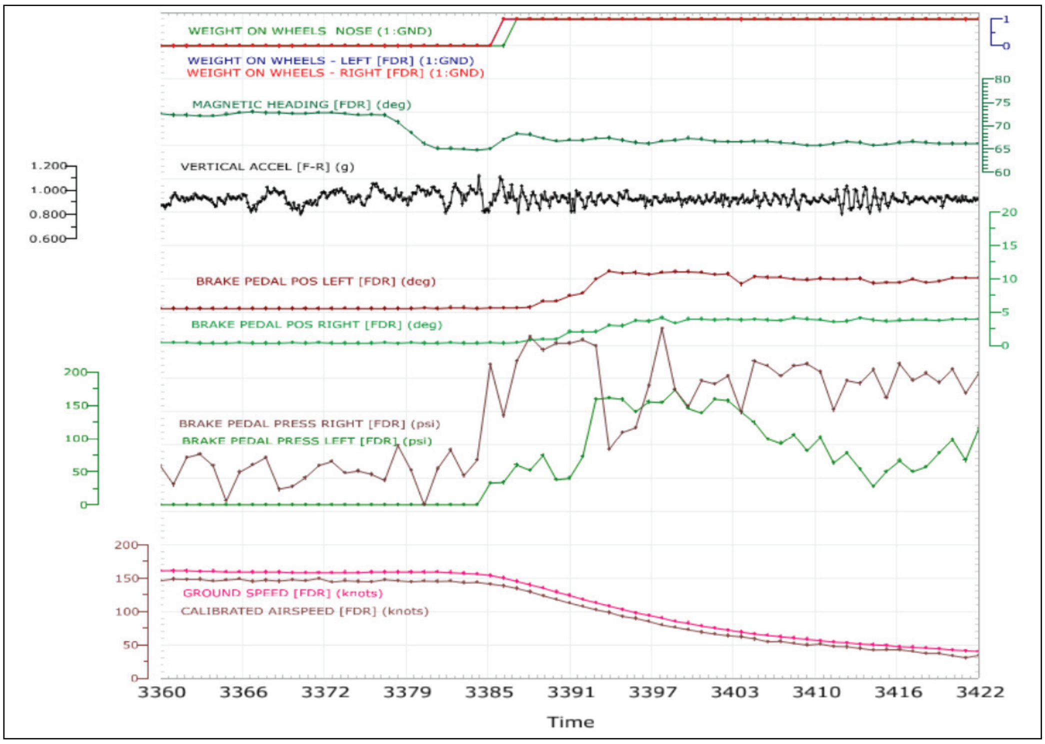

圖 2.6-1 B7 885 航班於最後進場及落地期間相關參數變化

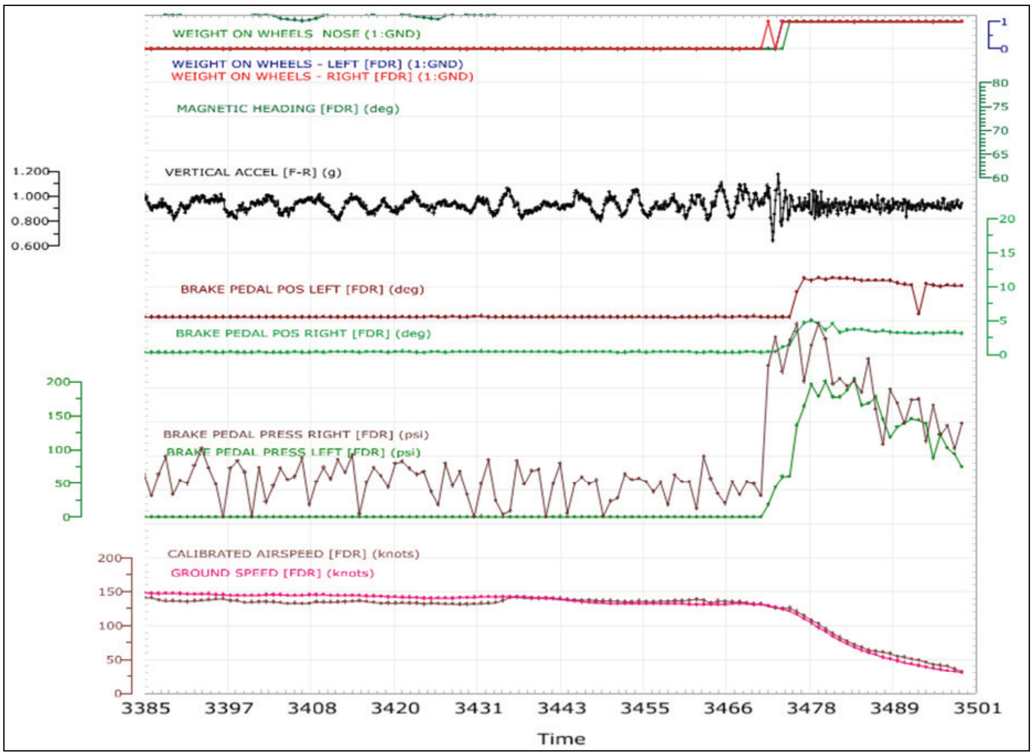

圖 2.6-2 B7 886 航班於最後進場及落地期間相關參數變化

2.7 航務主管之設置及相關法規

2.7.1 立榮航空航務部門相關主管之設置

依據 1.17.3 節之事實資料，立榮航空運航本部（部級以上主管職位包括：運航本部最高主管、執行總機長、副執行總機長、航行部經理、航行管制部經理、及服勤部經理。

立榮航務主管於訪談時表示，立榮與長榮航空於民國 98 年實施合署辦公及資源共享。民國 100 年 1 月 1 日起執行總機長及副執行總機長之職務從缺。民國 100 年 5 月 1 日起航行管制部經理暫代運航本部最高主管，並兼任航行部經理。另長榮航空相當職務人員會支援立榮航空之航務管理業務。

民航局之立榮航空主任航務檢查員訪談時表示，知悉該公司航務相關主管實際派任狀況，認爲航務相關主管雖未補實或爲暫代，但功能上皆有人員代爲執行，認爲其未違反航務手冊。

綜上所述，立榮航空於執行總機長及副執行總機長從缺後，未依其航務手冊補實；航行簽派部經理一人兼任運航本部協理及航行部經理；航務檢查員於立榮航空部分航務相關主管從缺後，未要求立榮航空確實依航務手冊另行指派。

2.7.2 民航法規對航務主管資格之要求

依據航空器飛航作業管理規則第十四條規定，航務主管應持有或曾持有民航運輸駕駛員檢定證並擔任大型航空器機長三年以上經驗、或擔任使用大型航空器機構之航務主管或航務相關業務三年以上之經驗。據此規定，民航運輸業航務主管並非一定要具備民航運輸駕駛員之資歷，凡具備航務相關業務三年以上之經驗人員即符合擔任航務主管之最低限制。

參考美國聯邦航空法規第 119.67 條（詳如 1.17.2 節及附錄四）與航空器飛航作業管理規則第十四條有相關之內容，航務主管之資格需曾持有民航運輸駕駛員檢定證並擔任大型航空器機長三年以上經驗係必要條件，且要求航務主管須具備三年

以上航務相關督導或管理經驗。

綜上所述，相較於美國聯邦航空法規第 119.67 條之內容，我國民航法規未將民航運輸業之航務主管須具備民航運輸業駕駛員及航務相關督導或管理經驗列爲必要條件。

2.8 跑道鋪面抗滑影響因素

本節討論影響跑道鋪面抗滑因素之跑道鋪面排水性能及鋪面紋理深度，另外亦針對現行抗滑通報及處理之問題提出討論。

2.8.1 鋪面橫坡度

影響鋪面排水性能的關鍵因素爲跑道鋪面橫坡度之設計，若跑道鋪面橫坡度降坡過小，易肇致跑道產生停滯性積水；若橫坡度降坡過大，可能產生航機朝下坡持續滾行之風險，因此需權衡兩者影響，保持跑道鋪面坡度均勻下降。

民航局「民用機場設計暨運作規範」（譯自國際民航組織第 14 號附約）第 3.1.18 節建議：*飛機大小爲 E 分類的之跑道其橫坡度不應大於 1.5%，亦不應小於 1%*。民航局所提供該機場於民國 97 年 5 月 8 日完成量測之「跑道縱橫斷面位置圖」，06/24 跑道橫坡度降坡，符合橫坡度不應大於 1.5%，亦不應小於 1%之規範要求。

2.8.2 鋪面平坦度

影響鋪面排水性能的另一因素爲鋪面的平坦度，平坦度不佳（3m 大於 3mm 空隙）的鋪面於降雨時可能產生水窪。

民航局「民用機場設計暨運作規範」附篇 A 第 5.1 節建議：*除了橫跨路拱頂部或橫跨排水溝外，完工磨耗層之表面，應達到以下之平坦度：即用 3m 長之直尺置於表面之任何地方、任何方向上測試時，沿著直尺邊之任何地方直尺底面與道面間之空隙不大於 3mm*。另依據民航局「民用機場鋪砌道面狀況應注意事項」（譯自國際民航組織機場服務手冊第 2 冊）第 3.4 節建議：*...由於壓實作用發生，跑道剖面將逐漸改變...當水塘深度已大於水滑可能發生之臨界深度（約 3 公釐），則須採取*

養護措施。依據本報告第 1.12.2 節顯示事故發生時，06/24 跑道應有少部份區域因平坦度不佳產生水窪，調查發現：民航局欠缺機場跑道平坦度檢測指導之相關規定，另桃園機場未執行 06/24 跑道平坦度檢測。

2.8.3 降雨量與鋪面水深

第 2.8.1 節述及 06/24 跑道鋪面橫坡度符合規範標準，但若跑道在降雨量大的狀況下，仍可能造成跑道鋪面水深變高，影響航機起降作業。

依本報告表 1.7.2 AWOS 06/24 之 1 小時累積雨量資料，該機落地前 6 分鐘（2032 時至 2038 時）06/24 跑道降雨量達到 3.8 公釐；另參照表 1.12.2 內容：6 分鐘降雨量達到 2.4 公釐時，能造成 95％鋪面約有 1 公釐水深。惟限該跑道降雨量與鋪面水深之研究樣本數不足，難以精確推估事故機落地時之鋪面水深。

2.8.4 摩擦係數檢測

航機起降之胎屑日漸殘留跑道後，會填平跑道鋪面紋理（新建跑道鋪面粗質紋理深度至少爲 1 公釐），造成跑道鋪面摩擦係數值降低，特別是當降雨時，在特定條件下如航機進場速度高，胎紋深度低及駕駛員濕滑落地技術均符合下，可能會造成鋪面上的水不能及時經由鋪面紋理深度及胎紋深度間排出。

爲防止因胎屑沉積影響摩擦係數值，民航局「民用機場設計暨運作規範」及「民用機場鋪砌道面狀況應注意事項」建議機場管理者使用標準檢測車於跑道中心線兩側 3 公尺或 5 公尺處，噴灑 1 公釐水深之水膜，以 65 及 95 公里/小時速度執行定期雙向檢測；「民用機場鋪砌道面狀況應注意事項」表[30]4-1 亦提供跑道鋪面抗滑

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檢測儀器	新建跑道道面設計標準*	跑道道面養護規劃標準*	跑道道面最低抗滑標準*	估計供水深度（公釐）	抗滑檢測速度（公里/小時）	檢測輪胎壓（千帕）
Runway Friction Tester	0.82	0.60	0.50	1.0	65	210
	0.72	0.54	0.41	1.0	95	210

標準，其中檢測速度 65 公里/小時，Runway Friction Tester 之摩擦係數養護規劃標準爲 0.6，最低抗滑標準爲 0.5；檢測速度 95 公里/小時，Runway Friction Tester 之摩擦係數養護規劃標準爲 0.54，最低抗滑標準爲 0.41。

檢視該機場 06/24 跑道之鋪面摩擦檢測方法、檢測速度、檢測儀器、最小摩擦等級數值及低於最小摩擦等級的公告方式，並發布於 AIP_機場_第 1.1.5 節，及該跑道採 2 週檢測一次之頻率及雙向檢測法，符合相關規範；另檢視該機場 06/24 跑道於 5 月 13 日之跑道鋪面摩擦係數檢測報告（本報告表 1.10-1 及 1.10-2），顯示以 65 公里/小時及 95 公里/小時之檢測速度條件，所有 06/24 跑道每 100 公尺[31]鋪面摩擦係數平均值均高於摩擦係數養護規劃標準及最低抗滑標準。

2.8.5 跑道鋪面狀況之觀測、通知及處理

以下就摩擦係數值公告、鋪面狀況觀測、航機煞車狀況通報、及相關單位處理等，分述如下。

2.8.5.1 摩擦係數值公告

若該跑道定期摩擦係數值低於最低抗滑標準，依據民航局「民用機場鋪砌道面狀況應注意事項」第 2.3.2 節建議：*...若道面抗滑能力低於最低可接受標準，必須採取養護改善措施；此外，亦須提供「當跑道潮濕時可能滑溜」之訊息...*。飛航管理程序[32]（以下簡稱 ATMP）

第 3-3-4 節 *d.註－ 當跑道摩擦係數較公佈之摩擦係數等級 1 爲低時，航空站將發布飛航公告，跑道於潮濕時可能滑溜，並於 WET/WATER PATCHES/FLOODED 時通知航管單位。該飛航公告將持續至完成改善措施。當接獲航空站通知跑道狀況時，於 ATIS 通知駕駛員。*

檢視桃園機場 06/24 跑道，於摩擦係數值低於養護規劃標準時，均即進行胎屑

[31]跑道維護目的:使用 100 公尺摩擦係數平均值;宣告予駕駛員目的:採用跑道 3 區分段摩擦係數平均值。
[32]Air Traffic Management Procedures 版期：CHG-4 JUNE 30, 2010

清除作業，直至事故前，無低於最低抗滑標準而致須發布飛航公告之情況。

2.8.5.2 鋪面狀況觀測

在跑道橫坡度及平坦度符合規範的狀況下，當降雨量大時，仍有可能造成鋪面因有水深，影響駕駛員起降操控之情形。

依據民航局「民用機場空側應注意事項」（譯自國際民航組織機場服務手冊第 8 冊）第 6.2.1 節建議：*惡劣的天氣影響期間，機場航務單位應將道面情況及可能受天氣影響的各項設施的檢查結果告知飛航管制單位，有關之措施應納入相關作業程序內。*第 6.2.2 節建議：*惡劣天候狀況包括：...c）強風。d） 大雨－導致跑道摩阻力降低。e） 霧或低能見度...*。另依民航局「民用機場鋪砌道面狀況應注意事項」第 4.3 節建議：*跑道中心二分之一寬度範圍出現積水時應提出報告，同時需對積水深度提出評估，爲提高跑道狀況描述之準確性，應採用下列定義與相關敘述：微濕（Damp）－道面表面因濕氣而變色。潮濕（Wet）－道面表面濕潤但未出現積水。局部積水（Water patch）－可觀察到局部積水現象。氾濫（Flooded）－可觀察到大範圍積水現象。*另依 ATMP 第 3-3-1 節 *e. 按照航空站權責單位報告有關跑道道面情況，告知航空器該項實際資料。告知駕駛員跑道或是滑行道狀況並以 DAMP,WET,WATER PATCHES,或是 FLOODED 等術語描述*。上述規範顯示民航局依國際規範建議機場管理當局在惡劣天氣下，藉由接收氣象單位之資訊（如例行天氣報告（METAR）或特別天氣報告（SPECI）），進行鋪面狀況及設施巡場不定期目視觀察，再依跑道狀況描述術語通知塔台轉知駕駛員，駕駛員可據此資訊選擇安全的起降操控方式。

BR806 事故前下午 1541 時至 2038 時最大降雨報告爲中雷雨，未達大雨條件，機場管理單位未啓動不定期巡場機制，提供鋪面狀況資訊。

另依本報告第 1.10.3 節，事故前約 1 年期共有約 152 筆鋪面狀況不定期巡場紀錄，其中部份資料顯示機場管理當局於執行鋪面狀況檢查後已通知航管單位。

惟檢視桃園機場相關規範發現，「台灣桃園國際機場活動區之巡場與維護作業

程序」5.1.2 節雖有「不定時巡場」之規定，然爲使值勤人員有更明確之依循，建議於該節內，依據「民用機場空側作業應注意事項」第 6 章第 6.2.2 節，將惡劣天候狀況之條件（如：強風、大雨、霧或低能見度）加以敘明。

2.8.5.3 航機煞車狀況通報

駕駛員起降後可向航管通知煞車狀況，依立榮 MD-90 QRH Page PD.10.15（詳表 2.5-1），煞車狀況（Braking Action）共分 6 級：爲「Good」、「Good to Medium」、「Medium」、「Medium to Poor」、「Poor」及「Nil」，除相對應的定義外，表格右方另提供駕駛員評估參考：如「Good」對應之鋪面水深爲 3 公釐（含）以下或鋪面摩擦係數值 0.4（含）以上、「Poor」對應之鋪面水深爲 3 公釐（含）以上或鋪面摩擦係數值 0.25-0.21 間。

駕駛員依據煞車狀況與鋪面狀況分類表判斷機場跑道狀況，調查發現：該公司有關煞車狀況之術語與民航局飛航管理程序之用法相符且均符合國際民航組織規範。惟煞車狀況分類與機場服務單位即時宣告之鋪面狀況術語分類並無甚關聯，可能會造成駕駛員與機場服務單位間的溝通風險。

爲提供有效且一致的跑道鋪面狀況評估及報告術語，使駕駛員根據航機性能執行安全的起降操作，國際民航組織於 2008 年建立 Friction Task Force（FTF）工作小組[33]，預計 2012 年國際民航公約修訂第 14,15 號附約及相關 Circular 中，將納入有關評估及報告跑道磨擦特性方法、磨擦係數值的使用以及即時移除跑道汙染部份規定，另將參考過往研究如：International Runway Index；the Canadian Runway Friction Index；the U.S. FAA Take-off and Landing Performance Assessment；及 EASA's Runway Friction Characteristics Measurement and Aircraft Braking，研議以駕駛員爲導向之鋪面狀況報告，使相關鋪面狀況術語趨於一致，這項統合作業預計在 2014 年完成。

[33] http://www2.icao.int/en/RunwaySafety/Publications/RE%20Runway%20Surface%20Condition.pdf

表 2.8-1 立榮航空 MD-90 QRH 煞車狀況表

Braking Action Terms & Correlation with Runway Surface

Braking Action		Estimated Correlations				
Term	Definition	Runway Surface Condition	ICAO Mu	Landing Distance Table	T/O REF	X-WIND Limit
Good	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal	Water depth of 0.125’”(3mm)or less Dry snow less than 0.75”(18.7mm) depth	0.40 & above	PD.10.5 PD.10.6	WET Performance	22
Good to Medium			0.39 -0.36	PD.10.5 PD.10.6	WET Performance	20
Medium (Fair)	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be slightly reduced.	Dry snow 0.75”(18.7mm) or greater in depth Sanded snow Sanded ice Compacted snow with OAT above -15^{o}C	0.35 -0.30	PD.10.7 PD.10.8	WET Performance	18
Medium To Poor			0.29 -0.26	PD.10.7 PD.10.8	WET Performance	16
Poor	Braking deceleration is significantly reduced for the wheel braking effort applied. Potential for hydroplaning exists. Directional control may be significantly reduced.	Wet snow Slush Water depth more than 0.125” (3mm)	0.25 -0.21	PD.10.9 PD.10.10	Contaminated (6mm)	15
		Ice (not melting)	0.25 -0.21	PD.10.9 PD.10.10		
Nil	Braking deceleration is minimal to non existent for the wheel braking effort applied Directional control may be uncertain. Note: Taxi, takeoff, and landing operations is Nill conditions are prohibited.	Ice (melting) Wet Ice	0.20 & below	N/A	N/A	N/A

2.8.5.4 相關單位處理

依 ATMP 第 3-3-4 節煞車狀況：按駕駛員或航空站權責單位通知之跑道煞車狀況，以下列方式提供給所有航空器：*a.以「良好」、「中等」、「不好」等術語或這些術語的組合描述煞車之效果。*

依 ATMP 第 3-3-5 節顯示塔台接獲某架航機報告煞車狀況「中等」或「不好」後應：在 ATIS 加報煞車狀況諮詢實施中；提供隨後航機最新煞車狀況資訊；若收到跑道煞車狀況爲「不好」，應通知航空站權責單位；並在終端資料自動廣播服務（ATIS）上加報來自航空站權責單位的跑道摩擦係數量值。

機場管理當局應依民航局「民用機場設計暨運作規範」第 2.9.8 建議：*當懷疑跑道在特殊情況下可能會產生滑溜（slippery）時，應在出現此種情況時進行特別測試；而當該測試顯示跑道或其部分已出現滑溜（slippery）時，則應備有該跑道道面摩擦特性之資料。*另依民航局「民用機場鋪砌道面狀況應注意事項」第 6.2.3 節建議：*除 6.2.1 節所述之定期跑道抗滑檢測外，當得知於異常狀況下跑道滑溜時，亦應於發生此等狀況時增行檢測，且當此增行檢測顯示跑道或部分道面變得滑溜時，跑道道面抗滑狀況資訊需提供予合適單位。*上述規範建議機場管理單位應於駕駛員反應煞車狀況後，增加一項特別摩擦係數檢測，以提供後續航機駕駛員參考即時之鋪面摩擦係數檢測值。

該機落地後通報塔臺跑道煞車狀況爲「poor」之後，後續之 ATIS J 有加報「runway zero six braking action is poor」，但塔臺並未將此資訊通知桃園機場公司航務處。桃園機場公司未依「民用機場設計暨運作規範」及「民用機場鋪砌道面狀況應注意事項」建議，將增加抗滑檢測之情況納入如「臺灣桃園國際機場跑道鋪面摩擦阻力檢測及維護作業規定」等相關程序中。

2.9 跑道中心線燈

桃園機場 06 跑道屬日夜間使用及第 I 類精確進場跑道，無跑道中心線燈。

依「民用機場設計暨運作規範」第 5.3.12.2 節建議[34]—*第 I 類精確進場跑道上應設置跑道中心線燈，特別是當跑道係供高速[35]著陸飛機使用或當跑道邊燈之間距[36]大於 50m 時。*

於 06 跑道落地之航機多屬高速著陸飛機，且跑道寬 60 公尺，適用「民用機場設計暨運作規範」第 5.3.12.2 節建議設置跑道中心線燈之大於 50 公尺之條件。因此如 06 跑道能考量設置跑道中心線燈，應可有效強化飛航組員於落地期間對正跑道之目視參考依據及觸地後減少衝偏出跑道之風險。

2.10　飛航管制[37]

2.10.1 近場臺管制作業

「飛航管理程序」第 2-9-2 節終端資料自動廣播服務作業程序：

d. 管制員應確定駕駛員已收到現行終端資料自動廣播服務內容。如果駕駛員未說明收到的廣播資料代碼，應詢問駕駛員以確認其是否收到。

依據航管錄音抄件，BR806 駕駛員於 2021:02 時與近場臺管制員初次構聯時，管制員未依「飛航管理程序」確認駕駛員是否收到最新之 ATIS 內容。

依據航管錄音抄件，1227:19 時該機回覆近場臺桃南席管制員「descend and maintain five thousand eva eight zero six we are ready for approach」，當時該機高度約 10,000 呎，距 06 跑道頭 17.6 浬。1229:27 時管制員呼叫「eva eight zero six turn right heading zero two zero maintain three thousand until established cleared i l s runway zero six approach」，當時該機高度 5,886 呎，距 06 跑道頭 14.9 浬，高於下滑道約 1,000 呎。

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[34]「民用機場設計暨運作規範」前言對於「建議」之強制性說明為：應力求遵守。
[35]依 FAA AC150/5340-30 係指 approach speed over 140 knots。
[36]依 FAA AC150/5340-30 係指 runways greater than 170 feet (50m) in width。
[37]本節述及之時間為 ATC 時間，與其他章節所使用以 FDR 為基準之時間，時間差距約 90 秒（ATC 時間+90 秒=FDR 時間）。

依據 CVR 錄音抄件，1230:38 時（FDR 時間 1232:08 時）正駕駛員呼叫「應該可以下快一點　高於 glide slope 一 dot 喔」；1230:50 時（FDR 時間 1232:20 時）正駕駛員接著呼叫「等攔截到再說」，顯示 BR806 之高度一直高於下滑道。

「飛航管理程序」第 5-9-1 節引導至最後進場航道：

雷達引導進場之前或一開始時，告知駕駛員進場種類及所使用跑道。除 7-4-3「引導作目視進場」規定外，引導到場航空器攔截最後進場航道：

b. 精確進場時，其空層不高於下滑道，且不低於進場程序圖指定之最低下滑攔截空層。

以上有關引導航空器進場之規定, 引導航空器攔截進場航道時, 攔截高度不得高於下滑道，1229:27 時近場臺管制員許可 BR806 進場時，該機攔截 ILS 之高度高於下滑道約 1,000 呎，未符合飛航管理程序之規定。

「飛航管理程序」第 5-9-4 節到場指示：

在航空器到達進場口之前應頒發下列各項資料：

a. 與最後進場航道上某定位點之相關位置。若雷達幕上未標示或程序亦未說明時，則頒發航空器與提供最後進場導引之某助航設施或機場之相關位置資料。

上述規定要求管制員於許可航空器進場時，應提供航空器相關距離資料。1229:27 時近場臺管制員許可 BR806 進場時，未依據飛航管理程序頒發該機與最後進場航道上某定位點之相關位置，如「six miles from tulip」。

當晚天氣變化劇烈，2000 時天氣系統位於機場西方，2016 時雷暴位於機場西南方至西北方，向東移動，2030 雷雨接近機場，2035 時雷雨在機場上空。依近場臺之管制錄音分析，1227:44 時至 1232:27 時不到 5 分鐘的時間內，桃南席管制員管制下之航空器超過 10 架，航空器請求偏航躲避天氣、管制員指示航空器調整速度、無線電通訊互相干擾...等，管制工作已超過正常所能負荷之程度。管制員雖於

1229:23 時曾質疑 BR806 是否已完成進場準備（confirm ready for approach），惟管制員許可並引導該機攔截航道時，該機高度仍高於下滑道，且管制員未提供航空器相關距離資料，供駕駛員交互參考，駕駛員在無充裕之反應時間下需以調整外型與進場速度，並於攔上左右定位台後，即需加大下降率攔截下滑道，管制員未依 ATMP 規定提供適當之飛航服務，增加駕駛員進場操作之風險。

依據「臺北近場管制塔臺業務手冊桃園國際機場離到場分區管制暨餽給席作業規定」，由督導或協調員視航情決定是否開啓餽給席作業，當開啓餽給席時，指定高度以上，由餽給席負責管制；餽給席原則上令進管航機依到場程序飛行，並於需要時，指示航機於規定之待命點待命。於當晚之惡劣天氣情況下，桃南席管制員同時管制超過 10 架以上之航空器，包括離到場、引導進場，同時又有數架班機請求避讓惡劣天氣，管制員與駕駛員無線電通訊經常互相干擾，工作負荷過重，已達有礙飛安之程度; 但是近場臺督導及協調員並未視天氣情況與航行量所造成工作量之變化，主動調配人力，開啓餽給席以分擔桃南席之工作負荷。

建議民航局加強督導飛航服務總台航管作業，重新檢視並落實飛航服務之管理政策，確保督導席及協調席善盡其席位管制之工作職責。

2.10.2 塔臺機場席管制作業

「飛航管理程序」第 2-9-2 節終端資料自動廣播服務作業程序：

b. 當駕駛員報告已收到現行終端資料自動廣播時，管制員可省略廣播中所包含之項目。天氣驟變之情況則應由航管單位告知。

d. 管制員應確定駕駛員已收到現行終端資料自動廣播服務內容。如果駕駛員未說明收到的廣播資料代碼，應詢問駕駛員以確認其是否收到。如初次確認後，作業資料又有變化，管制員應提供最新資料。

「飛航管理程序」第 3-10-2 節於最後進場階段更新資料：

a. 塔台自近場管制接管航空器後，儘速告知下列資料：

1. 跑道。

2. 高度表撥定值。

3. 風向及風速之顯著變化。

註—

當管制員掌握之地面風資料爲分量數值時，顯著變化指：

平均逆風：10 浬/時。

平均順風：2 浬/時。

平均側風：5 浬/時。

4. 任何在最後進場區域之風切及亂流之最新資料。

5. 能見度低於 10 公里之現行能見度，或條件適用時，預定使用跑道之跑道視程數值。

b. 於最後進場階段，立即告知航空器下列資料：

1. 突然出現的危害（例如：跑道上未經授權之相關航情）。

2. 現行地面風的顯著變化，以最小及最大值方式表示。

3. 跑道道面狀況之顯著變化。

4. 所需之目視及非目視助航設施其運作狀態之變化。

5. 觀測到的跑道視程數值或能見度之變化。

2016 時雷暴位於機場西南方至西北方，向東移動，機場有小陣雨。2030 時之機場例行天氣觀測爲風向 040 度、風速 16 浬/時[38]，能見度 3,500 公尺有小陣雨…（ATIS I）。隨後雷暴接近機場，2031:15 時氣象臺將發布一小時的雷暴警報通知塔臺資料席。2031:27 時該機與塔臺構聯，機場席提供該機之天氣資料爲風向 030 度、風速 10 浬/時，高度表撥定值 1010 百帕，能見度 3,500 公尺。2033:12 時機場席於

[38]AWOS 測得之地面風向風速資料經由電腦運算後傳輸至氣象臺及塔臺顯示器，氣象臺編發之機場天氣觀測（含 ATIS），其風向風速值係為 10 分鐘平均；塔臺管制員則讀取 2 分鐘平均風向風速值並提供起降航空器參考使用。

管制波道廣播雷暴警報進行中之訊息。2034 時雨勢變大，氣象臺編發機場特別天氣觀測，為風向 020 度、風速 15 浬/時、風向變動範圍 300 度至 060 度，能見度 800 公尺有中度雷雨…（ATIS J）。2035:09 時（FDR 時間為 2036:39 時）該機著陸，1235:17 塔臺機場席於管制波道廣播能見度 800 公尺。

依據 AWOS 於 06 跑道頭之風向風速紀錄資料，2031:27 時該機與塔臺構聯後，因雷暴接近機場，地面風速逐漸增強並轉為正側風。桃園機場 AWOS 之塔臺顯示器除顯示風向風速外，亦同時顯示其分量數值，即相對於跑道的順、逆及側風。表 2.10-1 為塔臺 AWOS 顯示器顯示之之 06 跑道頭 2 分鐘平均地面風及 1 分鐘平均跑道視程，自 2031:27 時該機與塔臺構聯，至 2035:09 時該機著陸，約 3 分半鐘，06 跑道頭左側風由 4 浬/時逐漸增強至 15 浬/時，其側風變化量遠高於「飛航管理程序」訂定之平均側風顯著變化量 5 浬/時，惟塔臺機場席因廣播雷暴警報，及其他航機徵詢雷雨天氣資訊，致未能掌握地面風之變化，並提供予航空器。

表 2.10-1 塔臺 AWOS 顯示器顯示之 06 跑道頭天氣資訊[39]

ATC 時間	FDR 時間	風向	風速	側風	頂風	RVR
2031:27	2032:57	030	10	04L	09H	2000
2032:00	2033:30	010	11	07L	08H	2000
2032:25	2033:55	360	11	08L	07H	2000
2032:36	2034:06	350	11	09L	06H	2000
2032:42	2034:12	350	12	10L	06H	2000
2033:00	2034:30	340	12	11L	05H	2000
2033:13	2034:43	340	13	12L	05H	2000
2033:30	2035:00	340	14	13L	05H	2000
2034:07	2035:37	340	14	14L	04H	2000
2034:30	2036:00	340	15	15L	04H	2000
2035:09	2036:39	330	15	15L	03H	2000
2035:24	2036:54	330	16	16L	03H	2000

[39] 2 分鐘平均風向（度）、風速（浬/時）、側風及頂風風速值（浬/時，L 表示左側風，H 表示頂風），以及 1 分鐘平均跑道視程 RVR（公尺）。

一般而言 ATIS 對天氣的快速變化較無法即時反應，故「飛航管理程序」規定「天氣驟變之情況則應由航管單位告知」。雷暴、鋒面及熱帶氣旋等天氣系統常伴隨地面風之顯著變化，因而增加駕駛員操作航空器落地的困難度，在此情況下，於最後進場階段，塔臺機場席爲航空器唯一的地面天氣資訊來源，但本案機場席因工作負荷較重而疏於對 AWOS 訊息的掌控，致未能提供 BR806 地面風顯著變化之資訊。

由近年來事故調查案例中，曾發現 2 次管制員未按「飛航管理程序」規定提供航空器重要天氣資料的情況，本案近場臺及塔臺之航管作業亦有類似之情況，顯示現行訓練考核及席位查核作業未能發揮應有之機制。民航局及飛航服務總台應重新檢視航管訓練考核及席位查核作業規定，確認改善機制無法發揮功能之原因，並評估管制員工作負荷及工作環境，落實「飛航管理程序」提供氣象資訊之規定，杜絕類似情況再度發生。

第三章　結論

3.1 與可能肇因有關之發現

1. 落地當時自 500 呎至落地期間有約 10 浬/時至 20 浬/時之左側風；飛航組員落地前未獲知風速顯著變化資訊；落地後未能及時伸展地面擾流板，致無法破壞機翼升力，減低地面風對航機右傾之影響；落地後左側風增至最大 18 浬/時，航機左機翼因側風使升力增加使左機翼上揚，操控駕駛員亦未及時向上風邊壓桿，克服左翼上揚現象，因而使航機產生向右坡度之右偏；側風落地時遭遇風標效應，飛航組員未能即時將反推力器回收至慢車減少側向分力，更加劇航機右偏，終致航機短暫偏出跑道。（1.11、2.3.2、2.3.2.1）

3.2 與風險有關之發現

1. 飛航組員通知航管完成進場準備時之外型、高度、空速及距離機場距離，未符該公司「交叉檢查執行」及「下降計劃」要求。（1.11.1、 1.11. 2、2.2、2.3.1.3）
2. 飛航組員於航機高度較正常下降計畫高且速度較快時警覺不足；且未能於確認及討論後再執行相關操作。（1.11.1、2.3.3.2）
3. 臺北近場臺桃南席管制員許可 BR806 進場時，該機攔截 ILS 之高度高於下滑道約 1,000 呎，且未提供航空器相關距離資料，增加駕駛員進場操作之風險。（1.9、1.11、2.10）
4. 飛航組員下降前所獲之天氣資料及落地前塔台告知之天氣資料，符合副駕駛員落地操作標準，但此後因天氣變動，致使該機於落地前側風之變化已超出副駕駛員落地標準；落地前飛航組員並未獲知最新之天氣資料。（1.7、1.18.1.、2.3.1.2、2.10）
5. 臺北近場臺桃南席管制員未依「飛航管理程序」確認駕駛員是否收到最新之 ATIS。（1.9、2.10）
6. 塔臺機場席因廣播雷暴警報與能見度，以及其他航機徵詢雷雨天氣資訊，致未能掌握地面風之變化，並提供 BR806 地面風顯著變化之資訊。（1.7.2、1.18.1.、

2.10）

7. 該機左右主輪及鼻輪三輪同時著陸，平飄至著陸期間之著陸姿態異常，未符 MD90 標準操作手冊之要求。（1.11.2、2.3.2）
8. 航機落地後出現偏側時正駕駛員未能及時接手。（1.11.1、1.11.2、2.3.2）
9. 該二名飛航組員未能依照立榮航空 MD90 標準操作手冊要求實施呼叫，公司應加強航務自我督察作業。（1.5.1、1.5.2、2.3.1.1、2.3.3.1）
10. 正駕駛於該機落地後，忽略檢查擾流板之狀態，在擾流板未自動展開時以手動方式使其展開。（1.11.1、1.11.2、1.16.2、1.16.3、2.4、2.5）
11. 較可能造成該機落地後擾流板未自動展開之原因，係駕駛員雖有將減速板拉起但未拉至正確備動位置，或遺漏執行拉起減速板手柄至備動位置之動作，且於執行落地檢查時未完成確認。（1.11.1、1.11.2、1.16.2、1.16.3、2.4、2.5）
12. 近場台管制員工作負荷過重，班務督導及協調員未視航行量及工作量變化，主動調配人力，開啓餽給席以分擔桃南席之管制工作。（1.9、2.10）
13. 由近年的事故調查案例中，曾發現 2 次值班管制員未按「飛航管理程序」規定提供航空器重要天氣資料的情況，顯現訓練考核與席位查核作業未能發揮應有之改善機制。（1.18.1、2.10）

3.3 其他發現

1. 飛航組員相關飛航資格，符合現行民航法規之規定。（1.5.1、1.5.1.2、2.1）
2. 無證據顯示飛航組員於飛航中曾受任何生理、心理、藥物及酒精影響。（1.5.2.1、1.5.2.2、2.1）
3. 該班機載重平衡在限制範圍內，無證據顯示本次事故與航機之維修及適航有關。（1.6.2、2.1）
4. 該機飛航組員如能參考 ALAR Tool Kit 第 8.6 節內容，將可於飛航中適時獲得有關風之資訊。（1.18、2.3.3.1）
5. 該機落地時鋪面有發生水飄的條件及環境，但因該機著陸後第 3 秒及第 4 秒左主輪離地，第 6 秒及第 7 秒右主輪離地，之後該機即偏出跑道，本次偏出跑道

事故應非水飄現象所致。（2.3.2）

6. 該機無線電高度 200 呎以下至主輪著陸期間，風切危害因子小於 0.1、CVR 及 FDR 資料亦顯示機上風切警告系統（windshear alerting and guiding system）未致動、且當時地面觀測亦無風切警告，故無風切現象。（1.11.2、2.3.2）
7. 該具 FDR 紀錄之「煞車踏板位置」、「煞車壓力」及「地面擾流板位置」三參數，非屬我國現行法規要求紀錄之 32 項必要參數，惟屬於 ICAO 第六號附約第 9 版之標準及建議措施所要求紀錄之 78 項必要參數。（1.11.2、2.6）
8. 民航局航務檢查員於立榮航空部分航務相關主管從缺後，未要求立榮航空確實依航務手冊另行指派。（1.17.4.、2.7.1）
9. 我國民航法規未將民航運輸業之航務主管須具備民航運輸業駕駛員及航務相關督導或管理經驗列爲必要條件。（1.17.1、1.17.2、2.7.2）
10. 桃園機場 06/24 跑道鋪面橫坡度符合「民用機場設計暨運作規範」需求，但若跑道在降雨量大的狀況下仍可能造成跑道鋪面水深變高之現象。（1.10.1、1.10.3、2.8.1、2.8.3）
11. 民航局欠缺機場跑道平坦度檢測指導之相關規定，另桃園機場未執行 06/24 跑道平坦度檢測。（1.12.2、2.8.2）
12. 事故後，桃園機場 06/24 跑道摩擦係數值均高於摩擦係數養護規劃標準及最低抗滑標準。（1.10.2、2.8.4）
13. 「台灣桃園國際機場活動區之巡場與維護作業程序」之不定期巡場程序，未依據「民用機場空側作業應注意事項」建議將惡劣天候狀況之條件（如：強風、大雨、霧或低能見度）加以敘明。（1.10.3、 2.8.5.2）
14. 該機落地後通報塔臺跑道煞車狀況爲「poor」之後，該資訊有加報於後續之 ATIS，但塔臺未將此資訊通知桃園機場公司航務處。（1.11、2.8.5.4）
15. 桃園機場公司未依「民用機場設計暨運作規範」及「民用機場鋪砌道面狀況應注意事項」建議，將需增加特別抗滑檢測之情況納入如「臺灣桃園國際機場跑道鋪面摩擦阻力檢測及維護作業規定」等相關程序中。（1.10.3、2.8.5.4）

16. 桃園機場 06/24 跑道落地之航機多屬高速著陸飛機，且跑道寬 60 公尺，適用「民用機場設計暨運作規範」建議設置跑道中心線燈之條件。（1.10.1、2.9）

第四章 飛安改善建議

4.1 改善建議

致立榮航空公司

1. 加強 MD-90 機隊正駕駛員於擔任監控駕駛員時，於發現操控駕駛員操作異常時應及時接手之認知。（ASC-ASR-12-05-001）
2. 加強 MD-90 機隊飛航組員訓練、考核及自我督察項目，其中應包括：（ASC-ASR-12-05-002）
   A.於側風、跑道濕滑下之落地及操控技巧，包括側風落地遭遇風標效應反推力器之使用；並對航務手冊有關組員資源管理有關狀況警覺及資訊交換之執行。
   B. 有關飛航組員遵守標準操作程序及計畫（包括檢查及標準呼叫），及檢視並考量修訂現行 MD-90 機隊飛航組員於落地前對減速板手柄位置之檢查程序及操作方式，以確保落地後地面擾流板之伸展。
3. 考量參考 ICAO Tool Kit 有關風之相關資訊並有效運用於飛航中。（ASC-ASR-12-05-003）
4. 重新依據航務手冊檢視運航本部航務相關主管之派任。（ASC-ASR-12-05-004）
5. 重新檢視飛航資料紀錄器之年度檢查程序及其感應裝置的校準作業，以確保飛航資料紀錄器所記錄參數之正確性。（ASC-ASR-12-05-005）
6. 檢討現行飛航資料分析系統無法捕捉及分析航空器偏出跑道風險類的關鍵參數原因，研擬強化飛航資料分析系統功能之辦法。（ASC-ASR-12-05-006）

致交通部民用航空局

1. 督導立榮加強 MD-90 機隊正駕駛員於擔任監控駕駛員時，於發現操控駕駛員操作異常時應及時接手之認知。（ASC-ASR-12-05-007）
2. 督導立榮加強 MD-90 機隊飛航組員訓練及考核及自我督察項目，其中應包括：（ASC-ASR-12-05-008）

A.於側風、跑道濕滑下之落地及操控技巧，包括側風落地遭遇風標效應反推力器之使用；並對航務手冊有關組員資源管理有關狀況警覺及資訊交換之執行。

B. 有關飛航組員遵守標準操作程序及計畫（包括檢查及標準呼叫），及檢視並考量修訂現行 MD-90 機隊飛航組員於落地前對減速板手柄位置之檢查程序及操作方式，以確保落地後地面擾流板之伸展。

3. 督導立榮檢視並考量修訂現行 MD-90 機隊飛航組員於落地前對減速板之操作、檢查程序及方式，包括落地前減速板手柄位置之檢查，以確保落地後地面擾流板之伸展。（ASC-ASR-12-05-009）
4. 督導立榮參考 ICAO Tool Kit 有關風之相關資訊，有效運用於飛航中。（ASC-ASR-12-05-010）
5. 督導立榮重新依據航務手冊檢視運航本部航務相關主管之派任。（ASC-ASR-12-05-011）
6. 督導立榮重新檢視飛航資料紀錄器之年度檢查程序及其感應裝置的校準作業，以確保飛航資料紀錄器所記錄參數之正確性。（ASC-ASR-12-05-012）
7. 督導立榮檢討現行飛航資料分析系統無法捕捉及分析航空器偏出跑道風險類的關鍵參數原因，研擬強化飛航資料分析系統功能之辦法。（ASC-ASR-12-05-013）
8. 督導飛航服務總台航管作業，重新檢視並落實飛航服務之管理政策，確保督導席及協調席善盡其席位管制之工作職責。（ASC-ASR-12-05-014）
9. 檢視航管訓練考核及席位查核之規定，並督導航管作業，使訓練考核及席位查核發揮應有之機制，確保航管服務皆能符合規定。（ASC-ASR-12-05-015）
10. 督導飛航服務總台評估管制員工作負荷及工作環境，落實「飛航管理程序」提供氣象資訊之規定。（ASC-ASR-12-05-016）
11. 落實飛航管理程序中塔台若收到跑道煞車狀況報告，應通知機場權責單位之相關規定。（ASC-ASR-12-05-017）
12. 考量增訂機場平坦度檢測之相關指導規定；督導桃園機場公司，增訂不定期巡

場作業程序之啓動條件並於駕駛員通報跑道煞車狀況時，增加特別抗滑檢測或其它因應作爲之機制。（ASC-ASR-12-05-018）

致桃園機場公司

1. 增訂不定期巡場作業程序之啓動條件，並於駕駛員通報跑道煞車狀況不好時，增加特別抗滑檢測或其它因應作爲之機制。（ASC-ASR-12-05-019）

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附錄一　飛行前檢查單（Preflight Check Sheet）

MD-90-30 Preflight Check Sheet

UNI AIR 立榮航空

Aircraft No.： B-179 17　**Station：** TPE　**FLT No.：** BR428　**Date：** MAY / 12 / 2011

Start Time： 06 : 00

End Time ： 08 : 30

FLIGHT DECK	**Note: Apply external power as necessary**
M [redacted]	1. Perform general check for the following：
	a. Check flight log and cabin log.
	b. Check levers, switches and confirm yellow label C/Bs push in flight deck.（total：10EA）(參考”駕駛艙檢查程序表”執行相關測試 – 此程序表置於maintenance log簿內)
	c. Check the main batteries condition from DC volts/amps Meter.
M [redacted]	d. **Pressurized both hydraulic systems, set AUTOBRAKE CONTROL SWITCH to T.O. position and set both ANTISKID AND AUTOBRAKE ARM switches to ARM position. Set parking brakes and release, Make sure no "ANTISKID AND AUTOBRAKE" FAULT message show on E.O.A.P., Put switches and hydraulic system to off/disarm position, if no longer require. (N/A for 919,920 ,921,922)**
	NOTE: Before pressurized HYD systems, use **HAND PUMP** pressurized both HYD system and manually bleed both HYD reservoir and make sure no air from the reservoir bleed port.(建壓前，請先用 HAND PUMP 預壓，並執行系統手動排氣確認，確認沒有殘存氣體後再行建壓)
M [redacted]	2. Check flight deck for the following：
	a. A.P.U./Engine fire test.
	b. Air condition/pneumatic operational check.
	c. Aligned I.R.U. and E.O.A.P. message check.
	d. F.D.R./ C.V.R/ E.G.P.W.S test.
	e. Flight director takeoff mode test.
	f. Brake temperature test.
	g. Engine display panel test.
	h. Takeoff warning test.
	i. Windshear alert and guidance system test.
M [redacted]	j. Verify fuel pump (J-23,H-23,H-21,J-21,H-19,J-19,(H-25, J-25 for B-17922 only) and Aux. hydraulic pump (S-27,T-27) circuit brake condition. If circuit breaker trip, refer AMM 20-50-06 page 202 for isolated and corrected (AD NO: CAA-2008-05-014)
PASSENGER CABIN	3. Check cabin compartment interior for the following：
	a. Check lavatories.
M [redacted]	b. Check Video and Tape pre-recorder system. (N/A for 919, 920,921,922).
	c. Check the cabin attendant Demo kits、Medical kits and First Aid kits are available.
M [redacted]	4. Initial daily charging for photoluminescent floor proximity emergency escape path marking system. The Cabin sidewall / ceiling lights must be ON for a minimum of 15 minutes. Required that the doors of the baggage bins be closed during the charging period and none passenger boarding.
M [redacted]	5. Push and hold all faucets to bleed residual air from water system on all lavatories and galleys（include coffee maker）.
M [redacted]	6. Perform all lavatories smoke detectors functional test by test switch.
FUSELAGE AND WING	7. Lower the flaps and slats.
	Caution: Before lower flaps and slats make sure ground clear.
M [redacted]	8.360° Walk around check fuselage and exterior doors for condition.(Include L1、R1 and cargo door area skin for damage and A/C exterior service panels/doors for security.

Prepared by：UNI ENGINEERING DEPT. [redacted]

Reviewed by: [redacted]　Verified by：[redacted]

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Date：OCT/18/2010
REV.：29
FORM NO.：EM0128-00
Start Date: NOV/16/2010

MD-90-30 Preflight Check Sheet

UNI AIR 立榮航空

9.360° Walk around check exterior access panel for security.

10. Check upper/lower wings surface for damage and corrosion.

11. Check water quantity indication is more then 3/4 in the potable water service panel.

12. Remove static ports protective cover and check the skin around static ports for damage, corrosion or loose rivets **(RVSM Related Task)**
Note: 每逢豪大雨，請特別檢查靜壓口有無遭水氣或水膜堵塞，並排除水氣與水膜。

13.Check F.A.K. on board.（**for China and Japan flight only**）
Note: If F.A.K. spare parts are used, write down to the F.A.K. MATERIAL CHANGE NOTICE application form, and advise Supply Dept. for replenishment.

EMPENNAGE

M [redacted]

14.Check the empennage for the following:
Vertical fin、rudder、horizontal stab.、elevator from ground level for obvious damage.

LANDING GEAR

M [redacted]

15.Check and record data for tire and NLG shock strut dimension, charge as necessary.

Nose tire pressure（155~160 psi）and NLG shock strut dimension
Left：156 psi // Right：157 psi
NLG：6.5 inch (Ref. Dimension: 5.5" ～ 7.0") (With sand bags) 30
NLG：X inch (Ref. Dimension: 6.5" ～ 8.5") (No sand bags)
Note: 此高度值爲參考數據，如有異常偏高或偏低，請依據 AMM 32-21-01 檢查
Main tire pressure（180 ± 5 psi）including 8ea of brake hydraulic hoses quick disconnect couplings for proper connected. (Refer to EN #E93208004)
No.1：182 psi // No.2：181 psi // No.3：182 psi // No.4：180 psi

16. After A/C towing to the gate, check main and nose landing gear down lock pins are removed and nose steering bypass pin is installed.
Note: If the landing gear down lock pins are installed, maintenance should verify the down lock pins are removed before flight.

POWERPLANT AND PYLONS

M [redacted]

M [redacted]

17.Check powerplant and pylon area for following：
a. Check intake, rotating vanes and turbine for F.O.D. and clearance and do a general visual inspection for condition and security.
b. Check engines for evidence of fluid leaks.
c. Check cowling、pressure relief door、access door and latches for condition and security.

18. Check engines、VSCF Generators and A.P.U. oil fill cap to the closed position and security.
Bite APU RBD and record Hour/Cycle, Hour 24269 Cycle 24753

19. Retract the Flaps/ Slats, make sure all indication extinguish in system display panel.

20. Remove External power and ground wire as necessary.

Accepted by：[redacted]

A/E License No.：[redacted]

Note. Perform item 21 in every Saturday. 請於每週六執行 item 21.

21.Perform APU operational test (PPM raise condition monitor) (Incorporated work card No.3130IN and MACS key in)
N/A TODAY IS NOT SATURDAY. [redacted]

EGAT A528

Prepared by：UNI ENGINEERING DEPT. [redacted]

Reviewed by: [redacted] Verified by：[redacted]

Page 2 of 2

Date：OCT/18/2010
REV.：29
FORM NO.：EM0128-00
Start Date: NOV/16/2010

附錄二　地面擾流板作動機制

MD-80/MD-90 In-Flight Ground Spoiler Lockout Mechanism

The in-flight spoiler lockout mechanism on MD-80 and MD-90 airplanes prevents manual movement of the speed brake lever in flight while flaps are extended. Flight crews, maintenance crews, and engineers for operators of these airplanes can best understand the mechanism by reviewing the regulatory requirements that govern its function as well as its design and operation.

An in-flight ground spoiler lockout mechanism was incorporated on MD-80 and MD-90 airplanes to prohibit inadvertent movement of the speed brake lever during flight with flaps extended. The mechanism does not degrade autospoiler deployment performance during landing rollout. In addition, no single failure in the mechanism prevents the flight crew from manually deploying ground spoilers during landing rollout. The lockout mechanism is operationally transparent to the flight crew until its intended function is required. Understanding the operation of the in-flight ground spoiler lockout mechanism includes knowledge of the following:

1. Regulatory issues.
2. System design.
3. Speed brake lever lockout.
4. Unlocking the mechanism.

Regulatory Issues

The MD-80 certification basis for lift and drag devices is defined by U.S. Federal Aviation Regulation （FAR） 25.697, Amendment 22, which refers only to wing flap controls. Paragraph b of the subpart states that the wing flap control must be designed and located to make inadvertent operation improbable. The spoiler lockout system was not required for U.S. Federal Aviation Administration certification on the MD-80. It was incorporated as baseline after the Canadian Ministry of Transportation （MOT） mandated it for its certification of the MD-80.

The MD-90 certification basis for lift and drag devices, however, was established at a later amendment level than for the MD-80. FAR 25.697, Amendment 46 revised paragraph b to state, "Each lift and drag device control must be designed and located to make inadvertent operation improbable. Lift and drag devices intended for ground operation only must have means to prevent the inadvertent operation of their controls in flight if that operation could be hazardous." This established the requirement for an in-flight spoiler lockout feature. As a result, the MD-90 was certified with the present in-flight spoiler lockout mechanism with weight-on-wheels input. Douglas Products Division had originally defined the MD-90 with the lockout feature as baseline.

System Design

The MD-80 and MD-90 spoiler system consists of three spoiler panels located forward of the flaps on the upper surface of each wing. The two outboard panels on each wing function as flight spoilers that are in phase with aileron input to assist in lateral control of the airplane. The flight spoilers also function symmetrically as airborne speed brakes and as ground spoilers in conjunction with the third inboard panels that deploy only on the ground.

The speed brake lever on the flight deck control pedestal controls symmetrical movement of the flight spoiler panels on both wings during speed brake deployment. Because speed brake deployment with flaps extended is not a desirable aerodynamic configuration for the MD-80 and MD-90 wing, the "Limitations" section of the MD-80 and MD-90 Airplane Flight Manual prohibits this flight control surface configuration.

Speed Brake Lever Lockout

Movement of the speed brake lever moves a closed-loop cable connected to the two outboard flight spoiler control valves on each wing. Movement of the flap/slat handle moves a closed-loop cable connected to the dual-flap control valves in the left main landing gear （MLG） wheel well. Cable sectors are installed in the speed brake cable loop and flap system cable loop under the pedestal. When the flaps are extended eight degrees or greater, a programming cam on the flap sector transmits an input through a torque tube to a lockout arm at the speed brake sector. The lockout arm engages a gate on the speed brake sector and prevents its rotation.

If the flight crew extends the flaps while the speed brakes are deployed, a spoiler/flap extended alert is annunciated, and the flap sector input places the lockout arm in a spring-loaded standby mode. When the flight crew retracts the speed brake lever in response to the alert, the lockout arm engages the speed brake sector and prevents its movement in the extended direction. The lockout remains in effect until an unlocking input is received or the flaps are retracted.

Unlocking the Mechanism

Any one of three independent unlocking inputs associated with landing is required to unlock the speed brake lever for ground spoiler deployment:

- Autospoiler actuator extension.
- MLG weight-on-wheels.
- Nose landing gear strut compression.

If the flight crew makes a sustained effort to manually move the speed brake handle while the system is locked out, the system kinematics allow each of the inputs to overcome the resultant preload in the speed brake sector and unlock the speed brake lever.

AUTOSPOILER ACTUATOR EXTENSION.

The autospoiler actuator provides the primary unlocking input at touchdown as soon as the MLG wheels reach speeds from 390 rpm to 725 rpm. Wheel spin-up transducers located in each of the four axles provide wheel rotation speed data to the ground spoiler control box on the MD-80. On the MD-90, the transducers provide wheel spin data to the antiskid/ autobrake system control unit. Although all four spin-up transducers normally send this information, only two inputs are required for autospoiler operation. The two inputs include one spin-up signal from either the right outboard wheel or left inboard wheel transducers, and one spin-up signal from either the left outboard or right inboard wheel transducers. An increasing-radius cam driven by the autospoiler actuator drives a cam follower arm that is attached to a push-pull cable mounted on the front of the pedestal. Rotation of the cam follower arm unlocks the mechanism by retracting the lockout arm and allowing rotation of the speed brake cable sector. If the speed brake lever is armed, the autospoiler actuator automatically moves it to the ground spoiler position.

MLG WEIGHT-ON-WHEELS.

An electric solenoid unlocks the speed brake lever within the first two inches of right MLG strut compression at touchdown. This allows the flight crew to manually deploy ground spoilers prior to compression of the nose landing gear （NLG） strut if either spin-up or autospoiler actuator deployment fails to occur at MLG touchdown. The solenoid independently drives the same cam follower arm operated by the autospoiler actuator. This provides an unlocking input through the same push-pull cable to retract the lockout arm and allow rotation of the speed brake cable sector.

Compression of the right MLG strut closes ground spoiler gear interlock relay R2-291 with an input from the D1-57 weight-on-wheel sensor through the B5-80 proximity switch electronic unit（figure 1）. Closure of R2-291 allows 28 volts of direct current （V dc） to pass through spoiler control circuit breaker B1-244 to close spoiler lockout -2 relay R2-592. Closure of R2-592 allows 28-V dc power to pass through spoiler lockout circuit breaker B1-1009 to close and latch spoiler lockout -1 relay R2-591. The latching feature ensures that loss of MLG strut compression and the subsequent opening of relays R2-291 and R2-592, which may occur if the airplane bounces after initial touchdown, have no impact on the mechanism. Closure of R2-591 simultaneously supplies 28 V dc through B1-1009 to energize the solenoid, which unlocks the speed brake lever to allow manual movement, as necessary, prior to lowering the nose.

Compression of the NLG strut also results in rotation of the ground shift drum to ground mode. The shift to ground mode provides an unlocking input through a second push-pull cable to retract the lockout arm and allow rotation of the speed brake cable sector. The compressed NLG strut maintains the speed brake lever in an unlocked condition throughout all ground taxi and takeoff operations, regardless of flap deployment.

Compression of the NLG opens ground shutoff relay R2-590, which opens relay R2-591 and de-energizes the solenoid. Since compression of the NLG strut mechanically maintains the speed brake lever in an unlocked condition throughout all ground taxi and takeoff operations, the solenoid unlocking input is no longer required. Therefore, the solenoid is powered only from MLG touchdown to NLG touchdown to maximize its service life.

When the airplane rotates for takeoff, a time delay in ground shutoff relay R2-590 prevents the solenoid from energizing for the first 10 seconds of flight. By then, the airplane is airborne, and the right MLG strut is fully extended. This saves energy and extends the service life of the solenoid, which other-wise would be actuated on NLG strut extension during rotation.

NOSE LANDING GEAR STRUT COMPRESSION.

Compression of the NLG strut provides an alternate electrical signal to activate the autospoiler actuator, as well as a backup mechanical unlocking input that deploys if both the autospoiler actuator and solenoid are inoperative.

Summary

The MD-80 and MD-90 in-flight spoiler lockout mechanism prevents the undesirable flight control configuration of deployed spoilers in either the speed brake or ground spoiler mode when flaps are extended. This is accomplished through the use of a flap input/spoiler output interlock, and the mechanism is subsequently unlocked by input from any of the three independent sources. While the system was originally required by the Canadian MOT for installation aboard the MD-80, it was later incorporated into the baseline MD-80. The feature is also incorporated on all MD-90 airplanes.

Design Engineer
MD-80/MD-90 Design Office
Douglas Products Division

以上報告之連結網址如下：

http://boeing.com/commercial/aeromagazine/aero_03/textonly/sy02txt.html

附錄三　波音公司回函

Chief Engineer
Air Safety Investigation
Commercial Airplanes

The Boeing Company
P.O. Box 3707 MC 07-32
Seattle, WA 98124-2207

BOEING

25 July 2011
66-ZB-H200-ASI-18615
[redacted]
National Transportation Safety Board
490 L'Enfant Plaza SW
Washington, DC 20594

Subject: Landing Analysis – UNI MD-90 B17917 Runway Excursion Taiwan 12 May 2011

References: (a) E-mail, 07 July 2011, Aviation Safety Council of Taiwan to Boeing, same subject

Dear Mr. [redacted]

Boeing was requested to produce a Landing Analysis and address several questions submitted by the Aviation Safety Council, Taiwan (ASC). This related to the subject runway excursion.
Enclosed please find the Landing Analysis and the Boeing responses to the ASC questions.

The information included with this correspondence is controlled under the US Export Administration Regulations (15 CFR Parts 300-799) and has been categorized as ECCN: 9E991. Information categorized as ECCN 9E991 is acceptable for public release.

Please feel free to contact us if you have any questions.

Best regards,

<original signed by>

Chief Engineer
Air Safety Investigation

Enclosure: Landing Analysis – UNI MD-90 B17917 Runway Excursion Taiwan 12 May 2011

cc: Mr. [redacted], Aviation Safety Council of Taiwan

BOEING

Event Description

An MD-90 landed at Taoyuan International airport runway 06 on May 12 at 20:36 Hrs local time. After touchdown, the landing gear momentarily veered off the right side of runway. Four runway lights were damaged and a maintenance check found three landing gear tires slightly damaged and few engine blades with minor damage. No injury to passengers or crew members was reported.
The event is under investigation by the Aviation Safety Council of Taiwan (ASC), with the National Transportation Safety Board (NTSB) serving as the US accredited representative. The ASC has requested a report of the recorded data from Boeing.

FDR Data

The data from the Flight Data Recorder (FDR) was received from the ASC for analysis. The binary file, `br806.bin`, contained the recorded data from the previous landing and the entire event flight. The parameters we decoded using the data frame found in report MDC 92K9081, *MD-90 DFDAU Interface Control Document*, Revision "I", 23 July 2007. Database 3 was used.
The data were imported into the Insight Analysis software for plotting and analysis.
Parameters analyzed that appear reasonable:

- Airspeed
- Brake Pedal – Left & Right
- Brake Pressure – Left
- EPR – Engines 1 & 2
- Ground Speed
- Lateral Acceleration
- Localizer Deviation – 1 & 2
- Longitudinal Acceleration
- Magnetic Heading
- Pitch Attitude
- Radio Altitude – 1 & 2
- Roll Attitude
- Rudder Position
- Spoiler Positions – Left Outboard & Right Inboard
- Throttle Resolver Angle (TRA) – Engines 1 & 2
- Thrust Reverser Positions – Engines 1 & 2
- Vertical Acceleration
- Weight on Wheels (WOW) – Nose

Parameters investigated without success (bad conversions or bad data):

- Brake Pressure – Right
- Throttle Lever Angle (TLA) – Engines 1 & 2

Data Analysis

The analysis focused specifically on three areas 1) whether there was a bounce at touchdown 2) the functioning of the ground spoilers and 3) braking.
Figure 1 shows the basic parameters used in determining the moment of initial touchdown for the landing. The vertical acceleration spike at the low radio altitude indicates that the airplane touched down at Subframe Reference Time 5760.3 seconds. The Subframe Reference Time is a relative time from the beginning of the analysis file; it does not have any real-world significance. For the remainder of the plots touchdown (SRT=5760.3) is shown as Time=0.
Figure 2 shows selected parameters at the time of touchdown. The airplane touched down in a flat or slightly nose-down pitch attitude, with a right-wing-down roll attitude. Such an orientation results in nearly simultaneous contact runway contact by the nose landing gear (NLG) and the right main landing gear (MLG). Although the radio altitude indicates a small positive value (+2 feet) 1.5 seconds after touchdown, it is not possible to determine, with 100% accuracy, if the airplane actually rebounded ("skipped") off the runway surface. Several factors, including an apparent slight positive bias in the radio altimeter recoding and the persistent nose-down pitch suggest that there probably was no skip or bounce. Throttle resolver angle (TRA) at touchdown is at or very near zero, corresponding to throttle levers at idle. Although the throttle lever positions themselves were not successfully decoded from the binary recording, TRA has a direct correlation and is an acceptable substitute for throttle lever position. Positive TRA corresponds to forward thrust; negative TRA corresponds to reverse thrust.

Figure 3 shows the spoiler and braking parameters. Normally on an MD-90, the automatic ground spoiler (AGS) system, if armed, will deploy all spoilers to a deflection of 60 degrees upon MLG wheel spin-up or NLG compression. In this case the right MLG spin-up signal (not recorded) and NLG compression likely occurred less than a second apart due to the flat touchdown pitch attitude. However, the spoilers did not deploy. The minor spoiler deflections seen 10 seconds after touchdown are due to control wheel input, not the ground spoiler system. There is a "knock-down" feature of the AGS that will retract the spoilers when the #2 throttle is advanced in order to prevent a go-around with the spoilers deployed. However, as can be seen in Figure 3, the throttles were at idle at touchdown and in reverse thrust immediately afterward, so the throttle knock-down can be ruled out as a cause for the failure of the spoilers to deploy.
The brake pressure and pedal positions are also shown in Figure 3. The offset between left and right brake pedal position is likely due to a recording anomaly and not from actual asymmetric braking. It appears that the left brake pressure parameter is functioning normally and the right brake pressure parameter is not recording correctly.
Figure 4 shows the same parameters as Figure 3, but for the previous landing. It can be seen that the spoilers deployed normally. Braking was light.

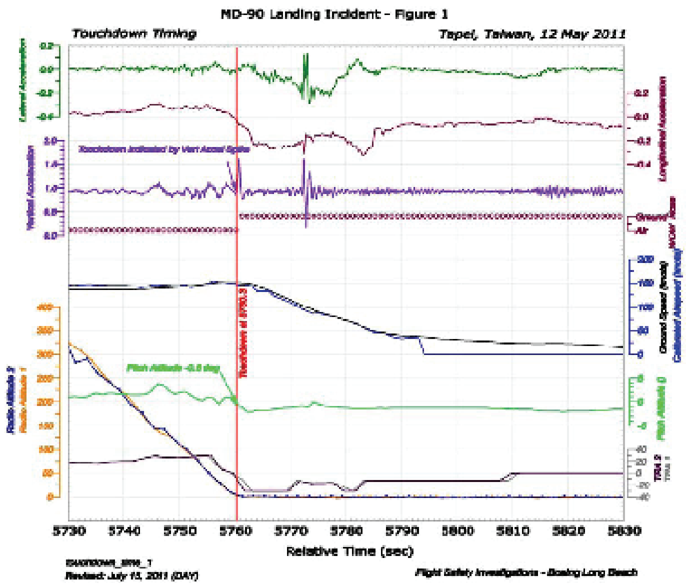
Summary

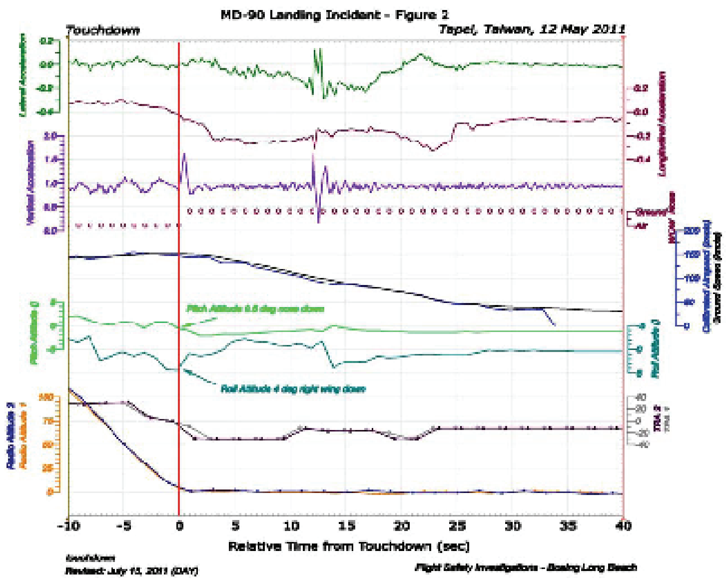
Boeing analyzed the Flight Recorder Data from the subject flight. This report focuses on the touchdown, spoilers, and brakes.
The airplane touched down in a slightly nose-down pitch attitude with a right-wing-down roll attitude. Spoilers did not deploy, either automatically or manually. Reverse thrust and brakes were used, although anomalies in the parameters prevent a complete confirmation of the actual braking levels used.

BOEING

Enclosure to 66-ZB-H200-ASI-18615

Landing Analysis – UNI MD-90 B17917 Runway Excursion Taiwan
12 May 2011





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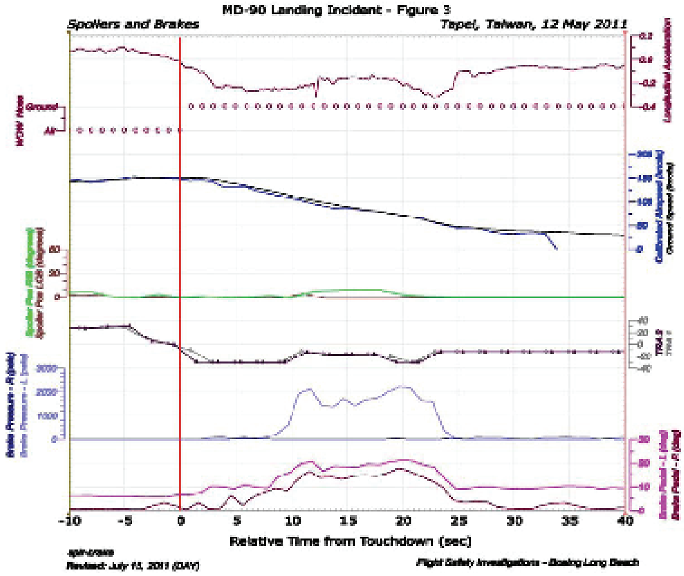
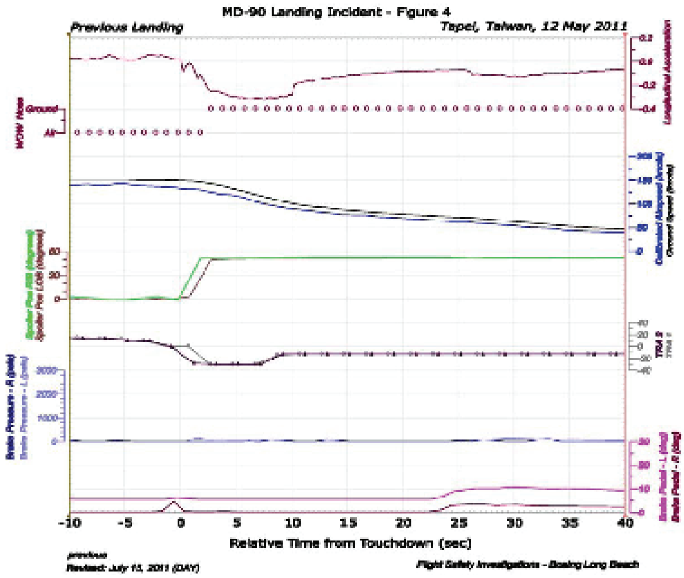
Enclosure to 66-ZB-H200-ASI-18615

Landing Analysis – UNI MD-90 B17917 Runway Excursion Taiwan

12 May 2011





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Landing Analysis – UNI MD-90 B17917 Runway Excursion Taiwan
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Boeing responses to the ASC questions in the order received.

Question 1: Are there any possibilities that ground spoiler will not activated even the spoiler lever was armed?

Boeing Response:
There is always a possibility that a failure(s) within the auto ground spoiler system could result in the non-extension of the ground spoilers during landing. A failure in the system would be annunciated to the Master Warning and Caution Controller (MWCC). The MWCC would then illuminate an amber, AUTO SPOILER FAIL caution message on the Electronic Overhead Annunciator Panel (EOAP). The presence of this caution message does not preclude the use of manual spoilers. Note: The caution message will not be present when the auto ground spoiler system is inoperative and the airplane is dispatched in accordance with the MD-90 MMEL item 27-62-01 (Refer to the MD-90 DDG for specific details).
Information provided to Boeing thus far makes no mention of an annunciated failure during the subject event landing or that the ground spoiler system was placarded via the above referenced MMEL.

Question 2: How many different positions or modes (air mode, land mode, ground mode) when the ground spoiler actuator receive the electric signals from all kinds of operations?

Boeing Response:
There is only the ground mode that would permit the spoilers to extend to the ground spoiler position (60 degrees). After landing, or for a rejected takeoff, all spoilers (outboard flight and inboard ground-only) may be extended to 60 degrees to serve as ground spoilers. Extension to the ground spoiler position may occur automatically when the spoiler/speed brake lever is fully armed (red armed placard is exposed and the lever latches in the up position) or manually through flight crew action. With the speed brake lever armed and all components relevant to the auto spoiler system functional, either main wheel spin up or nose strut compression (aircraft in ground mode) will cause auto spoiler actuation. Auto spoiler actuation will also occur if main wheel spin up and nose strut compression occur at the same time. (Note: The main gear weight-on-wheels (WOW) signal is not used for auto spoiler actuation.)

An in-flight spoiler lockout mechanism prevents manual movement of the speed brake lever in flight when the flaps are extended 8 degrees or greater. The auto spoiler actuator provides the primary unlocking input and automatic speed brake lever deployment upon main landing gear spin-up. A weight-on-wheels (WOW) unlocking input provides manual speed brake lever movement capability at right main landing gear touchdown, independent of the spin-up input, and prior to lowering the nose. Compression of the nose landing gear strut provides a secondary unlocking input.

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Question 3: The spoiler lever was not armed, when touch ground, the ground spoiler did not deploy, but the ground spoiler actuator was activated (motor sound was recorded). What happening to the ground spoiler actuator?

Boeing Response:
Unless there is a discrepancy in the auto ground spoiler system, the auto spoiler actuator will operate at touchdown whether the spoiler handle is armed or not. If the spoiler handle is armed, a crank that is driven by the actuator will be in line with a bearing in the handle. When the actuator operates, the crank will push against the bearing and move the handle to the ground spoiler position. If the spoiler handle is not armed, the crank will not be in line with the bearing and the handle will remain at the retracted position when the actuator operates. Note that review of the FDR data indicated that the spoilers were deployed on the previous landing and it appears that post-event ground tests on the event airplane indicated that the ground spoiler system was functional.

ASC comment: "The operator claimed they encounter from time to time that the spoiler delayed to extend after on ground and flight crew need to manually deploy the spoiler immediately. We like to know is there any historical records exist."

Boeing response:

It is not known whether this operator comment, reporting an occasional occurrence of ground spoilers failing to properly deploy upon landing, is perceived as a UNI fleet issue or an issue specific to this aircraft (B17917). It is also not clear if the operator's internal investigation of such events indicate an operational problem regarding spoiler arming or a mechanical problem with the spoiler system. A review of recent message traffic with this operator reveals no correspondence reporting such events. Regardless, the operator should report any such event to Boeing Service Engineering for operational or technical awareness and assistance.

The following spoiler related excerpt is taken from the MD-90 FCOM "Landing Roll Procedure" :

"Spoilers: When main gear is on the runway, Pilot Not Flying (PNF) observe spoiler lever moves aft to EXT. PNF call "SPOILERS DEPLOYED". If spoiler lever does not move aft or does not remain in the EXT position, PNF call "NO SPOILERS" and PF move lever aft to full extend position and up to latched position"

As noted in the Landing Analysis, during the event landing, the spoilers were not extended, either automatically or manually via the above FCOM procedure. Regardless of pilot interviews or CVR recordings indicating that the checklist regarding spoiler arming was accomplished, the event data indicate a landing in which the spoilers were "not" armed and therefore did not deploy when the actuator motor activated upon landing. This is supported by the fact that system operated properly on landings preceding the event landing and, to the best of our knowledge, has been operating properly since with no maintenance corrective action taken.

A second procedural failure in not deploying the spoilers manually, per the above FCOM procedure, compounded the problems experienced during this landing.

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附錄四　美國聯邦航空法規第 119.65 及 119.67 條

PART 119—CERTIFICATION: AIR CARRIERS AND COMMERCIAL OPERATORS

Subpart C—Certification, Operations Specifications, and Certain Other Requirements for Operations Conducted Under Part 121 or Part 135 of This Chapter

119.65 Management personnel required for operations conducted under part 121 of this chapter.

(a) Each certificate holder must have sufficient qualified management and technical personnel to ensure the highest degree of safety in its operations. The certificate holder must have qualified personnel serving full-time in the following or equivalent positions:

(1) Director of Safety.

(2) Director of Operations.

(3) Chief Pilot.

(4) Director of Maintenance.

(5) Chief Inspector.

(b) The Administrator may approve positions or numbers of positions other than those listed in paragraph (a) of this section for a particular operation if the certificate holder shows that it can perform the operation with the highest degree of safety under the direction of fewer or different categories of management personnel due to—

(1) The kind of operation involved;

(2) The number and type of airplanes used; and

(3) The area of operations.

(c) The title of the positions required under paragraph (a) of this section or the title and number of equivalent positions approved under paragraph (b) of this section shall be set forth in the certificate holder's operations specifications.

(d) The individuals who serve in the positions required or approved under paragraph (a) or (b) of this section and anyone in a position to exercise control over operations conducted under the operating certificate must—

(1) Be qualified through training, experience, and expertise;

(2) To the extent of their responsibilities, have a full understanding of the following materials with respect to the certificate holder's operation—

(i) Aviation safety standards and safe operating practices;

(ii) 14 CFR Chapter I (Federal Aviation Regulations);

(iii) The certificate holder's operations specifications;

(iv) All appropriate maintenance and airworthiness requirements of this chapter (e.g., parts 1, 21, 23, 25, 43, 45, 47, 65, 91, and 121 of this chapter); and

(v) The manual required by §121.133 of this chapter; and

(3) Discharge their duties to meet applicable legal requirements and to maintain safe operations.

(e) Each certificate holder must:

(1) State in the general policy provisions of the manual required by §121.133 of this chapter, the duties, responsibilities, and authority of personnel required under paragraph (a) of this section;

(2) List in the manual the names and business addresses of the individuals assigned to those positions; and

(3) Notify the certificate-holding district office within 10 days of any change in personnel or any vacancy in any position listed.

119.67 Management personnel: Qualifications for operations conducted under part 121 of this chapter.

(a) To serve as Director of Operations under §119.65(a) a person must—

(1) Hold an airline transport pilot certificate;

(2) Have at least 3 years supervisory or managerial experience within the last 6 years in a position that exercised operational control over any operations conducted with large airplanes under part 121 or part 135 of this chapter, or if the certificate holder uses only small airplanes in its operations, the experience may be obtained in large or small airplanes; and

(3) In the case of a person becoming a Director of Operations—

(i) For the first time ever, have at least 3 years experience, within the past 6 years, as pilot in command of a large airplane operated under part 121 or part 135 of this chapter, if the certificate holder operates large airplanes. If the certificate holder uses only small airplanes in its operation, the experience may be obtained in either large or small airplanes.

(ii) In the case of a person with previous experience as a Director of Operations, have at least 3 years experience as pilot in command of a large airplane operated under part 121 or part 135 of this chapter, if the certificate holder operates large airplanes. If the certificate holder uses only small airplanes in its operation, the experience may be obtained in either large or small airplanes.

(b) To serve as Chief Pilot under §119.65(a) a person must hold an airline transport pilot certificate with appropriate ratings for at least one of the airplanes used in the certificate holder's operation and:

(1) In the case of a person becoming a Chief Pilot for the first time ever, have at least 3 years experience, within the past 6 years, as pilot in command of a large airplane operated under part 121 or part 135 of this chapter, if the certificate holder operates large airplanes. If the certificate holder uses only small airplanes in its operation, the experience may be obtained in

either large or small airplanes.

(2) In the case of a person with previous experience as a Chief Pilot, have at least 3 years experience, as pilot in command of a large airplane operated under part 121 or part 135 of this chapter, if the certificate holder operates large airplanes. If the certificate holder uses only small airplanes in its operation, the experience may be obtained in either large or small airplanes.

(c) To serve as Director of Maintenance under §119.65(a) a person must—

(1) Hold a mechanic certificate with airframe and powerplant ratings;

(2) Have 1 year of experience in a position responsible for returning airplanes to service;

(3) Have at least 1 year of experience in a supervisory capacity under either paragraph (c)(4)(i) or (c)(4)(ii) of this section maintaining the same category and class of airplane as the certificate holder uses; and

(4) Have 3 years experience within the past 6 years in one or a combination of the following—

(i) Maintaining large airplanes with 10 or more passenger seats, including at the time of appointment as Director of Maintenance, experience in maintaining the same category and class of airplane as the certificate holder uses; or

(ii) Repairing airplanes in a certificated airframe repair station that is rated to maintain airplanes in the same category and class of airplane as the certificate holder uses.

(d) To serve as Chief Inspector under §119.65(a) a person must—

(1) Hold a mechanic certificate with both airframe and powerplant ratings, and have held these ratings for at least 3 years;

(2) Have at least 3 years of maintenance experience on different types of large airplanes with 10 or more passenger seats with an air carrier or certificated repair station, 1 year of which must have been as maintenance inspector; and

(3) Have at least 1 year of experience in a supervisory capacity maintaining the same category and class of aircraft as the certificate holder uses.

(e) A certificate holder may request a deviation to employ a person who does not meet the appropriate airman experience, managerial experience, or supervisory experience requirements of this section if the Manager of the Air Transportation Division, AFS–200, or the Manager of the Aircraft Maintenance Division, AFS–300, as appropriate, finds that the person has comparable experience, and can effectively perform the functions associated with the position in accordance with the requirements of this chapter and the procedures outlined in the certificate holder's manual. Grants of deviation under this paragraph may be granted after consideration of the size and scope of the operation and the qualifications of the intended personnel. The Administrator may, at any time, terminate any grant of deviation authority issued under this paragraph.

本頁空白

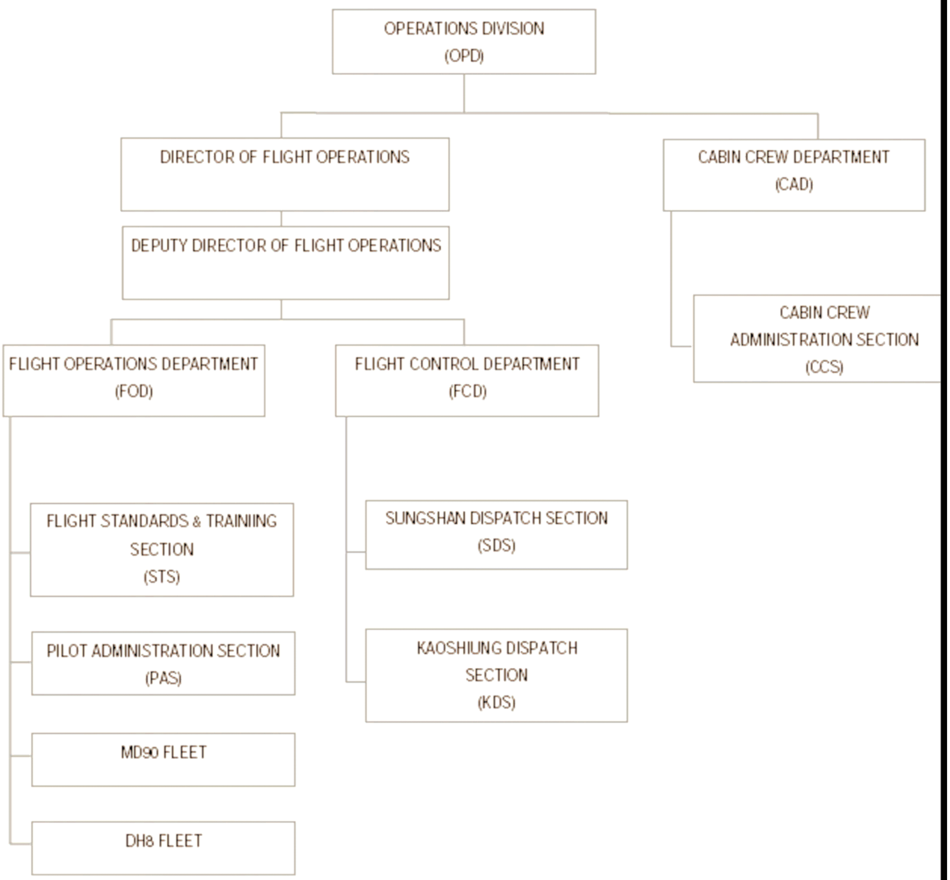
附錄五　航務手冊第三章-工作職掌及職責（Chapter 3 － Duties and Responsibilities）

3. DUTIES AND RESPONSIBILITIES

3.1. FLIGHT OPERATIONS DIVISION

The functions and responsibilities of various departments and personnel within Operations Division are described below.

3.1.1. Organizational Chart



3.2. OPERATIONS DIVISION - MANAGEMENT POSITIONS

3.2.1. Head of Operations Division

The head of Operations Division reports directly to the Company President and is responsible for the direction, coordination and oversight of all divisional plans, policies and programs within the Operations Division. He will ensure:

a. Compliance with the regulatory authorities

b. Adherence to company policies

c. Adherence to company standards

d. Responsible that the safety and quality of operations are maintained

3.2.2. Director of Flight Operations

Reports to the Head of Operations Division. Responsibilities and functions include:

a. Responsible for all aspects of flight operations;

b. Develop plans for the flight operations;

c. Cooperate with Flight Safety Division;

d. Coordinate flight crew issues that directly relate to Operations Division;

e. Formulate and develop divisional plans, policies and programs;

f. Responsible for the interview and selection process for all pilots;

g. Responsible for pilot staffing requirements;

h. Cooperate with agencies that provide services for flight operations;

i. Disseminate information from States, aircraft manufacturers and regulatory agencies;

j. Supervise the maintenance of OPD manuals and documents;

k. Coordinate the introduction of new aircraft type(s);

l. Promote fuel conservation programs;

Minimum qualifications/experience:

a. Thoroughly conversant with the content of the operations manual, operations specifications and all other pertinent regulations and rules that are necessary for the proper performance of this duties; and

b. Holds a CAA airline transport pilot certificate and has had at least three years of experience as PIC of a large aircraft.

3.2.3. Deputy Director of Flight Operations

Report to Director of Flight Operations. Responsibilities and functions include:

a. Act on behalf of the Director of Flight Operations during his absence in the office related duties;

b. Assist the Director of Flight Operations with related duties assigned by the Director of Flight Operations.

Minimum qualifications/experience:

a. Thoroughly conversant with the content of the operations manual, operations specifications and all other pertinent regulations and rules that are necessary for the proper performance of this duties; and

b. Holds a CAA airline transport pilot certificate and has had at least three years of experience as PIC of a large aircraft.

3.2.4. Head of Flight Operations Department

Report to the Head of Operations Division. Responsibilities and functions include:

a. The Company's Operation Policy & Relevant SOP

b. The Standardization of Pilots' Assignments and Checks

c. Planning for Special Operation Procedures

d. Contact the Domestic and Foreign Civil Aviation Authorities

e. Management of Aviation Regulations and Relevant Manuals

f. Aircraft Takeoff, Landing, Weight and Balance Performance Analysis

g. Operations Manuals, Revision and Management

h. New Aircraft, System Evaluation and Study

i. A/C Irregularity Report study and Survey

j. Special Project of Flight Operations

k. Route Data Analysis

l. Aircraft Performance and Deterioration Monitoring

m. Flight Event and Voyage Report Processing

n. Fuel Purchase

o. AB-INITIO Training

p. ADVANCED Training

q. Flight Crewmember training

r. Flight Crew Training manuals and material

s. Evaluation of external Flight Training facilities

t. Training Review Board

u. Training Record Tracking and Filing

v. New training equipment introduction

w. Maintenance and certification of Training Equipment

x. Crew Planning

y. Crew Rostering

z. Pilot Recruitment

aa. Administrative Records

bb. Flight Crew Documents

cc. Accommodation Arrangements

dd. Pilot Administration Manual

3.2.5. Chief Pilot

Responsibilities and functions include:

a. Liaising with regulatory agencies to seek operational approvals on behalf of Operations Division;

b. Ensuring safe and efficient operations of his fleet;

c. Promoting and ensuring standardization within the fleet;

d. Instilling a sense of motivation and discipline to enhance morale in all pilots;

e. Maintain manuals and develop procedures in compliance with regulations;

f. Supervising all check airmen assigned to the fleet;

g. Collating, disseminating and distribution of fleet line operational information;

h. Assisting Pilot Administration Section (PAS) in ensuring that disciplinary standards are maintained and where necessary, assisting with flight crew guidance and counseling;

i. Liaison with other departments and sections within Operations Division (OPD), Flight Safety Division (FSD) and where necessary other departments and sections outside OPD, on matters of safety, operations, technical, etc;

j. Representing the company in meetings with CAA, other regulatory bodies, civic and community groups;

k. Reviewing and ensuring that the fleet flight crew schedule is well maintained and equitably distributed prior to finalization;

l. Participating in the recruitment of pilots for his fleet;

m. Researching and evaluating operational aspects of new equipment and instrument design(s) and upgrade(s) applicable to the fleet and recommending modification(s) if appropriate, and in accordance with company and regulatory agency directives;

n. Coordinating implementation of modification(s) to aircraft equipment and systems;

o. Assisting Flight Control Department (FCD) in all planning aspect of flight operations.

Minimum qualifications/experience:

a. Thoroughly conversant with the content of the operations manual, operations specifications and all other pertinent regulations and rules that are necessary for the proper performance of this duties; and

b. Holds a current airline transport pilot certificate with appropriate rating for at least one of the type of aircraft used and

c. Has had at least 3 years of experience as PIC of a large aircraft.

3.2.6. Deputy Chief Pilot

Responsibilities and functions include:

a. Act on behalf of the Chief Pilot - Fleet during his absence in fleet related duties;

b. Assist the Chief Pilot - Fleet with fleet related duties assigned by the Chief Pilot - fleet.

3.2.7. Standards Check Airman

Report to the Chief Pilot. Responsibilities and functions include:

a. Assist Fleets in developing standard operating procedures;

b. Administration of aviation regulations and related information;

c. Training and certification of all supervisory pilots;

d. Selection and supervision of check airmen;

e. Developing and maintaining Flight Operations Manual;

f. Developing and maintaining Flight Operations Supplementary Manual;

g. Overseeing the development of checking curricula, and to ensure curricula meet CAA minimum requirements;

h. Maintaining a central register for and coordinating the issue of all bulletins and notices, with the exception of FCOM related bulletins, to flight crew;

i. Ensure FCOM information does not contradict company flight operations policies as stated in the FOM;

j. Maintaining harmonization of all OPD Manuals;

k. Ensure that all checks are carried out in accordance with established guidelines and procedures;

l. Ensure that all flight crew in his fleet are checked and operate the aircraft as per SOP;

m. Conduct and administer checks in accordance to the CAA rules and regulations;

n. Report deviations from SOP to the Chief Pilot;

o. Make recommendations for upgrade and supervisory pilot selection;

p. Liaise with other sections, departments and divisions on training, technical and other related matters as directed by the Chief Pilot;

q. Assist Fleet in developing SOP's;

r. Assist Training Supervisor in improving training methods and training aids, provide assistance for developing training programs;

s. Arrange and supervise Check Airman meetings;

t. Act on behalf of the Chief Pilot during his absence in related office duties at delegated by the Chief Pilot.

3.2.8. Training Supervisor

Responsibilities and functions include:

a. Overseeing all pilot training;

b. Supervising the development, implementation and maintenance of all pilot training programs and curricula;

c. Development and maintenance of all training manuals, including FOTM, fleet specific Flight Crew Training Manuals, and all documentation associated with the training and standardization of Company pilots;

d. Ensuring all training programs and checking covers all mandatory requirements for certification and renewal of all certificates and ratings as required by the CAA and follow Company procedures;

e. Ensuring all operational and training standards are maintained and are complied with;

f. Supervising the training of supervisory pilots;

g. Supervising and coordinating the procurement and maintenance of flight simulators and trainers, and other training equipment and aids;

h. Supervising and coordinating all contract training programs, including external training agreements;

i. Supervising a system for monitoring individual crewmember checking and training requirements;

j. Liaising with regulatory agencies on training issues;

k. Participating in or representing the company at meetings with CAA, other regulatory agencies or companies, or symposiums concerning training issues;

l. Flight and simulator training for pilots on his fleet;

m. Development and implementation of fleet training programs;

n. Ensure compliance of all training programs with CAA requirements and other regulatory bodies;

o. Continuous evaluation and assessment of all programs. Initiate updates and changes where necessary;

p. Supervise and develop the content of IP meetings as directed by the Chief Pilot ;

q. Ensure Instructor standardization;

r. Inform the Chief Pilot of sub-standard performance during training;

s. Liaise with other Sections, Department and Divisions on training and related matters;

t. Approve additional and supplemental training;

u. Ensure that all flight and simulator training is carried out in a proper and timely manner;

v. Development of training material;

w. Ensure that fleet simulators operate to the required standard;

x. Make recommendations for IP selection.

y. Act on behalf of the Chief Pilot during his absence in related office duties at delegated by the Chief Pilot.

3.2.9. Duty Pilot

The Duty Pilot function is assigned to the CP, DCP, Standards Check Airman or Training Supervisor for a 24 hour period. His duties include, but are not limited to the following:

a. Be the central individual to be contacted in the event of non normal line operations.

b. When required, communicate with the flight crew and offer suggestions and guidance.

c. Refer specific fleet related matters to the concerned fleet management for their input.

d. When required, provide clarification of Flight Operation Policy and Practices.

e. Attend operational meetings and briefings when necessary.

3.2.10. Head of Flight Control Department

Report to the Director of Flight Operations. Responsibilities and functions include:

a. Flight Dispatch Center

b. Flight Watch

c. Flight Release and Movement Control

d. Emergency Response Center

e. Flight Dispatcher Training

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附錄六 航務手冊第五章-組員資源管理（Chapter 5 - Crew Resource Management , CRM）

CHAPTER 5 - CREW RESOURCE MANAGEMENT (CRM)

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5. CREW RESOURCE MANAGEMENT (CRM)

5.1. CRM PHILOSOPHY

CRM consists of management skills used to effectively direct, control and coordinate all available resources for safe and efficient operations. Six skills are emphasized; threat analysis, decision making, workload management, communication, situational awareness and error management.

These skills improve the performance and job satisfaction of all flight crewmembers. Crews use these skills for the safe and efficient management of available resources - people, equipment, and information. CRM training involves the continuous improvement of attitudes, behaviors and procedures, applying teamwork, human factor concepts, and open communication.

5.2. CRM POLICY

Safe and efficient flight operations are achieved when crewmembers work together as a coordinated team. To achieve this optimum level of performance, all crewmembers shall use the following CRM principles and techniques and apply them in all aspects of flight operations:

a. CRM ability shall be criteria for flight crewmember selection;

b. CRM principles and practices shall be fully integrated into all aspects of flight operations training.

c. Recurring CRM assessments and performance feedback shall be conducted for all pilots, cabin crew and dispatchers in order to ensure effective team skills.

d. All crewmembers shall share the responsibility for establishing an environment of trust and mutual commitment prior to each flight, encouraging fellow crewmembers to speak out and to accept mutual responsibility for the safety of the passengers and equipment.

e. CRM skills and performance of all personnel shall be periodically evaluated to provide regular feedback and to ensure continuous improvement.

5.3. THE SIX CRM SKILLS

5.3.1. Threat analysis

All flights are exposed to threats, some are significant, and others are minor. Crews should identify the major threats and decide how those threats should be managed. When a crewmember recognizes a new threat, he should share that information with the rest of the crew.

5.3.2. Decision Making

- The PIC establishes a proper balance between command authority and crewmember participation in decision making.
- Decisions are made consistent with operating policies, which puts safety before all other considerations.
- The condition of the aircraft and operating environment is regularly assessed to ensure high levels of personal and crew situational awareness.
- Crewmembers anticipate and prepare for contingencies or abnormal situations.
- Crewmembers support the PIC and comply with his final decision unless they have serious concerns that safety will be compromised.

Decision Making Process

A standard mnemonic is used - S A F E - to assist the recall of the steps for effective decision-making.

SAFE means:

S - State the problem;
A - Analyze the options;
F - Fix the problem;
E - Evaluate the result.

It is a tool that gives structure to the decision-making process. A standard process means all flight crewmembers understand the process used and are able to contribute to each stage of the process. Faulty decisions can result if one of these measures was not applied correctly.

5.3.3. Workload Management

- The PIC distributes workload to ensure that time is available to assess and manage all operational situations.
- Priority is assigned to all tasks, delegated as necessary to ensure optimum use of available resources.
- Automated systems are used at appropriate levels.
- PF and PM duties are followed with regard to automated systems.
- Crewmembers verbalize and acknowledge inputs and changes to automated systems.
- Crewmembers recognize and report work overload conditions in self and others.
- In-flight rest and relief is actively planned to ensure crewmember alertness.

5.3.4. Communication

- Standard operating procedures (SOPs) and standard communication protocols are followed to reduce error.
- Thorough, interactive crew briefings are conducted for all operations.
- Crewmembers practice active listening, and use feedback to ensure instructions are understood correctly.
- Crewmembers inquire about operating conditions or plans when unclear.
- Crewmembers assert themselves with appropriate persistence to maintain a safe operation.
- Operational decisions are clearly stated and acknowledged by all crewmembers.
- Crew self-critique is encouraged with continuous improvement as the goal.

5.3.5. Situational Awareness

Situational Awareness (SA) is knowing what is happening around you, past present and future.

The information required for good SA comes from sources such as other crew, ATC, DME, ND, FMC, Radar, forecasts, NOTAMS, etc. Individuals have SA and crews have shared SA. Standard briefings are one tool that is used for increasing situational awareness

5.3.6. Error Management

It is recognized that all people make errors. Although the Company recognizes the inevitability of human error, it does not accept culpability or neglect.

The Error Management strategy has three elements: AVOID, TRAP and RECOVER.

AVOID - Situations which induce error should be avoided. This is achieved by following SOPs, using standard callouts, etc. Workload should be managed to allow time to complete all procedures promptly and without rush.

TRAP - Errors are trapped by routine use of checklists, alerting systems and cross-checking. Crews should be vigilant at all times. If an error occurs, or is anticipated to occur, the detecting crewmember shall state the problem immediately so that the error can be trapped.

RECOVER - If an error has occurred the primary task of the crew is to ensure safe flight; if an undesired aircraft state has also occurred then the flight shall be returned to a safe altitude, speed and configuration before any other action take place.

附錄七　航務手冊第六章-飛航派遣及操作限度（Chapter 6 - Flight dispatch, Operating Minima）

CHAPTER 6 - FLIGHT DISPATCH, OPERATING MINIMA

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6.13. WEATHER MINIMA - DESTINATION AND ALTERNATES

6.13.1. Required Weather Information:

To determine the suitability of an airport as a destination or alternate inflight or for dispatch, TAFOR or METAR reports or a combination of weather reports and forecasts may be used. If no official aviation weather reports are available, then at least one alternate shall be selected for which a TAFOR or METAR is available.

For planning purposes, weather information for the period of 1 hour before to 1 hour after the time of intended operation at that airport shall be considered (the 'period of operation") for destination, departure alternate and destination alternate.

Inflight, weather information at the time of intended landing at that airport shall be considered.

6.13.2. Flight Planning Minima

Available CATII/III approaches at an alternate may be considered if the aircraft type is capable of starting a low visibility approach with one engine inoperative.

6.13.2.1. Destination airport

If the appropriate weather reports and/or forecasts for the destination indicate that during the period of operation, the weather conditions will be below the applicable operational minima (CATII/III included) or no meteorological information is available for destination, then 2 destination alternates will be provided.

NOTE: TEMPO, INTER or PROB30/40 conditions below minima do not require selection of a second alternate airport.
See fuel policy for fuel requirements.

6.13.2.2. Alternate Airport Selection

Departure Alternate Selection

A departure alternate shall be selected if the weather conditions at the departure airport are below the lowest published operational landing minimums (CATII/III excluded) or if it is not possible to return to the departure airport for performance reasons.

Weather conditions at the selected departure alternate shall be at or above the applicable landing minima for the airport (CATII/III excluded).

TEMPO, INTER or PROB30/40 conditions must be taken into account.

Maximum distance from the departure airport to the nominated departure alternate airport:

- 2 engine aircraft: 1 hour flight time.

(The flight time and fuel requirement is based on one engine inoperative cruise speed in still air)

Destination Alternate Airports - Weather Requirements

A destination alternate shall be nominated in the operational flight plan unless the destination is isolated and there is no suitable destination alternate aerodrome.

Minimum weather conditions required for the selection of a destination alternate airport are:

- Minima for filing as alternate in the Jeppesen Airway Manual.

If Jeppesen Airway Manual does not list alternate minima:

- Planning minima - Alternate airport other than departure alternate

A destination alternate airport with a weather forecast with TEMPO, INTER or PROB30/40 condition below alternate minima for the period of operation is acceptable, provided that the alternate and the destination weather forecast are not below the published landing minima for the approach aid in use.

The forecast weather for the geographically isolated destination must be better than alternate planning minima (TEMPO, INTER or PROB30/40 conditions below alternate minima are acceptable, provided the forecast itself indicates weather above published minima for the approach aid in use).

附錄八　航務手冊第七章-標準操作政策（Chapter 7 - Standard Operating Policy）

CHAPTER 7 - STANDARD OPERATING POLICY

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7.10. APPROACH

7.10.1. General

When ATC issues a clearance to conduct an instrument approach, the published instrument approach procedure shall be followed, unless varied by ATC.

The applicable instrument approach chart shall be available for reference throughout the approach.

Whenever there is a NOTAM that an instrument approach is 'Not flight checked' or 'Unmonitored', the approach shall not be used in IMC conditions or at night. The instrument approach shall not be considered to determine minima for filing as alternate.

7.10.2. Use of the Autoflight System for Approach

The autoflight system should be used, when available, whenever the reported ceiling is less than 1,000 feet AAL or the visibility is less than 3,000 meters. The autopilot should remain engaged until the approach and landing can be continued visually.

7.10.3. Autoland

An autoland may be done at any runway equipped with an ILS unless the localizer is offset or unless precluded by information in a NOTAM or in the FOSM.

When conducting an automatic landing, the CM1 and CM2 duties for a low visibility approach shall be followed regardless of the visibility.

When conducting auto-pilot coupled approaches in weather below CAT I minimum. CM1 must assume PF duties prior to starting the final approach.

NOTE: The AFM certified autoland crosswind limitation shall be applied when the reported RVR/visibility is above CAT I.

7.10.4. Initial Approach Altitude

When operating on an unpublished route, or while being radar vectored, and an approach clearance is received, in addition to complying with the minimum altitude for IFR operations, the aircraft shall maintain the last assigned altitude unless a different altitude is assigned by ATC, until the aircraft is established on a segment of a published route or instrument approach procedure.

Once cleared for an instrument approach, further descent may be started in compliance with any altitude restrictions for the approach.

7.10.5. Navigation Aids

Flight crewmembers shall ensure that all appropriate navigation aids are identified prior to the start of an instrument approach.

7.10.6. Non-Precision Approaches

Continuous descent is the preferred method. The step-down method should only be used if it is not possible to use the continuous descent technique due to unique characteristics of the approach or due to FMC or instrument failure.

Continuous descent:

A continuous descent with a rate of descent adjusted to achieve a constant descent gradient to a point 50 ft above the threshold, with due regard for the minimum crossing altitudes specified for the FAF and any prescribed step-down fix. Approaching MDA, if the required visual reference is not achieved, or if the MAP is reached before reaching the MDA, a missed approach shall be initiated.

Stepdown:

The aircraft descends immediately to not below the minimum step-down fix altitude or MDA as appropriate. A missed approach is initiated at or before the MAP.

Non-precision approach procedures using ground based navigation aids:

During NDB approach, unless the ADF has another means to indicate a failure, the NDB aural identification shall be continuously monitored.

Raw data shall be monitored and followed throughout the approach.

If FMC derived information is to be used during the approach (flight modes LNAV/VNAV), the following conditions shall be met:

a. FMC receives position updates from GPS or suitable ground based navigation aids. There shall be no discernible map shift.

b. The approach profile is derived from a FMC database approach or has been constructed by use of existing database approach waypoints only.

Where the database does not contain a particular non-precision approach, another suitable approach in the database (ILS) may be used. Modification of an ILS approach procedure by changing the final approach point (FAP) crossing altitude and threshold crossing height (TCH) is acceptable.

7.10.7. Visual Approach

Flight crew may accept or request a visual approach if:

a. Meteorological conditions are not less than 1,500 feet ceiling and 5 kilometers visibility.

b. ATC has advised the flight crew of relevant traffic. The traffic has been identified by the crew and can be kept in sight and separation is assured.

Using an available instrument approach aid during a visual approach is encouraged.

7.10.8. Circling Approach

After establishing visual contact for circling, the runway environment (i.e. the runway threshold or approach lights, or other marking identifiable with the runway) shall remain in sight.

In the event of a missed approach, the missed approach specified for the initial instrument approach procedure shall be followed. However, once the 'circling' segment has commenced, the go-around shall be a climbing turn in the direction of the circling approach and towards the runway. This should position the aircraft overhead the aerodrome to then establish on the published missed approach track.

For runways where there is a specified missed approach procedure in case of an discontinued circling approach, that specified procedure must be followed.

7.10.9. Side Step Approach

Side step approaches may be done if the adjacent parallel runways are separated by 350 meters or less. This authorization requires a visual sidestep maneuver for runway alignment.

Pilots are expected to commence the sidestep maneuver as soon as possible after the runway or runway environment is in sight.

7.10.10. Contact Approach

Contact approaches are not permitted.

7.10.11. No Instrument Approach Procedure Chart Available

If there is a need to make an instrument approach when no approach procedure diagram is available, ATC shall be advised. ATC should then issue an appropriate clearance that shall include detailed information regarding the completion of the approach.

Necessary information should include:

a. Airport elevation.

b. Initial approach to facility including:
   - Course and distance.
   - Minimum altitude.

c. Procedure turn including:
   - Orientation of turn to final approach course.
   - Outbound/inbound course.
   - Altitude restriction.
   - Limit of procedure turn.

d. Minimum altitudes over fixes.

e. Course and distances from fixes to threshold.

f. Landing minima (DA, MDA and RVR, as applicable).

g. Missed approach flight path and altitude.

7.10.12. Go-Around

During an approach, a Go Around or Missed Approach must be considered:

- If there is a loss or a doubt about situation awareness.
- If there is a malfunction which jeopardizes the safe completion of the approach.
- If the ATC changes the final approach clearance resulting in rushed reaction from the crew or potentially unstable approach.
- If the approach is unstable, in such a way that most probably it won't be stable by 1000ft AGL.
- If required visual reference are not obtained at DA(H)/MDA(H) or maintained before touchdown
- If visual reference can not be maintained during visual approach.

- If any GPWS / TCAS or windshear alert occurs.

When executing a go-around after being cleared for an instrument approach, the published missed approach procedure for the instrument approach shall be followed, unless directed otherwise by ATC.

When executing a go-around after being cleared for a visual approach, State procedures shall be followed, unless directed otherwise by ATC.

No attempt shall be made to re-establish on the original approach.

Before accepting subsequent approaches, the traffic situation, weather, time available for holding, and any inherent risk when diverting to the alternate airport shall be evaluated.

7.11. LANDING

Landing performance according to actual conditions shall be considered before every landing.

The auto-brake shall be used whenever the system is available.

7.11.1. Landing Check

All checklists should be completed before leaving 1,000 feet AAL, or circling altitude when flying a circling approach.

7.11.2. Landing Clearance

All flight crew shall ensure that a landing clearance is received prior to landing.

Both CM1 and CM2 shall continue to monitor tower frequency until clear of the active runway or as specified by ATC.

7.11.3. Vacating Runways

After landing, unless otherwise instructed the aircraft shall clear the active runway as soon as possible.

No switch or lever shall be repositioned after landing until clear of the active runway, unless necessary for the safe control of the aircraft.

7.11.4. Land and Hold Short Operations (LAHSO)

Crewmembers shall not accept a clearance to 'Land and hold short'. However, there are no restrictions to takeoff and landing while LAHSO are in progress on crossing runways.

7.12. PARKING

The aircraft shall not be taxied into a parking position without a guidance system or a marshaller.

When a parking guidance system is suitable for viewing from the CM1 seat only, the aircraft shall be taxied into the parking position by CM1 only.

If there is any doubt about adequate wing tip or engine clearance, or if objects are situated in the parking area, the aircraft shall be stopped until ground crew have removed all of the objects from the parking area.

Before releasing the parking brake, CM1 shall verify that all engines are shutdown and confirmation has been received from the ground engineer that wheel chocks are in place.

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附錄九　航務手冊第八章-不良天候之操作（Chapter 8 -Adverse weather Operations）

CHAPTER 8 - ADVERSE WEATHER OPERATIONS

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8. ADVERSE WEATHER OPERATIONS

8.1. GENERAL

Aircraft operations in adverse weather conditions present additional problems due to the effects of extreme temperatures, slippery runways with crosswind, contaminated runways, extreme turbulence, and windshear. The following instructions are intended to supplement the normal operating procedures. Refer to the applicable FCOM for specific operating procedures.

Additional attention to detail is required by all crewmembers prior to encountering areas of suspected or actual adverse weather conditions. This includes:

a. The PIC must brief crewmembers for specific adverse conditions either existing or forecast to exist.

b. In deciding which flight crewmember may conduct either the take-off or landing, the PIC must consider:
   - relevant limitations as specified in the airplane flight manual, aircraft operating manual or flight crew operating manual;
   - all aspects of the adverse conditions, including weather trends;
   - the other flight crewmember's flying experience;
   - geographical considerations including runway length and conditions, etc.
   - delaying the approach or departure.

8.2. HOT WEATHER OPERATIONS

During extended ground operations prior to flight deck preparations, consideration should be given to reducing thermal emissions from equipment, displays, lights, etc.

All available air-conditioning packs should be switched on and all overhead outlets, including those in the cabin, should be open. Window shades on the sun-exposed side of the aircraft should be closed.

8.3. THUNDERSTORM AVOIDANCE AND USE OF WEATHER RADAR

8.3.1. General

Weather radar must be used for all flights in IMC or at night.

When on the ground and departing into an area where thunderstorms have been reported, it will be necessary to use the weather radar to scan the intended flight path.

The use of the antenna 'tilt' function will assist in assessing the vertical dimensions of the thunderstorm.

The use of range and gain controls should be in accordance with the recommended procedures in the relevant weather radar user's guide so as to provide information beneficial to the flight crew.

8.3.2. Before Takeoff

To avoid wind reversal and downdrafts, use extreme caution, if, in the opinion of the PIC, an active thunderstorm is approaching and will be within 6 kilometres (3 nautical miles) of the position of the aircraft directly after take-off. Weather radar should be used before take-off.

8.3.3. After Takeoff

If a clear flight path is not available on the allotted departure track, hold the aircraft clear of thunderstorms until the allotted departure track is clear or an alternative track is allotted by ATC. Early advice and requests to ATC may facilitate this procedure.

8.3.4. Cruise

Thunderstorms must be avoided. It is recommended that the minimum downwind distance to avoid a thunderstorm is 20 nautical miles.

8.3.5. Descent and Approach to Land

Fly the aircraft clear of thunderstorms either by holding or adopting an alternative approach track. The circuit and approach to land should be not closer than 6 kilometres (3 nautical miles) to an approaching storm at any time.

NOTE: During take-off and landing, storms that have passed may be approached closer than 6 kilometres (3 nautical miles), as the rear of the storm is comparatively inactive.

8.5. WINDSHEAR

8.5.1. General

Windshear, downdrafts and microbursts present a major threat to the safe operations of aircraft. It is recognized that these phenomena are sometimes so severe that they cannot be handled with the performance capability of the aircraft, even using optimum pilot response.

Therefore it must be the primary goal of the flight crewmembers to avoid severe windshear, downdrafts and microbursts.

8.5.2. Automatic Windshear Detection

On aircraft fitted with windshear detection equipment, all aural and visual windshear warnings and advisories must be responded to unless the PIC is satisfied that conditions conducive to the formation of windshear do not exist.

8.6. FLIGHT THROUGH HEAVY RAIN OR HAIL

During flight through heavy rain or hail, it is possible that there may be fluctuations in engine parameters including noticeable drop in EGT. There is an increased probability of engine flame-out.

Use the recommended procedures in FCOM, as appropriate, when encountering heavy rain and/or hail.

If hail has been encountered during flight, a Flight and Maintenance Log entry must be made.

8.11. LANDING ON WET, ICY OR SLIPPERY RUNWAYS

8.11.1. General

Consider the use of maximum flaps and a higher autobrake setting.

8.12. MINIMUM ALTITUDE CORRECTIONS IN LOW TEMPERATURES

8.12.1. General

WARNING: Extreme caution should be exercised when flying in proximity to obstructions or terrain in low ambient temperatures.

Pressure altimeters are calibrated to indicate true altitude under ISA conditions. When operating in cold temperatures or temperatures less than as in ISA, the true altitude of the aircraft will be lower than indicated on the altimeter.

8.12.2. Temperature/Altitude Correction

In conditions of cold weather, the values derived from the altitude correction chart must be added to any published instrument approach procedure, including minimum sector altitudes, acceleration altitude, minimum altitudes for a turn specified in a SID or missed approach and altitudes specified in engine-inoperative procedures to ensure adequate obstacle clearance.

If the crew elects to level off at an altitude other than that assigned or stated on the approach chart because of terrain clearence concerns, ATC clearence must be obtained. Whilst being radar vectored, ATC assigned altitudes are temperature compensated and require no corrective action by the flight crew.

See Altitude Correction chart in FOSM chapter 6 or Jeppesen Airway Manual.

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附錄十　MD-90 型機飛航組員操作手冊（Flight Crew Operations Manual, FCOM）NP.70.4~9

Before Landing

The V_{APP} will be the greatest of:

1. V_{REF} +5 knots.
2. V_{REF} +1/2 of the steady state wind greater than 20 knots. Maximum correction is 20 knots.
3. V_{REF} + gust factor:
   - With autothrottle on, correction is actual gust factor - 5 knots. Maximum correction is 15 knots.
   - With manual throttles, correction is actual gust factor. Maximum correction is 20 knots.
4. For landing in tailwind, always use V_{REF} +5 knots.

PF/PM **Cabin signal** . . . . **Receive**

PM **Cabin** . . . . **Alert**

– Three to five minutes before landing, PM cycles the SEAT BELTS Switch to give two chimes.

(CONTINUED)

Before Landing (Continued)

When required, configure aircraft as follows:

PF	PM
- Command "SLATS EXTEND".	Verify speed, - Respond "SLATS EXTEND" and move the FLAP/SLAT Handle to 0/EXT position. Verify Slats Advisory Light T/O is illuminated.
- Command "FLAPS ELEVEN".	Verify speed, - Respond "FLAPS ELEVEN" and move the FLAP/SLAT Handle to 11 position. Monitor flaps extend to 11 on the FLAPS Position Indicator. *NOTE: Minimum maneuvering speed for Flaps/Slats 11/T.O. is as for Flaps/Slats 15/T.O. + 5 knots.*
- Command "FLAPS FIFTEEN".	Verify speed, - Respond "FLAPS FIFTEEN" and move the FLAP/SLAT Handle to 15 position. Monitor flaps extend to 15 on the FLAPS Position Indicator.

(CONTINUED)

Before Landing (Continued)

PF	PM
- Command "GEAR DOWN".	Verify speed, - Respond "GEAR DOWN" and select GEAR Handle DOWN.
CM1: Verify Gear Lights indicate 3 greens, then raise SPD BRK Lever to ARM position. Select AUTO BRAKE (if equipped) to required setting and ARM. ***WARNING:* DO NOT ARM SPD BRK LEVER UNTIL LANDING GEAR HAS BEEN EXTENDED. THIS WILL PRECLUDE POSSIBLE INFLIGHT DEPLOYMENT DUE TO ERRANT GROUND SHIFT SIGNAL.**	
- Command "FLAPS __, LANDING CHECK".	Verify speed, - Respond "FLAPS __" and move the FLAP/SLAT Handle to __ position. Monitor flaps extend to __ on the FLAPS Position Indicator and verify Slats Advisory Light LAND is illuminated. Complete the Landing Check.

【END】

LANDING CHECK		
PM	CABIN.	ALERT
PF	LANDING GEAR.	DOWN, THREE GREENS
1	SPOILERS, AUTOBRAKE.	ARM, __
	(SPOILERS.	ARM, NO AUTOBRAKE)
PF	FLAPS, SLATS.	__, LAND

(CONTINUED)

Before Landing (Continued)

PF	PM
AUTOCALL "TWENTY-FIVE HUNDRED"	
- Call "CHECK"	- Call "CHECK"
***WARNING**: Check that the terrain clearance is not less than anticipated and respond "CHECK", if found satisfactory. If not satisfactory, or if in doubt, corrective action must be taken immediately.*	

ILS Approach CAT- I

PF	PM
WHEN ON AN INTERCEPT HEADING	
AUTOPILOT ENGAGED	
- Call "ARM ILS". Push ILS Button on FGCP.	Verify ILS in FMA Arm Window.
AUTOPILOT DISENGAGED	
-Command "ARM ILS".	- Respond "ARM ILS". Push ILS Button on FGCP. Verify ILS in FMA Arm Window
LOCALIZER MOVEMENT	
	- Call "LOCALIZER ALIVE".
LOCALIZER CAPTURE	
Verify **LOC CAP** followed by **LOC TRK** in FMA Roll Window.	
Set runway heading in the FGCP HDG Readout. Set Bank Limit Selector to 15 deg.	

(CONTINUED)

Before Landing (Continued)

ILS Approach CAT- I (Continued)

PF	PM
GLIDESLOPE MOVEMENT	
	- Call "GLIDESLOPE ALIVE".
GLIDESLOPE CAPTURE	
Verify **G/S CAP** followed by **G/S TRK** in FMA Pitch Window.	
Set missed approach altitude in the FGCP ALT Preselect Readout.	
PASSING FAF/FAP OR OUTER MARKER (AS APPLICABLE)	
- Respond "CHECK".	- Call "FINAL FIX / FINAL APPROACH POINT / OUTER MARKER __" (chart altitude).
Both flight crews will cross reference barometric altitude with charted altitude. If there is any undue discrepancy, suspect the QNH setting. If the difference is large and coupled with a high sink rate, suspect false glideslope capture.	
AUTOCALL "ONE THOUSAND"	
Crosscheck charted minima with Altitude Reference Index on the Altimeter. - Respond "CHECK".	Crosscheck charted minima with Altitude Reference Index on the Altimeter. - Call "DA __".
At 1000 feet RA, when PF has visual reference and is confident that visual contact can be maintained through to landing, then he may call "RUNWAY IN SIGHT". Thereafter, only the 500 feet callout by PM and response by PF are required.	

(CONTINUED)

Before Landing (Continued)

ILS Approach CAT- I (Continued)

PF	PM
AUTOCALL "FIVE HUNDRED"	
- Respond "CHECK".	If approach is stable, - Call "STABLE".
AT 100 FEET ABOVE MINIMUMS	
	-Call "APPROACHING MINIMUM"
AUTOPILOT ENGAGED	
Look outside for visual reference. When visual reference is established, - Call "RUNWAY / APPROACH LIGHTS IN SIGHT".	Continue monitor approach performance with reference to flight and engine instruments.
AT MINIMUMS	
- Call "LANDING", or - Call "GO AROUND- FLAPS FIFTEEN".	-Call "MINIMUM"
AUTOPILOT DISENGAGED	
Monitor approach performance with reference to flight and engine instruments.	Look outside for visual reference. When visual reference is established, - Call "RUNWAY / APPROACH LIGHTS IN SIGHT, AHEAD / RIGHT / LEFT".
AT MINIMUMS	
- Call "MINIMUM, LANDING" or - Call "MINIMUM, GO AROUND- FLAPS FIFTEEN".	

【END】

附錄十一　MD-90 型機飛航組員操作手冊（Flight Crew Operations Manual, FCOM）NP.80.1~3

Landing

PF	PM
AUTOCALL "FIFTY"	
Ensure throttles retard toward idle. If autothrottles are not engaged, manually retard throttles to idle. Touch down within the touchdown zone. After main gear touchdown, raise reverse thrust levers to interlock, and fly nosewheel onto runway.	Ensure throttles retard toward idle.
	Verify that spoilers deploy normally, - Call "SPOILER UP". If spoilers fail to deploy normally, - Call "NO SPOILER".
CM1: If spoilers do not deploy fully and automatically, deploy spoilers manually by moving Spoiler Handle to EXT (Aft) position. NOTE: *For automatic deployment of inboard spoilers, throttles must be at idle. If throttles are above idle at touchdown, all spoilers may deploy and then retract and ABS will disarm.*	
Select reverse thrust as required.	Monitor reverse indication. - Call "NO REVERSE" or "LEFT ONLY", "RIGHT ONLY" if required
WARNING*: *After reverse thrust is initiated, a full stop landing must be made.	
NOTE: *When reverse levers are pulled through the aft detent, Emergency Reverse is activated. It should only be used when stopping on the runway is anticipated not to be possible by normal means. The system will enter the "N1 MODE" and the "ENG SYSTEM FAILED" message will be displayed. A Flight Log entry must be made as engine inspection is required.*	

(CONTINUED)

Landing (Continued)

PF	PM
If using manual braking, - call "MANUAL BRAKING".	If ABS Disarm Light illuminates without "MANUAL BRAKING" call from PF, - Call "AUTOBRAKE DISARMED". Monitor landing roll and deceleration.
AT 80 KIAS	
If a safe stop is assured, reduce reverse thrust to reach idle reverse by 60 KIAS.	- Call "EIGHTY".
AT 60 KIAS	
Thrust should normally be at idle reverse at 60 KIAS. Cancel reverse thrust approaching taxi speed.	- Call "SIXTY".
CAUTION: Thrust levels above idle reverse may be used below 80 knots in an emergency, but may cause engine damage due to fan blade stress or FOD ingestion. ***Autobrake should be disarmed before reaching 10 knots ground speed to avoid abrupt stop due to antiskid cutout below 10 knots.***	

【END】

After Landing

CM1	CM2
WHEN CLEAR OF ALL ACTIVE RUNWAYS AND TAXI CLEARANCE RECEIVED	
	Write down taxi instructions
Retract SPOILERS and, - Call "FLAPS FIFTEEN".	
	Set flaps to 15/T.O. and carry out After Landing Procedure.

Engines cool down recommendations:

- run the engines for at least 3 minutes.

- use a thrust setting normally used for taxi operation.

1 SPD BRK Lever . . . . Retract

2 AUTO BRAKE . . . . OFF

2 FLAPS, SLATS . . . . 15/T.O.

2 Weather RADAR . . . . OFF

2 METER SEL & HEAT Selector. . . . . OFF

2 ANTI-ICE . . . . As required

2 HYD PUMPS AUX Switch . . . . OFF

2 TCAS/Transponder Function Selector . . . . XPDR

2 APU . . . . As required

– Delay APU start for as long as practical.

CAUTION: After APU PWR AVAIL Light illuminats:
Select Indicator Selector to "BATT VOLT" and make sure battery voltage indication is in +26v~+28v (To the right). If the battery voltage indication still remains at a steady +20v (To the right), this could be an indication that the APU Starter Relay is stuck in close position. Shut down APU and call maintenance immediately.

【END】

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附錄十二　MD-90 型機飛航組員訓練手冊（Flight Crew Training Manual, FCTM）Chapter 6.2

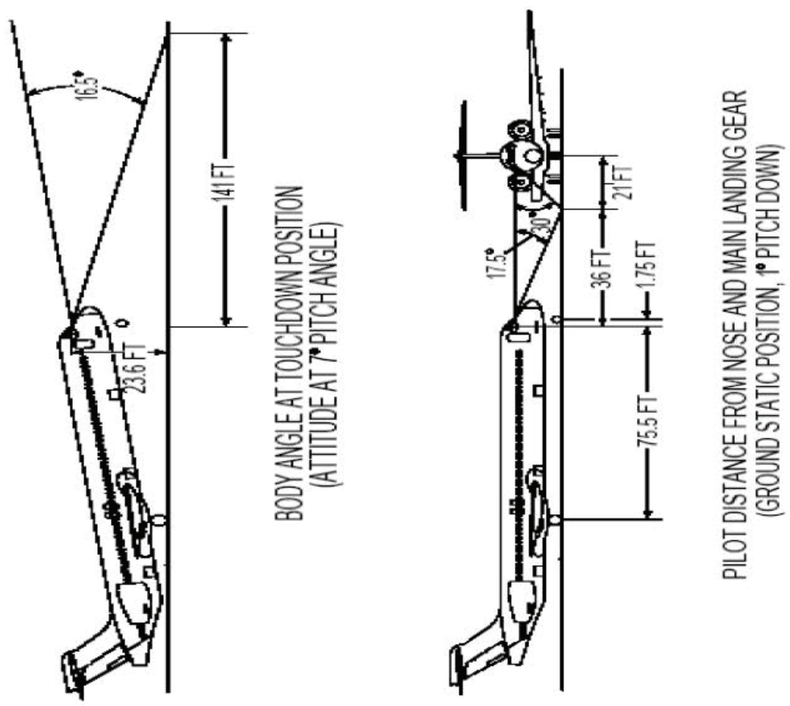
6.2. LANDING TECHNIQUE

Visual Aim Point

During visual approaches many techniques and methods are used to ensure main landing gear touchdown at the desired point on the runway. One of the most common methods used is to aim at the desired gear touchdown point on the runway, then adjust the final approach glide path until the selected point appears stationary in relation to the aircraft (the point does not move up or down in the pilot's field of view during the approach).

Flare distance accounts for the small difference in paths. Gear touchdown occurs very near the visual aim point. However, in today's jet aircraft, the difference in gear path and eye-level path has increased because of the longer wheelbase and the increased flight deck height. Consequently, the main gear do not touchdown on the runway at the selected visual aim point.

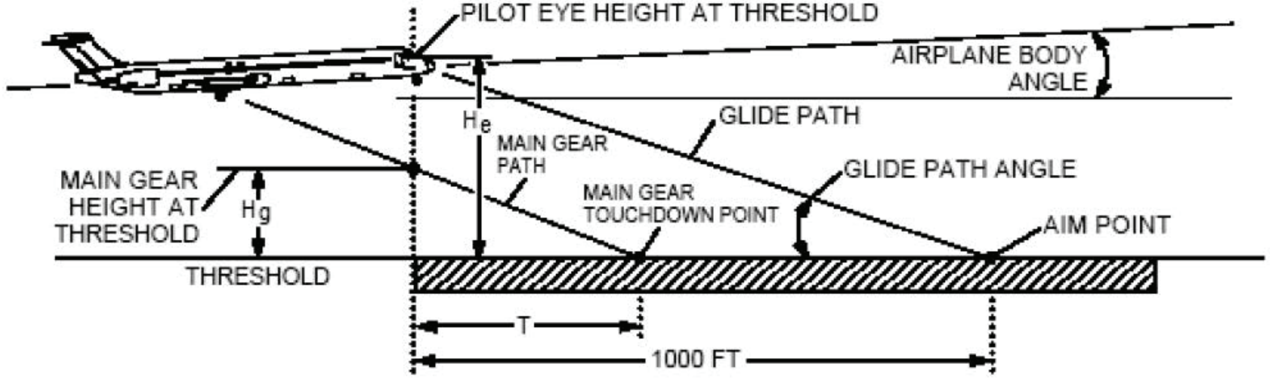
Visual aim points versus gear touchdown point differences increase as glide path angle decreases in a flat approach. For a particular visual approach, the pilot must account for the difference between gear path and eye level path.



Flaps 28 (1.3 Vs) Visual Approach

VISUAL APPROACH

ESTIMATED TOUCHDOWN POINT (NO FLARE) ASSUMING AN AIM POINT OF 1000 FT.

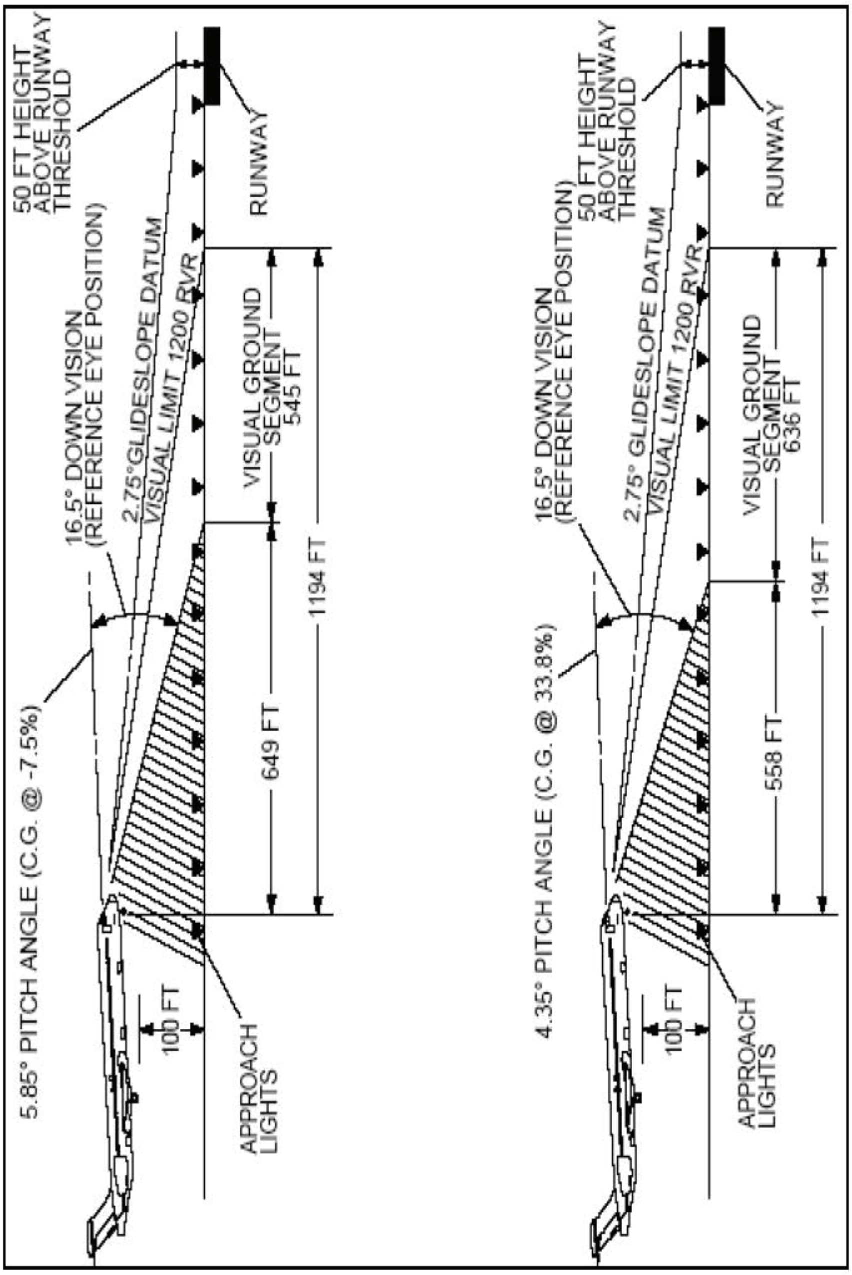


GLIDE PATH ANGLE (DEGREES)	ESTIMATED BODY ANGLE (DEGREES)		PILOT EYE HEIGHT H_e AT THRESHOLD (FEET)	MAIN GEAR HEIGHT H_g AT THRESHOLD (FEET)		MAIN GEAR TOUCH-DOWN POINT, T (FEET)	
	①	②		①	②	①	②
2.5	6.1	4.6	44	21	23	490	534
2.75	5.85	4.35	48	26	28	543	583
3.0	5.6	4.1	52	31	33	587	624

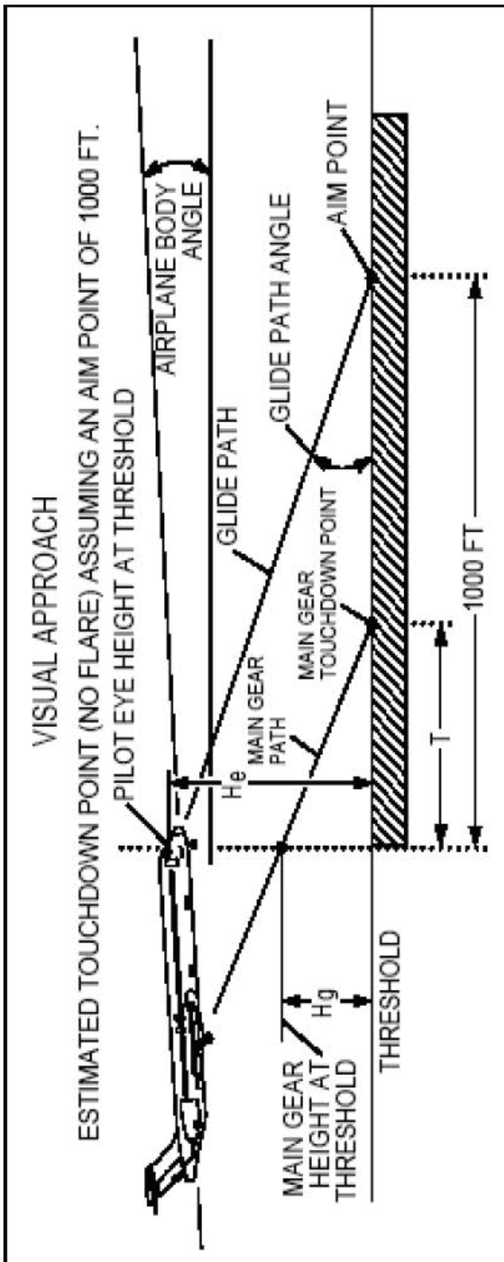
① C.G. @ -7.5% MAC　② C.G. @ 33.8% MAC

FOR MD-90 AIRPLANES

Visual Ground Segments (Flaps 28)



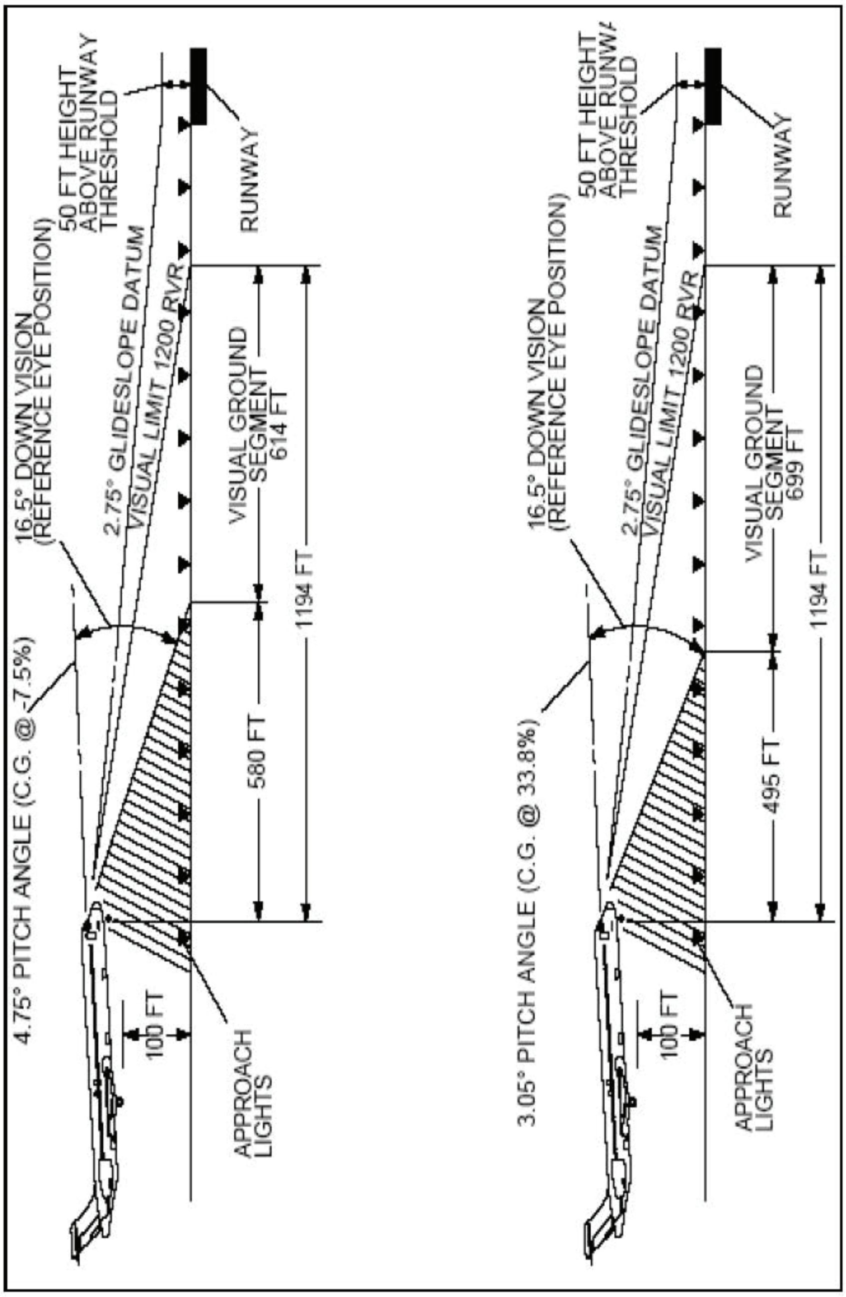
Flaps 40 (1.3 VS) Visual Approach



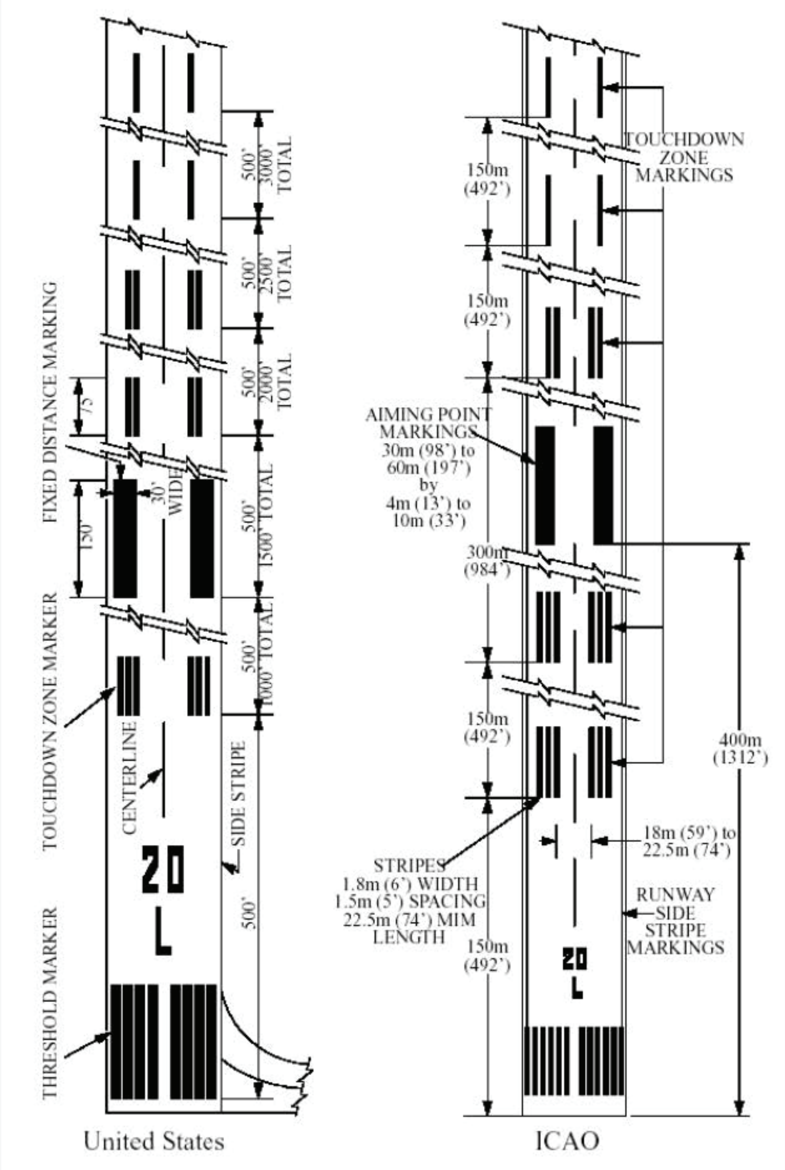
GLIDE PATH ANGLE (DEGREES)	ESTIMATED BODY ANGLE (DEGREES) ①	②	PILOT EYE HEIGHT H_e AT THRESHOLD (FEET)	MAIN GEAR HEIGHT H_g AT THRESHOLD (FEET) ①	②	MAIN GEAR TOUCH-DOWN POINT, T (FEET) ①	②
2.5	5.0	3.3	44	23	25	522	572
2.75	4.75	3.05	48	27	30	572	618
3.0	4.5	2.8	52	32	34	614	656

① C.G. @ -7.5% MAC ② C.G. @ 33.8% MAC FOR MD-90 AIRPLANES

Visual Ground Segments (Flaps 40)



Landing Runway Marking (Typical)



Threshold Height

Threshold height is a function of glide path angle and landing gear touchdown target. Special attention must be given to establishing a final approach that assures safe threshold clearance and gear touchdown at least 1,000 feet down the runway. Standardized callouts assist pilots in determining a proper profile.

Flare and Touchdown

The techniques discussed in this section are applicable to all landings including crosswind landings and slippery runway conditions. Unless an unexpected or sudden event occurs, such as windshear or collision avoidance situation, it is not appropriate to use sudden, violent or abrupt control inputs during landing. Begin with a stabilized approach on speed, in trim, and on glide path.

When the threshold passes under the aircraft nose and becomes out of sight, shift the visual sighting point to the far end of the runway. Shifting the visual sighting point assists in controlling the pitch attitude during the flare. Maintaining a constant airspeed and descent rate assists in determining the flare point. Initiate the flare when the main gear is approximately 20-30 feet above the runway by increasing pitch attitude approximately 2° - 3°. This slows the rate of descent.

After the flare is initiated, allow the autothrottle to smoothly retard the thrust levers to idle, and make small pitch attitude adjustments to maintain the desired descent rate to the runway.

Ideally, main gear touchdown should occur simultaneously with thrust levers reaching idle. A smooth power reduction to idle also assists in controlling the natural nose-down pitch change associated with thrust reduction. Hold sufficient back pressure on the control column to keep the pitch attitude constant. A touchdown attitude as depicted in the figure above is normal with airspeed of approximately VREF plus any gust correction.

NOTE: Do not trim during the flare or after touchdown. Trimming in the flare increases the possibility of a tailstrike.

Landing Flare Profile

Typically, the pitch attitude increases slightly during the actual landing. Do not over-rotate. Do not increase the pitch attitude after touchdown; this could lead to a tailstrike.

Shifting the visual sighting point down the runway assists in controlling the pitch attitude during the flare. A smooth power reduction to idle also assists in controlling the natural nose down pitch change associated with thrust reduction. Hold sufficient back pressure on the control column to keep the pitch attitude constant.

Avoid rapid control column movements during the flare. Do not use the pitch trim during flare or after touchdown. Such actions are likely to cause the pitch attitude to increase at touchdown and increase the potential for a tailstrike. Do not allow the aircraft to float; fly the airplane onto the runway. Do not attempt to extend the flare by increasing pitch attitude in an attempt to achieve a perfectly smooth touchdown. Do not attempt to hold the nose wheel off the runway.

Bounced Landing Recovery

If the aircraft bounces after touchdown, hold or re-establish a normal landing attitude and add thrust as necessary to control the rate of descent. Thrust need not be added for a shallow bounce or skip.

When a high, hard bounce occurs, initiate a go-around. Apply go-around thrust and use normal go-around procedures. Do not retract the landing gear until a positive rate of climb is established for a second touchdown may occur during the go-around.

Bounced landings can occur because higher than idle power is maintained through initial touchdown, disabling the automatic speedbrake deployment even though the speedbrakes are armed.

Normal Touchdown Attitude

(To be determined)

Body Clearance at Touchdown

(To be determined)

Pitch and Roll Conditions

Prolonged flare increases the body pitch attitude. If prolonged flare is coupled with a misjudged height above the runway, aft body contact is possible.

Fly the aircraft onto the runway at the desired touchdown point and at the desired airspeed. Do not hold it off and risk the possibility of a tailstrike.

> *NOTE: A smooth touchdown is not the criterion for a safe landing.*

After Touchdown and Landing Roll

Avoid touching down with thrust above idle since this may create an aircraft nose up pitch tendency and increase landing roll.

> *NOTE: For automatic deployment of spoilers, speedbrake lever must be the in the ARM (up) position, and thrust levers must be at idle. If thrust levers are above idle at touchdown, all spoilers may deploy and then retract, and causing autobrakes (if installed) to disarm.*

After main gear touchdown, initiate the landing roll procedure. If the speedbrakes do not extend automatically, move the speedbrake lever to the EXT (aft) position without delay. Fly the nose wheel onto the runway smoothly by relaxing aft control column pressure. Control column movement forward of neutral will not be required. Do not attempt to hold the nose wheel off the runway. Holding the nose up after touchdown for aerodynamic braking is not an effective braking technique.

> ***CAUTION: Pitch rates sufficient to cause aircraft structural damage can occur if large nose down control column movement is made prior to nose wheel touchdown.***

To prevent the risk of tailstrike, do not allow the pitch attitude to increase after touchdown. However, applying excessive nose down elevator during landing can result in substantial forward fuselage damage. Do not use full down elevator. Use an appropriate autobrakes setting or manually apply wheel brakes smoothly with steadily increasing pedal pressure for runway condition and runway length available. Maintain deceleration rate with constant or increasing brake pressure, as required, until aircraft is stopped or desired taxi speed is reached.

Spoiler / Speedbrake

The spoiler/speedbrake system is controlled with the speedbrake lever. The spoiler/speedbrake system consists of individual spoiler panels which the pilot can extend and retract by moving the SPD BRK lever.

The spoiler/speedbrakes can be fully raised after touchdown while the nose wheel is lowered to the runway, with no adverse pitch effects. The speedbrakes spoil the lift from the wings, which places the aircraft weight on the main landing gear, providing excellent braking effectiveness.

Unless spoiler/speedbrakes are raised after touchdown, braking effectiveness may be reduced substantially, since very little weight is on the wheels and brake application may cause rapid anti-skid modulation. Normally, spoiler/speedbrakes are armed to extend automatically. Both pilots will monitor spoiler/speedbrake extension after touchdown. In the event auto extension fails, the spoiler/speedbrake will be manually extended immediately.

Pilot awareness of the position of the speedbrake lever during the landing phase is important in the prevention of runway over-run. The position of the spoiler/speedbrakes will be announced during the landing phase by the PM. This improves the crew's situational awareness of the position of the spoilers during landing and builds good habit patterns, which can prevent failure to observe a malfunctioned or disarmed spoiler system.

Directional Control and Braking after Touchdown

If the nose wheel is not promptly lowered to the runway, braking and steering capability are significantly degraded and no drag benefit is gained. Rudder control is effective to approximately 60 knots. Rudder pedal steering is sufficient for maintaining directional control during the rollout. Do not use the nose wheel steering tiller until reaching taxi speed. In a crosswind, displace the control wheel into the wind to maintain wings level will aid directional control. Perform the landing roll procedure immediately after touchdown. Any delay markedly increases the stopping distance.

Stopping distance varies with wind conditions and any deviation from recommended approach speeds.

Wheel Brakes

Braking force is proportional to the force of the tires on the runway and the coefficient of friction between the tires and the runway. The contact area normally changes little during the braking cycle. The perpendicular force comes from aircraft weight and any downward aerodynamic force such as speedbrakes.

The coefficient of friction depends on the tire condition and runway surface, e.g., concrete, asphalt, dry, wet or icy.

Automatic Brakes

EVA recommends that whenever the runway is limited, when using higher than normal approach speeds, or when landing on slippery runways or landing in a crosswind, the autobrakes system will be used.

For normal operation of the autobrakes system, select a deceleration setting.

Settings include:

MAX: Used when minimum stopping distance is required. Deceleration rate is less than that produced by full manual braking.

MED: Should be used for wet or slippery runways or when landing rollout distance is limited.

MIN: These settings provide a moderate deceleration effect suitable for all routine operations.

Flight crew experience with aircraft characteristics relative to the various runway conditions routinely encountered may provide initial guidance as to the desirable level of deceleration selected.

Immediate initiation of reverse thrust at main gear touchdown and full reverse thrust allow the autobrake system to reduce brake pressure to the minimum level. Since the autobrake system senses deceleration and modulates brake pressure accordingly, the proper application of reverse thrust results in reduced braking for a large portion of the landing roll.

The importance of establishing the desired reverse thrust level as soon as possible after touchdown cannot be overemphasized. This minimizes brake temperature, tire and brake wear, and reduces stopping distance on very slippery runways.

The use of minimum reverse thrust almost doubles the brake energy requirements and can result in brake temperatures much higher than normal.

During the landing roll, use manual braking if the deceleration is not suitable for the desired stopping distance.

The autobrakes will be released by smoothly applying brake pedal force, as in a normal stop, until the autobrake system disarms. Following disarming the autobrakes, smoothly release brake pedal pressure.

Disarming the autobrakes before coming out of reverse thrust provides a smooth transition to manual braking.

All crewmembers will be alert for ABS Disarm Light during the landing roll so that manual braking can be initiated if required.

The aircraft speed at which the transition from autobrakes to manual braking is made varies with aircraft deceleration and stopping requirements. For runway conditions that produce good deceleration, the transition from autobrakes to manual brakes will be made at about 60 knots. The transition speed will be closer to a safe taxi speed on very slippery runways or when runway length is limited. For some reason, if autobrakes unable to be disarmed by correctly depressing the brake pedals, PF shall command "AUTOBRAKES OFF" then PM select the AUTO BRAKE Selector to OFF position.

A table in the Performance In-flight section of the AFM shows the relative stopping capabilities of the available autobrake selections.

Manual Braking

The following technique for manual braking provides optimum braking for all runway conditions:

The pilot's seat and rudder pedals will be adjusted so that it is possible to apply maximum braking with full rudder deflection.

Immediately after main wheel touchdown, smoothly apply a constant brake pedal pressure for the desired braking. For short or slippery runways, use full brake pedal pressure.

- Do not attempt to modulate or pump, or any other special techniques to improve braking effectiveness.
- Do not release the brake pedal pressure until the aircraft speed has been reduced to a safe taxi speed.
- The antiskid system stops the aircraft for all runway conditions in a shorter distance than is possible with either antiskid off or brake pedal modulation.

The antiskid system adapts pilot applied brake pressure to runway conditions by sensing an impending skid condition and adjusting the brake pressure to each individual wheel for maximum braking effort. When brakes are applied on a slippery runway, several skid cycles occur before the antiskid system establishes the right amount of brake pressure for the most effective braking.

If the pilot modulates the brake pedals, the antiskid system is forced to readjust the brake pressure to establish optimum braking. During this readjustment time, braking efficiency is lost.

Low braking coefficient of friction on extremely slippery runways at high speeds may be interpreted as a total antiskid failure. Pumping the brakes or turning off the antiskid degrades braking effectiveness. Maintain steadily increasing brake pressure, allowing the antiskid system to function at its optimum.

Although immediate braking is desired, manual braking techniques normally involve a four to five second delay between main gear touchdown and brake pedal application even when actual conditions reflect the need for a more rapid initiation of braking. This delayed braking can result in a loss of 800 to 1,000 feet of runway. Directional control requirements for crosswind conditions and low visibility may further increase the delays. Distractions arising from a malfunctioning reverser system can also result in delayed manual braking application.

Braking with Antiskid Inoperative

When the antiskid system is inoperative, the following techniques apply:

- Ensure that the nose wheel is on the ground and the speedbrakes are extended before applying the brakes.
- Initiate wheel braking using very light pedal pressure and increase pressure as ground speed decreases.
- Apply steady brake pressure and DO NOT PUMP the brake pedals.

Antiskid-off braking requires even greater care during lightweight landings.

Carbon Brake Life

Brake wear is primarily dependent upon the number of brake applications. For example, one firm brake application causes less wear than several light applications. Continuous light applications of the brakes to keep the aircraft from accelerating over a long period of time (riding the brakes) to maintain a constant taxi speed produces more wear than proper brake application.

During taxi, proper braking will involve applying brakes to decelerate the aircraft, releasing the brakes when lower speed is attained, and then allowing the aircraft to accelerate. Repeat this process as necessary.

During landing, one hard, high energy, long-duration brake application produces the same amount of wear as a light, low-energy, short application. This is different from steel brakes whose wear is a function of the energy input during the stop.

Brake Cooling

A series of taxi-back or stop-and-go landings without additional in-flight brake cooling can cause excessive brake temperatures. The energy absorbed by the brakes from each landing is cumulative.

Extending the gear a few minutes early on the approach normally provides sufficient cooling for a landing.

The BRAKE TEMP gage may be used for additional flight crew guidance in assessing brake energy absorption. This gage indicates a stabilized value approximately fifteen minutes after brake energy absorption. Therefore, an immediate or reliable indication of tire or hydraulic fluid fire, wheel bearing problems, or wheel fracture is not available. The BRAKE TEMP gage readings may vary between brakes during normal braking operations.

Close adherence to recommended landing rollout procedures ensures minimum brake temperature build up.

Slippery Runway Landing Performance

When landing on slippery runways contaminated with ice, snow, slush or standing water, the reported braking action must be considered. Relevant performance data are provided in the AFM. Pilots will use extreme caution to ensure adequate runway length is available when poor braking action is reported.

Pilots will keep in mind slippery/contaminated runway performance data is based on an assumption of uniform conditions over the entire runway. This means a uniform depth of slush/standing water for a contaminated runway or a fixed braking coefficient for a slippery runway.

The data cannot cover all possible slippery/contaminated runway combinations and does not consider factors such as rubber deposits or heavily painted surfaces near the end of most runways. With these caveats in mind, it is up to the airline to determine operating policies based on the training and operating experience of their flight crews.

One of the commonly used runway descriptors is coefficient of friction. Ground friction measuring vehicles typically measure this coefficient of friction. Much work has been done in the aviation industry to correlate the friction reading from these ground friction measuring vehicles to aircraft performance.

Use of ground friction vehicles raises the following concerns:

- The measured coefficient of friction depends on the type of ground friction measuring vehicle used. There is not a method, accepted worldwide, for correlating the friction measurements from the different friction measuring vehicles to each other, or to aircraft's braking capability.

- Most testing to date, which compares ground friction vehicle performance to aircraft performance, has been done at relatively low speeds (100 knots or less).
- The critical part of an aircraft's deceleration characteristics is typically at higher speeds (120 to 150 knots).
- Ground friction vehicles often provide unreliable readings when measurements are taken with standing water, slush or snow on the runway. Ground friction vehicles might not hydroplane (aquaplane) when taking a measurement while an aircraft may hydroplane (aquaplane). In this case, the ground friction vehicles would provide an optimistic reading of the runway's friction capability. The other possibility is the ground friction vehicles might hydroplane (aquaplane) when an aircraft would not, this would provide an overly pessimistic reading of the runway's friction capability. Accordingly, friction readings from the ground friction vehicles may not be representative of an aircraft's capability in hydroplaning conditions.
- Ground friction vehicles measure the friction of the runway at a specific time and location. The actual runway coefficient of friction may change with changing atmospheric conditions such as temperature variations, precipitation etc. Also, the runway condition changes as more operations are performed.

The friction readings from ground friction measuring vehicles do supply an additional piece of information for the pilot to evaluate when considering runway conditions for landing. Crews will evaluate these readings in conjunction with the PIREPS (pilot reports) and the physical description of the runway (snow, slush, ice etc.) when planning the landing. Special care should be taken in evaluating all the information available when braking action is reported as POOR or if slush/standing water is present on the runway.

Reverse Thrust Operation

Awareness of the position of the forward and reverse thrust levers must be maintained during the landing phase. Improper seat position as well as long sleeved apparel may cause inadvertent advancement of the forward thrust levers, preventing movement of the reverse thrust levers.

The position of the hand will be comfortable, permits easy access to the autothrottle disconnect switch, and allows control of all thrust levers, forward and reverse, through full range of motion.

NOTE: Reverse thrust always reduces the "brake only" stopping distance, and brake and tire wear. Reverse thrust is most effective at high speeds.

After touchdown, with the thrust levers at idle, rapidly raise the reverse thrust levers up and aft to the interlock position, and then apply reverse thrust as required.

The PM will monitor engine operating limits and call out any engine operational limits exceeded, any thrust reverser failure, or any other abnormalities.

Maintain reverse thrust as required, up to maximum, until the airspeed approaches 80 knots. At this point start reducing the reverse thrust so that the reverse thrust levers are moving down at a rate commensurate with the deceleration rate of the aircraft. The thrust levers will be positioned to reverse idle by taxi speed, then to full down after the engines have decelerated to idle. The PM will call out 80 knots to assist the pilot flying in scheduling the reverse thrust. The PM should also call out any inadvertent selection of forward thrust as reverse thrust is cancelled. If an engine surges during reverse thrust operation, quickly select reverse idle on all engines.

As the aircraft starts to weathervane into the wind, the reverse thrust side force component adds to the crosswind component and drifts the aircraft to the downwind side of the runway. Main gear tire cornering forces available to counteract this drift are at a minimum when the antiskid system is operating at maximum braking effectiveness for the existing conditions.

To correct back to the centerline, reduce reverse thrust to reverse idle and release the brakes. This minimizes the reverse thrust side force component without the requirement to go through a full reverser actuation cycle, and improves tire cornering forces for realignment with the runway centerline. Use rudder pedal steering and differential braking as required, to prevent over correcting past the runway centerline. When re-established near the runway centerline, re-apply maximum braking and symmetrical reverse thrust to stop the aircraft.

Reverse Thrust – Emergency Reverse

Emergency reverse mode is invoked when reverse lever is pulled through the aft detent causing EPR to rise above the limited rating. Use emergency reverse to prevent imminent overrun. When aircraft safety is assured, adjust thrust to maintain engine parameters within normal limits.

Reverse Thrust - Engine Inoperative

Asymmetrical reverse thrust may be used with one engine inoperative. Use normal reverse thrust procedures and techniques with the operating engine. If directional control becomes a problem during deceleration, return throttle to reverse idle detent.

6.3. FACTORS AFFECTING LANDING DISTANCE

The field length requirements are contained in the Performance In-flight section of the AFM and RAM. Actual stopping distances for a maximum effort stop are approximately 60% of the dry runway field length requirement. Factors that affect stopping distance include: height and speed over the threshold, glide slope angle, landing flare, lowering the nose to the runway, use of reverse thrust, speedbrakes, wheel brakes, and surface conditions of the runway.

NOTE: Reverse thrust and speedbrakes are most effective during the high speed portion of the landing. Deploy the speedbrakes and activate reverse thrust with as little time delay as possible.

NOTE: Speedbrakes fully deployed, in conjunction with maximum reverse thrust and maximum manual anti-skid braking provides the minimum stopping distance.

Floating above the runway before touchdown must be avoided because it uses a large portion of the available runway. The aircraft will be landed as near the normal touchdown point as possible. Deceleration rate on the runway is approximately three times greater than in the air.

Threshold crossing height also has a significant effect on total landing distance. For example, an aircraft passing over the runway threshold on a 3° glide path at 100 feet altitude rather than 50 feet could increase the total landing distance by approximately 950 feet. This is due to the length of runway used up before the aircraft actually touches down.

Glide path angle also affects total landing distance. As the approach path becomes flatter, total landing distance is increased even with the same threshold crossing height.

附錄十三　ALAR Tool Kit

Flight Safety Foundation

ALAR

Approach-and-landing Accident Reduction

Tool Kit

FSF ALAR Briefing Note 8.6 — Wind Information

Wind information is available to the flight crew from two primary sources:

- Air traffic control (ATC); and,
- Aircraft systems.

Statistical Data

The Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force found that adverse wind conditions (i.e., strong crosswinds, tail winds or wind shear) were involved in about 33 percent of 76 approach-and-landing accidents and serious incidents worldwide in 1984 through 1997.[1]

Reporting Standards

Recommendations for measuring and reporting wind information have been developed by the International Civil Aviation Organization (ICAO).

They have been implemented by ICAO member states' national weather services (NWSs) and local airport weather services (AWSs).

Average Wind and Gust

Wind direction and wind velocity are sampled every second by wind sensors that may be distant from the runway touchdown zone.

Data averaged over the past two-minute period provide the automatic terminal information service (ATIS) or tower-reported "average wind."

The average wind is available to the controller on a display terminal. (Some control towers, however, have instantaneous indications of wind direction and wind velocity.)

A wind profile of data collected over the past 10-minute period shows the maximum (peak) wind value recorded during this period; this value is reported as the *gust*.

ICAO recommends that gusts be reported if the 10-minute peak value exceeds the two-minute average wind by 10 knots or more.[2] Nevertheless, gust values lower than 10 knots often are provided by AWSs.

Figure 1 (page 186) shows a 10-minute wind profile with:

- A two-minute average wind of 15 knots; and,
- A gust of 10 knots (i.e., a 25-knot peak wind velocity) during the 10-minute period.

This wind condition would be shown in an aviation routine weather report (METAR) as "XXX15G25KT," where XXX is the wind direction, referenced to true north. ATIS and tower-reported winds are referenced to magnetic north.

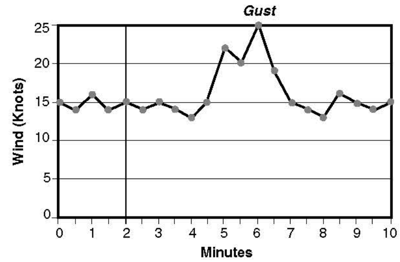
If the peak wind value is observed during the past two-minute period, the gust becomes part of the average wind (Figure 2, page 186).

Such a wind condition would be shown as:

- "XXX20G25KT"; or,
- "XXX20KT" (if the five-knot gust is not included).

Average-wind values and gust values displayed to a controller are updated every minute.

Wind Profile Resulting in ATC/ATIS Report of 15-Knot Wind Velocity And Gusts to 25 Knots

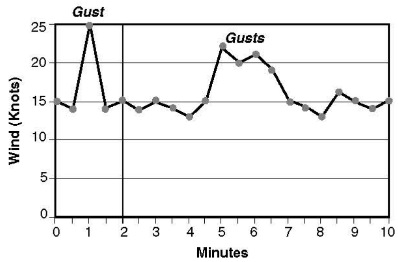


ATC = Air traffic control
ATIS = Automatic terminal information service

Source: Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force

Figure 1

Wind Profile Resulting in ATC/ATIS Report of 20-Knot Wind Velocity With Gusts to 25 Knots



ATC = Air traffic control
ATIS = Automatic terminal information service

Source: Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force

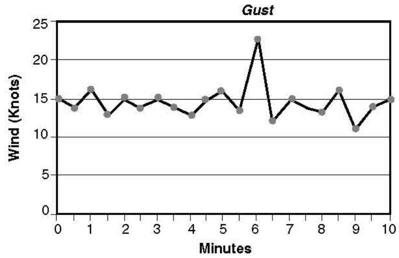
Figure 2

The two-minute average wind and the 10-minute peak gust are used by ATC for:

- ATIS broadcasts; and,
- Wind information on ground, tower, approach and information frequencies.

METARs include a 10-minute average-wind velocity and the 10-minute peak gust (Figure 3).

Wind Profile Resulting in METAR Report of 15-Knot Wind Velocity And Gusts to 23 Knots



METAR = Aviation routine weather report

Source: Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force

Figure 3

Maximum Demonstrated Crosswind

The *maximum demonstrated crosswind* published in the approved airplane flight manual (AFM), aircraft operating manual (AOM) and/or quick reference handbook (QRH) is the maximum crosswind component that was encountered and documented during certification flight tests or subsequent tests by the manufacturer.

The wind value is recorded during a time period bracketing the touchdown (typically from 100 feet above airport elevation to when the airplane reaches taxi speed).

For some aircraft models, if a significant gust is recorded during this period, a demonstrated gust value also is published.

The maximum demonstrated crosswind;

- Is not an operating limitation (unless otherwise stated);
- Is not necessarily the maximum aircraft crosswind capability; and,
- Generally applies to a steady wind.

Maximum Computed Crosswind

The *maximum computed crosswind* reflects the design capability of the aircraft in terms of:

- Rudder authority;
- Roll-control authority; and,
- Wheel-cornering capability.

Crosswind Capability

Crosswind capability is affected adversely by the following factors:

- Runway condition (e.g., contaminated by standing water, snow, slush or ice);
- Systems malfunctions (e.g., rudder jam); or,
- Minimum equipment list (MEL)/dispatch deviation guide (DDG) conditions (e.g., inoperative nosewheel steering).

Wind Information on Navigation Display

The wind information on the navigation display (ND) consists of two elements (Figure 4):

- A wind arrow:
  - The direction of the wind arrow is referenced to magnetic north and indicates the wind direction;
  - The length of the wind arrow may be fixed (velocity information is displayed separately), or the length of the wind arrow may be varied to indicate the wind velocity (depending on aircraft models and standards); and,
  - The wind arrow is the primary visual wind reference during the final approach (together with the groundspeed display); and,
- Digital wind information showing wind direction (typically referenced to true north) and wind velocity:
  - Digital wind information is used primarily to compare the current wind to the predicted wind, as provided on the computerized flight plan.

Depending on aircraft models and standards, the wind information may be computed either by the inertial reference system (IRS) or by the flight management system (FMS).

Lower-left Corner of Navigation Display Shows Winds From 212 Degrees At 20 Knots

Source: Flight Safety Foundation Approach-and-landing Accident Reduction (ALAR) Task Force

Figure 4

Depending on the equipment, different time delays for "smoothing" (i.e., averaging) the wind value are applied, as discussed below.

The wind information on the ND is updated typically 10 times per second.

IRS Wind

IRS wind is assessed geometrically using the triangle of true airspeed (TAS), groundspeed and wind vectors.

The TAS vector and groundspeed vector are defined, in terms of velocity and direction, as follows:

- TAS vector:
  - Velocity: TAS from the air data computer (ADC); and,
  - Direction: magnetic heading from the IRS; and,
- Groundspeed vector:
  - Velocity: groundspeed from the IRS; and,
  - Direction: magnetic track from the IRS.

The IRS wind is computed and is transmitted typically 10 times per second to the electronic flight instrument system (EFIS) for display on the ND.

The IRS wind display provides, for practical purposes, *near-real-time* wind information.

FMS Wind

FMS wind is computed similarly to IRS wind, but FMS wind is averaged over a 30-second period.

FMS wind is more accurate than IRS wind because distance-measuring equipment (DME) position or global positioning system (GPS) position, when available, are included in the computation.

FMS wind is less accurate (i.e., delayed) under the following conditions:

- Shifting wind;
- Sideslip; or,
- Climbing or descending turn.

FMS wind cannot be considered instantaneous wind, but the FMS wind shows:

- More current wind information than the ATIS or tower average wind; and,
- The wind conditions prevailing on the aircraft flight path (aft of the aircraft).

Summary

METAR wind is a 10-minute average wind.

ATIS wind or tower average wind is a two-minute average wind.

ATIS gust or tower gust is the wind peak value during the past 10-minute period.

The ATIS broadcast is updated only if the wind direction changes by more than 30 degrees or if the wind velocity changes by more than five knots over a five-minute time period.

If an instantaneous wind reading is desired and is requested from ATC, the phraseology "instant wind" should be used in the request. (ATC may provide instant-wind information without request under shifting/gusting wind conditions.)

IRS wind is near-real-time wind.

FMS wind is a 30-second-average wind.

Maximum demonstrated crosswind generally applies to a steady wind and is not a limitation (unless otherwise stated).

The most appropriate source of wind information should be selected for the flight phase.

The following FSF ALAR Briefing Notes provide information to supplement this discussion:

- *8.5 — Wet or Contaminated Runways*; and,
- *8.7 — Crosswind Landings*.♦

References

1. Flight Safety Foundation. "Killers in Aviation: FSF Task Force Presents Facts About Approach-and-landing and Controlled-flight-into-terrain Accidents." *Flight Safety Digest* Volume 17 (November–December 1998) and Volume 18 (January–February 1999): 1–121. The facts presented by the FSF ALAR Task Force were based on analyses of 287 fatal approach-and-landing accidents (ALAs) that occurred in 1980 through 1996 involving turbine aircraft weighing more than 12,500 pounds/5,700 kilograms, detailed studies of 76 ALAs and serious incidents in 1984 through 1997 and audits of about 3,300 flights.
2. International Civil Aviation Organization (ICAO). International Standards and Recommended Practices, Annex 3 to the Convention of International Civil Aviation, Meteorological Service for International Air Navigation. Chapter 4, "Meteorological Observations and Reports." Thirteenth edition – July 1998.

Related Reading from FSF Publications

Flight Safety Foundation (FSF) Editorial Staff. "Crew Fails to Compute Crosswind Component, Boeing 757 Nosewheel Collapses on Landing." *Accident Prevention* Volume 57 (March 2000).

FSF Editorial Staff. "Unaware of Strong Crosswind, Fokker Crew Loses Control of Aircraft on Landing." *Accident Prevention* Volume 56 (November 1999).

FSF Editorial Staff. "MD-88 Strikes Approach Light Structure in Nonfatal Accident." *Accident Prevention* Volume 54 (December 1997).

FSF Editorial Staff. "Flight Crew of DC-10 Encounters Microburst During Unstabilized Approach, Ending in Runway Accident." *Accident Prevention* Volume 53 (August 1996).

Regulatory Resources

International Civil Aviation Organization. *International Standards and Recommended Practices, Annex 11 to the Convention of International Civil Aviation, Air Traffic Services. Air Traffic Control Service, Flight Information Service, Alerting Service.* Twelfth edition – July 1998, incorporating Amendments 1–39.

World Meteorological Organization. *Guide to Meteorological Instruments and Methods of Observation*. Sixth edition – 1996.

Notice

The Flight Safety Foundation (FSF) Approach-and-landing Accident Reduction (ALAR) Task Force has produced this briefing note to help prevent ALAs, including those involving controlled flight into terrain. The briefing note is based on the task force's data-driven conclusions and recommendations, as well as data from the U.S. Commercial Aviation Safety Team (CAST) Joint Safety Analysis Team (JSAT) and the European Joint Aviation Authorities Safety Strategy Initiative (JSSI).

The briefing note has been prepared primarily for operators and pilots of turbine-powered airplanes with underwing-mounted engines (but can be adapted for fuselage-mounted turbine engines, turboprop-powered aircraft and piston-powered aircraft) and with the following:

- Glass flight deck (i.e., an electronic flight instrument system with a primary flight display and a navigation display);
- Integrated autopilot, flight director and autothrottle systems;
- Flight management system;
- Automatic ground spoilers;
- Autobrakes;
- Thrust reversers;
- Manufacturers'/operators' standard operating procedures; and,
- Two-person flight crew.

This briefing note is one of 34 briefing notes that comprise a fundamental part of the FSF *ALAR Tool Kit*, which includes a variety of other safety products that have been developed to help prevent ALAs.

This information is not intended to supersede operators' or manufacturers' policies, practices or requirements, and is not intended to supersede government regulations.

附錄十四　A33-16: ICAO Global Aviation Safety Plan (GASP)

Reaffirming that the primary objective of the Organization continues to be to improve the safety of international civil aviation worldwide;

Recognizing that the worldwide rate for fatal accidents in air transport operations has been stagnant at a low level for a number of years;

Noting that the expected increase in the volume of international civil aviation will result in an increasing number of aircraft accidents unless the accident rate is reduced;

Realizing that the public's perception of aviation safety is largely based on the number of aircraft accidents rather than the accident rate;

Recognizing that improvements in the accident rate will require new approaches, in particular pro active and risk analysis based approaches, on the part of all participants in the aviation industry, including ICAO, States, aircraft manufacturers and operators;

Recognizing that the human element in the aviation system is of paramount importance to accident prevention initiatives and aviation safety; and

Noting with concern that controlled flight into terrain (CFIT) and approach and landing type accidents remain as significant accidents in airline operations;

The Assembly:

1. Stresses the need for a reduction in the number and rate of fatal accidents in air transport operations;
2. Urges Contracting States to adopt the GASP objectives to reduce aircraft accidents and to reduce the worldwide accident rate;
3. Urges Contracting States to apply the political will to take the remedial action identified by USOAP audits, to correct the deficiencies identified in the regional

planning process and related activities, and to promulgate the necessary regulations to implement the safety systems developed under the GASP umbrella;

4. Reiterates the need for implementation of the ICAO prevention of controlled flight into terrain (CFIT) and approach and landing accident reduction (ALAR) programmes;
5. Urges all Contracting States to provide the needed support for the various elements of the ICAO Global Aviation Safety Plan;
6. Endorses the concept of concentrating the safety- related activities of ICAO on those safety initiatives, planned or currently under way, that offer the best safety dividend in terms of reducing the accident rate;
7. Requests the Council and Secretary General to ensure that all safety-related items that fall under the GASP umbrella are fully funded in the ICAO budget, including safety-related tasks performed by the Regional Offices;
8. Instructs the Council and Secretary General to participate in efforts by States to improve existing safety database systems and the exchange of safety-related information, and to participate in activities aimed at the development of a comprehensive data analysis and information dissemination network, taking into account the need to adequately protect privileged information and its sources;
9. Encourages the free communication of safety- related information amongst users of the aviation system, including the reporting of accident and incident data by States to the ICAO Accident/Incident Data Reporting (ADREP) system;
10. Urges all Contracting States to examine and, if necessary, adjust their laws, regulations, and policies to achieve the proper balance among the various elements of accident prevention efforts (e.g. regulation, enforcement, training, and incentives to encourage voluntary reporting) and to encourage increased voluntary reporting of events that could affect aviation safety, and instructs ICAO to develop appropriate

policies and guidance in this respect;

11. Urges all Contracting States to ensure that their aircraft operators, providers of air navigation services and equipment, and maintenance organizations have the necessary procedures and policies for voluntary reporting of events that could affect aviation safety;
12. Requests the Council to develop a programme to encourage States to implement approach procedures with vertical guidance (APV) utilizing such inputs as GNSS or DME/DME, in accordance with ICAO provisions;
13. Encourages States to foster regional safety groups;
14. Encourages States to foster the creation of international advisory groups of experts, or other initiatives where appropriate, on aviation safety and assistance to:
    a. bring together the efforts, experience and the resources of interested countries, international and regional organizations, aviation manufacturers and operators, financial and other funding institutions and of ICAO;
    b. study the aviation safety issues of a subgroup of member States; and
    c. develop a civil aviation safety management frame-work and recommendations for improving safety and providing assistance;
15. Instructs the Secretary General to distribute the GASP document on a regular basis through a State letter and on the ICAO public Web site; and
16. Instructs the Council to provide a progress report on the ICAO Global Aviation Safety Plan to future sessions of the Assembly.

本頁空白

附錄十五　BR806 座艙語音紀錄器抄件

RDO　: Radio transmission from occurrence aircraft
CAM　: Cockpit area microphone voice or sound source
　-1 : Voice identified as captain
　-2 : Voice identified as first officer
APP　: Taipei approach
TWR　: Taipei tower
GND　: Taipei ground
OTH　: Radio transmission from other aircraft
…　: Unintelligible words
( )　: Remarks or translation
*　: Communication not related to operation

hh[40]	mm	ss	Source	Context
12	30	28.3		（CVR 記錄開始）
12	30	32.1	CAM-2	今天你看看 不知道 如果眞的不行的話我們就到 jammy 去 holding
12	30	43.1	CAM-1	呵呵呵　來呀
12	30	45.4	CAM-1	好　我來 approach check 還沒有做喔
12	30	48.2	CAM-2	老大抱歉（台語）
12	30	48.8	CAM-1	one zero zero niner 喔
12	30	50.4	CAM-2	正在忙　轉彎對不對 passing six thousand …
12	30	53.1	APP	eva eight zero six confirm ready for approach
12	30	55.8	RDO-1	affirm eva eight zero six
12	30	57.3	APP	eva eight zero six turn right heading zero two zero maintain tree thousands until establish clear i-l-s runway zero six approach
12	31	02.5	CAM-1	速度速度
12	31	04.0	CAM-1	收 先收回去
12	31	06.2	RDO-1	right heading zero two zero three thousands until establish

[40]此抄件以 FDR 紀錄時間作為同步基準，使用 UTC 時間。

hh[40]	mm	ss	Source	Context
				clear i-l-s runway zero six approach eva eight zero six
12	31	12.1	CAM-1	喔 差一點差一點 你不怕飆到兩百四喔
12	31	12.6	CAM	（不明聲響）
12	31	14.6	CAM	（不明聲響）
12	31	15.1	CAM-1	放回去啦
12	31	21.8	CAM-1	喔 多少（台語） frequency 聽一下
12	31	27.2	CAM-1	identify 喔
12	31	32.4	CAM-1	就現在放 gear 沒問題喔
12	31	46.6	CAM-1	給他 arm i-l-s 吧
12	31	48.1	CAM-2	好啦 他可以攔截嗎
12	31	50.9	CAM-1	可以 clear for approach
12	31	59.7	CAM-1	*
12	32	08.5	CAM-1	應該可以下快一點 高於 glide slope 一 dot 喔
12	32	16.8	CAM-2	down draft
12	32	17.7	CAM-1	tulip 兩千五
12	32	20.4	CAM-1	等攔截到再說
12	32	22.6	CAM-2	gear down 好不好
12	32	23.6	CAM-1	好
12	32	23.9	CAM-2	flap fifteen
12	32	25.4	CAM	（起落架放下聲響）
12	32	26.5	CAM	（不明聲響）
12	32	31.9	CAM-2	continue
12	32	33.1	CAM-1	check
12	32	34.0	CAM-1	alive
12	32	34.8	APP	eva eight zero six contact tower one eighteen seven good day
12	32	37.2	RDO-1	one eighteen seven eva eight zero six good day
12	32	39.6	CAM-1	…
12	32	41.0	CAM-2	check
12	32	42.8	CAM-1	both cap * 不要這樣子
12	32	46.5	CAM-1	雷擊罷了
12	32	48.9	CAM-2	flaps twenty eight
12	32	52.0	CAM-1	ok twenty eight
12	32	53.4	CAM-1	speed check
12	32	55.4	CAM	（不明聲響）
12	32	57.4	RDO-1	taipei tower good evening eva eight zero six runway zero six

hh[40]	mm	ss	Source	Context
				nine miles final
12	33	00.0	CAM	（不明聲響）
12	33	02.6	CAM	（不明聲響）
12	33	03.8	TWR	eva eight zero six taipei tower runway zero six wind zero tree zero deg one zero knots q-n-h one zero one zero visibility tree thousand five hundred meters clear to land
12	33	10.4	CAM	（autopilot trim）
12	33	13.7	RDO-1	roger zero six q-n-h one zero one zero clear to land eva eight zero six
12	33	14.2	CAM	twenty five hundreds
12	33	16.7	CAM-2	好 flaps forty
12	33	18.2	CAM	（不明聲響）
12	33	19.7	CAM	（不明聲響）
12	33	20.4	CAM-2	medium
12	33	20.6	CAM	（autopilot trim）
12	33	21.2	CAM-1	medium 噢 好
12	33	23.6	CAM-1	*
12	33	24.6	CAM-2	landing check
12	33	25.7	CAM-1	landing check
12	33	27.2	CAM-1	uh cabin alert landing gear
12	33	29.2	CAM-2	down three green
12	33	29.7	CAM-1	spoiler brake armed uh medium flaps slat
12	33	33.6	CAM-2	uh forty land 我現在加五浬先放著喔
12	33	36.2	CAM-1	好
12	33	36.8	CAM-2	待會到 final 的時候一千呎我們看決定的速 不要把
12	33	39.4	CAM-1	你看一片紅喔　*
12	33	40.6	CAM-2	不要把速度低 弄得太低喔
12	33	43.5	CAM-1	是
12	33	45.2	CAM-1	對不對　能見度不高啊
12	33	46.5	CAM-2	landing check 已經 com 了噢
12	33	47.5	CAM-1	好
12	33	48.3	CAM-2	再 double check 三千 miss approach flaps fifteen 一四三
12	33	50.1	CAM-1	好 好（台語）
12	33	51.5	CAM-1	有 go around 準備　不行就 go around 喔
12	33	51.8	CAM-2	然後 嘿 go around flaps fifteen positive climb gear up 然後 go around 就去那個 sedum hold 油量三千九 ok 夠了

hh[40]	mm	ss	Source	Context
12	33	59.6	CAM-1	check
12	34	02.1	CAM	（autopilot trim）
12	34	02.4	CAM-2	幫我注意一下 check 速度喔
12	34	04.1	CAM-1	好沒問題
12	34	05.7	CAM-2	還有
12	34	07.2	CAM-1	速度就稍微小心一下
12	34	08.4	CAM-2	對　我知道喔
12	34	09.3	CAM-1	這個我幫你看　我會幫你看一下　就怕速度
12	34	11.6	CAM-2	現在是一三四 一三九　我再大一點大個大概十節左右喔
12	34	16.9	CAM-1	好
12	34	17.4	CAM-2	待會 final 的時候我再把它調回來
12	34	18.7	CAM-1	沒問題
12	34	20.1	CAM-2	我怕它當
12	34	20.2	CAM-1	可以啦　能見度 ok 啦
12	34	24.5	CAM-2	雨刷待會我需要時我再跟你說好不好
12	34	26.3	CAM-1	是　要 slow 還是 very fast *
12	34	29.8	CAM-2	* 可以看到了嘛
12	34	30.0	CAM-1	可以啦　可以　好沒問題的啦
12	34	37.6	CAM-2	* 甚麼 light rain 這是 heavy rain 好不好
12	34	39.8	CAM-1	*
12	34	41.4	TWR	taipei tower broadcasts thunderstorm alert in progress
12	34	46.3	CAM-2	好喔　隨時注意一下喔
12	34	47.1	CAM-1	是　好
12	34	52.1	CAM-1	final fix 過了喔　一千七喔
12	34	54.1	CAM-2	check
12	35	00.0	OTH	tower eva seven six five
12	35	02.8	TWR	go ahead
12	35	03.1	CAM-1	你先開一下雨刷
12	35	03.8	OTH	uh yes what’s direction the thunderstorm in related to the airport
12	35	04.4	CAM	（雨刷聲響）
12	35	07.9	CAM	one thousand
12	35	09.2	TWR	roger standby I will check for you for information we have proceeding landing traffic due to bad weather so you might want you may you may need to be waiting for couple of

hh[40]	mm	ss	Source	Context
				landings due to the separation is pretty close
12	35	09.5	CAM-1	d-a tree tree tree
12	35	10.7	CAM-2	check
12	35	18.1	CAM	（不明聲響）
12	35	27.9	TWR	uh roger that I will check the weather for you
12	35	29.8	OTH	謝謝喔
12	35	32.1	CAM-1	這不需要 這關掉跟我講
12	35	34.1	CAM-2	好
12	35	34.4	CAM-1	* 甚麼都沒看到耶 *
12	35	37.0	CAM-2	*
12	35	40.1	CAM-1	這邊雲很低喔
12	35	42.1	CAM-2	對啊
12	35	50.3	CAM-1	可以 看到
12	35	52.0	CAM	five hundred
12	35	53.4	CAM-2	stable
12	35	53.5	CAM-1	stable
12	35	58.2	CAM-1	好 approach light in sight 可以囉
12	36	00.1	CAM-2	好
12	36	00.5	CAM-1	有看到喔 approach minimum
12	36	02.8	CAM-2	check
12	36	04.2	CAM	（autopilot trim 聲響）
12	36	05.1	CAM-2	雨刷
12	36	05.9	CAM-1	好
12	36	09.3	CAM-1	要嗎
12	36	09.9	CAM-2	好 看到了喔
12	36	12.2	CAM-1	要雨刷開著喔
12	36	17.0	CAM-1	不行的話就丟給我 我這裡看到喔
12	36	20.0	CAM-2	autopilot disconnect
12	36	20.5	CAM	（autopilot 解除聲響）
12	36	21.3	CAM-1	check
12	36	28.2	CAM-2	幫我 check centerline
12	36	29.0	CAM	one hundred
12	36	29.9	CAM-1	ok 啦 可以啦
12	36	32.7	CAM	fifty
12	36	33.5	CAM	forty

hh[40]	mm	ss	Source	Context
12	36	34.5	CAM	（不明聲響）
12	36	34.9	CAM	thirty
12	36	36.0	CAM	twenty
12	36	36.9	CAM	ten
12	36	37.8	CAM	（不明聲響）
12	36	43.1	CAM-2	喂幫我注意一下 rudder rudder rudder
12	36	44.5	CAM-1	rudder rudder rudder rudder
12	36	46.5	CAM-1	reverse 先關掉
12	36	46.7	TWR	taipei tower broadcasts visibility eight hundred meters eight hundred meters
12	36	49.3	CAM	（異於正常滾行之聲響）
12	36	50.5	CAM-2	哇
12	36	53.6	CAM-1	*
12	36	54.4	CAM-2	*
12	36	55.8	CAM-1	甚麼東西
12	36	56.3	TWR	cathay four zero two visibility eight hundred meters r-v-r runway zero six more than two thousand meters continue approach
12	36	59.5	CAM-1	i have control
12	37	00.3	CAM-2	you have control
12	37	01.3	CAM-1	這甚麼東西
12	37	02.5	CAM-2	撞到甚麼　滑行燈嗎
12	37	03.1	OTH	continue cathay four zero two
12	37	07.8	CAM-2	趕快跟他講吧
12	37	09.6	CAM-1	看一下有沒有甚麼東西　我是覺得是 不是撞到 是 skid
12	37	13.8	TWR	eva eight zero six contact ground one two one decimal seven turn left high speed taxiway at sierra six good day
12	37	19.0	RDO-2	ground at sierra six eva eight zero five
12	37	22.8	CAM-1	我覺得應該是 skid
12	37	23.9	CAM-2	skid 喔
12	37	30.3	CAM-1	*方向控制不起來喔 flaps fifteen
12	37	36.1	CAM	（不明聲響）
12	37	41.7	RDO-2	taipei ground eva eight zero six sierra six
12	37	45.3	GND	eva eight zero six taipei ground taxi via sierra six sierra sierra to bay charlie one zero
12	37	50.9	RDO-2	uh sierra five charlie one zero eva eight sierra six

hh[40]	mm	ss	Source	Context
12	37	57.1	CAM-1	sierra sierra charlie one zero
12	37	58.9	GND	roger sierra six and sierra sierra to charlie one zero for eva eight zero six
12	38	04.7	RDO-2	sierra six
12	38	06.2	CAM-1	sierra sierra charlie one zero
12	38	07.1	RDO-2	sierra sierra charlie one zero eva eight zero six
12	38	10.2	CAM-1	sierra six sierra sierra one zero
12	38	11.5	CAM-2	你要不要看
12	38	11.7	CAM-1	flaps
12	38	13.2	CAM-1	啊
12	38	14.1	CAM	（雨刷聲響）
12	38	15.0	CAM-1	我可以看到沒關係
12	38	17.7	CAM-2	我們待會 check 一下那個
12	38	19.3	CAM-1	看 gear 就知道有沒有問題了
12	38	20.8	CAM-2	好好好
12	38	22.6	CAM-1	這關掉好了 沒關係我這邊看得到
12	38	27.0	CAM-1	我覺得屁股應該沒有到那邊啦
12	38	29.5	CAM-2	嗯
12	38	30.1	CAM-1	應該沒有到最邊邊啦 沒有吃草啦
12	38	42.4	CAM-1	跟他 report braking action
12	38	44.8	CAM-2	噢
12	38	45.5	CAM-1	poor
12	38	50.0	RDO-2	taipei ground eva eight zero five report braking action is poor
12	38	54.9	CAM-1	eight zero six
12	39	01.2	GND	confirm eva eight zero five calling
12	39	03.0	RDO-2	affirm eight zero six braking action poor
12	39	07.0	GND	roger thank you very much
13	00	39.6		（CVR 記錄終止）

本頁空白

附錄十六　飛航軌跡

依 1.11 節飛航紀錄器（CVR 及 FDR）及 1.12 節地面量測軌跡等事實資料，分析該機於最後進場至偏出期間飛航軌跡。依據 AIP 公布資料及本會實際量測結果，06 跑道兩側邊線外緣之寬度爲 200 呎。圖 2.2-1 爲事故班機無線電高度 200 呎以下航跡左右偏移量變化。圖 2.2-2 爲事故班機最後進場至偏出期間之發生經過。

依圖 2.2-1 顯示，36:22 時至 36:32 時（解除自動駕駛至通過 6 跑道頭上空），該機位於 06 跑道中心線左側約 4 呎至 20 呎，操控駕駛員曾以方向舵微量修正航向；36:31 時該機通過 06 跑道頭上空，至主輪著陸前 2 秒 36:37 時，航跡重心位置（△Ycg）持續位於 06 跑道中心線左側，其變化爲 15 呎（36:31 時）→23 呎（36:34 時）→2 呎（36:37 時）：平飄至著陸期間（36:33 時至 36:39 時），無線電高度 50 呎以下，航機持續右坡度（0.55 度→4.39 度），由 0.88 度仰角轉爲 1.05 度俯角，左右主輪及鼻輪同時著陸，該機重心位置右偏距跑道中心線約 9 呎；36:38 時至 36:48 時航跡右偏出期間（36:47 時~36:56 時），其垂直尾翼位置（△Y）右偏移量均大於 110 呎，最大右偏移量約 141 呎(36:50 時)，此時該機重心位置最大右偏移量約 110.6 呎，亦即最大右偏出跑道邊線之距離約 10.6 呎。

圖 2.2-2 紅色線飛航軌跡，係將 FDR 記錄之地速、航向、偏流角、飛航參數經積分後，參考多重監視源資料處理系統（MSTS）航跡；綠色線飛航軌跡爲 IRU 與左右定位台偏移參數（Localizer Deviation, LOC DEV）計算航機垂直尾翼及航機重心之橫向偏移量 。參照 FDR 左右定位台偏移參數及 1.18.1 節正副駕駛員訪談內容，IRU 計算飛航軌跡因 FDR 記錄飛航參數精度不足，造成通過 06 跑道頭及主輪著陸期間，偏離 06 跑道中心線現象，本報告採用之飛航軌跡係以 IRU 與左右定位台偏移參數計算（綠線）。

本頁空白

附錄十七　無線電通訊錄音抄件

APP1/ APP2：臺北近場管制臺桃南席管制員
LC：桃園國際機場管制塔臺機場管制席管制員
GC1/ GC2：桃園國際機場管制塔臺地面管制席管制員
SC：桃園國際機場管制塔臺資深輔導員
BR806：長榮 BR806 班機駕駛員

UTC	COM.	CONTENTS
1221:02	BR806	taipei approach good evening eva eight zero six we are descending approaching flight level one seven zero one zero mile right deviation for weather
1221:12	APP1	eva eight zero six taipei approach squawk ident descend and maintain one one thousand say heading now
1221:18	BR806	descent one one thousand now we maintain heading zero five five eva eight zero six
1221:23	APP1	eva eight zero six heading zero five five approved report clear of weather
1221:27	BR806	report clear of weather eva eight zero six
1222:29	APP2	eva eight zero six descend and maintain one one thousand correction descend and maintain seven correction maintain one one thousand
1222:35	BR806	descend and maintain one one thousand eva eight zero six
1223:06	APP2	eva eight zero six for your information airbus three twenty just landing runway zero six report thunderstorm around tulip
1223:16	BR806	copy that thank you
1225:39	BR806	eva eight zero six request direct hukou
1225:52	APP2	eva eight zero six unable direct due to traffic
1225:56	BR806	roger maintain request heading zero four zero
1225:59	APP2	eva eight zero six heading zero four zero approved descend and maintain one zero thousand
1226:03	BR806	heading zero four zero descend one zero thousand eva eight zero six
1227:17	APP2	eva eight zero six descend and maintain five thousand
1227:19	BR806	descend and maintain five thousand eva eight zero six we are ready for approach
1227:23	APP2	roger
1227:54	APP2	eva eight zero six turn left heading two seven zero
1227:56	BR806	turn left heading two seven zero eva eight zero six
1228:39	APP2	eva eight zero six stop heading three one zero descend and maintain three thousand

1228:43	BR806	heading three one zero descend three thousand eva eight zero six
1229:23	APP2	eva eight zero six confirm ready for approach
1229:26	BR806	affirm eva eight zero six
1229:27	APP2	eva eight zero six turn right heading zero two zero maintain three thousand until established cleared i l s runway zero six approach
1229:36	BR806	right heading zero two zero three thousand until established cleared i l s runway zero six approach eva eight zero six
1231:04	APP2	eva eight zero six contact tower one eighteen seven good day
1231:07	BR806	one eighteen seven eva eight zero six good day
1231:27	BR806	taipei tower good evening eva eight zero six runway zero six nine miles final
1231:33	LC	eva eight zero six taipei tower runway zero six wind zero tree zero degrees one zero knots q n h one zero one zero visibility tree tousand five hundred meters cleared to land
1231:43	BR806	runway zero six q n h one zero one zero cleared to land eva eight zero six
1233:12	LC	taipei tower broadcasting thunder storm alert in progress
1235:17	LC	taipei tower broadcasting visibility eight hundred meters eight hundred meters
1235:27	LC	cathay four zero two visibility eight hundred meters r v r runway zero six more than two thousand meters continue approach
1235:44	LC	eva eight zero six contact ground one two one decimal seven turn left high speed taxiway sierra six good day
1235:50	BR806	via sierra six eva eight zero five
1236:12	BR806	taipei ground eva eight zero six sierra six
1236:16	GC1	eva eight zero six taipei ground taxi via sierra six sierra sierra to bay charlie one zero
1236:23	BR806	ah sierra five charlie one zero eva…sierra six…
1236:30	GC1	via sierra six sierra sierra to charlie one zero for eva eight zero six
1236:36	BR806	sierra six sierra sierra to charlie one zero eva eight zero six
1237:14	GC1	taipei ground broadcasting q n h now one zero one two q n h one zero one two
1237:20	BR806	taipei ground eva eight zero five report the braking action… is poor
1237:32	GC1	confirm eva eight zero five calling
1237:35	BR806	affirm eight zero six braking action poor
1237:38	GC1	roger thank you very much
1242:41	GC1	taipei ground broadcasting q n h now one zero one one q n h one zero one one
1257:21	GC1	taipei ground broadcasting q n h now one zero one two q n h one zero one two
1258:55	BR806	ground eva eight zero six

1258:58	GC2	eva eight zero six go ahead
1258:59	BR806	教官我們剛才落地的時候疑似我們有吃..那個側滑吃草 你們可不可以派人檢查一下
1259:09	GC2	長榮八洞六 roger
1305:44	GC2	eva eight zero six taipei ground
1310:22	BR806	ground eva eight zero six
1310:24	GC2	長榮八洞六塔臺請
1310:26	BR806	麻煩請教一下你們現在檢查狀況是怎麼樣
1310:30	GC2	教官我們目前那個黃車那個航務組的那個黃車現在正在進跑道檢查現在還是不曉得是什麼問題那教官請問您疑似偏移的位置大概在哪裏
1310:43	BR806	疑似偏移右邊麻煩幫我們檢查一下
1310:46	GC2	教官那請問有沒有有沒有那個印象是在哪條滑行道附近
1310:51	BR806	歐沒有沒有我們是落地之後哦落地之後在煞車的過程中有一點偏滑那我們不確定有沒有那個吃到草我們想確定一下
1311:04	GC2	長榮八洞六 roger
1311:06	BR806	謝謝
1311:25	BR806	塔臺 長榮八洞六
1311:26	GC2	稍待
1311:30	GC2	長榮八洞六請你換么兩么點六聯絡
1311:50	BR806	呃 臺北 長榮八洞六
	SC	長榮八洞六 臺北請講
	BR806	教官 有沒有個電話可以播打過去 跟你們說明一下
	SC	是的 3983023
	BR806	3983023 謝謝
	SC	謝謝

本頁空白

附錄十八　各單位意見陳述之書面說明

立榮航空公司意見陳述：

UNI AIR 立榮航空

B17917飛航事故調查報告草案

立榮航空公司意見陳述簡報

報告人：立榮航空 [redacted]
長榮航空

中華民國101年4月24日

陳述事項

1. 建請貴會B17917飛航事故調查報告封面以「B17917」取代「BR806」。
2. 參考貴會日前公告他航之案例，建議事件描述增加「短暫」兩字，以符合實際狀況。

前言

- BR806為長榮航空濕租立榮航空MD90班機，依據民航局核定之營運規範，航空器濕租作業係由出租方(operating carrier) 肩負安全之責任。

中華民國 交通部
民用航空局

營運規範
OPERATIONS SPECIFICATIONS

第七章 航空器出租作業(濕租)
PART G AIRCRAFT LEASING OPERATIONS (WET LEASE)

1.本民用航空運輸業許可証持有人之營運規範，須依長榮航空與立榮航空所同意簽定之租賃條款執行各項作業，該項作業須符合中華民國民用航空局飛航作業管理規則、民用航空法及立榮航空之營運規範第二部份所授權之作業區域及本條文1(A)所列之機場執行各項作業並符合營運規範所核准之機場最低操作限制。本作業以 MD-90 機型由立榮航空公司之飛航組員執行之，並由立榮航空公司負責所有之飛航作業管制。

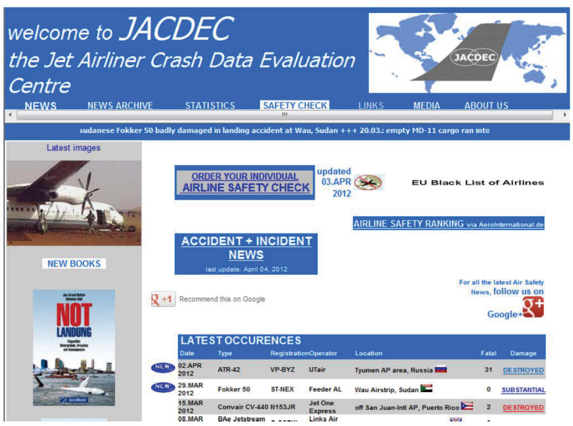
1. The holder of these AOC's operations specifications shall conduct all operations authorized under the terms of the lease agreement between the EVA Airways Corporation and the UNI Airways Corporation in accordance with the provisions of the CAA of R.O.C. operating regulations and rules and these operations specifications. Such operations are authorized over the routes and areas specified in Part B of these UNI Airways's operations specifications and to and from the pertinent aerodromes listed in the paragraph 1 (A) of this part, in accordance with the aerodrome operating minima specified in these operations specifications. Such operations shall be conducted with MD-90 type aircraft and UNI Airways Corporation flight crews. The UNI Airways Corporation shall be responsible for the operational control of such flights.

草案修改建議一

- 貴會B17917飛航事故調查報告，封面載記「立榮航空公司BR 806班機」，本公司建請貴會以「B17917」取代「BR806」。說明如后：

頁次	草案原文	草案修改建議
封面	ASC 行政院飛航安全委員會 飛航事故 調查報告草案 中華民國 100 年 5 月 12 日 立榮航空公司 BR 806 班機 MD-90 型機 國籍標誌及登記號碼 B-17917 於桃園機場落地時偏離跑道 報告編號：ASC-AOR-12-xx-xxx 報告日期：民國 101 年 x 月	ASC 行政院飛航安全委員會 飛航事故 調查報告草案 中華民國 100 年 5 月 12 日 立榮航空公司 MD-90 型機 國籍標誌及登記號碼 B-17917 於桃園機場落地時短暫偏離跑道 報告編號：ASC-AOR-12-xx-xxx 報告日期：民國 101 年 x 月

- Aero-International為德國專業航空雜誌，該雜誌與JACDEC顧問公司合作，每年公佈全球主要航空公司的安全排名。



JACDEC計算標準

- 最近30年(1981-2010)失事(航機全毀)件數及罹難人數
- 最近10年(2001-2010)重大意外事件數

  -- 以各國調查機關公佈資料為依據。 (2011年新增)

- 經詢問JACEDC，其 incident rate 的計算標準係以各國調查機關公佈的調查報告為依據。如貴會調查報告封面能以"B17917"取代"BR806"，對國籍航空公司在國際安全評比上助益甚大，亦能藉由此安全評比提升台灣的國際形象。

草案修改建議二

頁次	草案原文	草案修改建議
封面	於桃園機場落地時偏離跑道 國籍標誌及登記號碼 B-17917 於桃園機場落地時偏離跑道 報告編號：ASC-AOR-12-xx-xxx 報告日期：民國 101 年 x 月	於桃園機場落地時「短暫」偏離跑道 國籍標誌及登記號碼 B-17917 於桃園機場落地時短暫偏離跑道 報告編號：ASC-AOR-12-xx-xxx 報告日期：民國 101 年 x 月
說明：參考貴會日前公告他航之案例，增加「短暫」兩字，以符合實際狀況。		

以上說明

&

再次感謝貴會給予本公司此次說明之機會

交通部民用航空局意見陳述：

頁數/章節/段落/行數	調查報告草案內容	建議修正	理由
第 89 頁第二段 第 90 頁	2010 年 7 月 ICAO 頒布的 Annex 6 Part I 九版第二節飛航資料紀錄器「2.2.2.6 Type IA FDR. This FDR shall be capable of recording as appropriate to the aeroplane, at least the 78 parameters in Table A8-1.」，此 78 項必要紀錄參數中「34. Brakes（left and right brake pressure, left and right brake pedal position）」，「煞車踏板位置」參數已屬必要參數。 飛航資料分析計畫為安全管理系統（SMS） 28 的一部分，確保飛航資料紀錄內容之完整性及正確性，係為飛航資料紀錄器適航及其年度檢查的重要工作。事故機 FDR 紀錄之「煞車踏板位置」、「煞車壓力」及「地面擾流板位置」三參數，非屬我國現行法規要求紀錄之 32 項必要參數，惟第 9 版國際民航組織第 6 號附約之標準及建議措施所要求紀錄之 78 項必要參數已納入上述「煞車踏板位置」、「煞車壓力」及「地面擾流板位	建議刪除。 建議刪除。	1. 依據 2010 年 7 月 ICAO 頒布的 Annex 6 Part I 九版第 6.3 節飛航紀錄器「6.3.1.2.11 All aeroplanes of a maximum certificated take-off mass of over 5 700 kg for which the individual certificate of airworthiness is first issued after 1 January 2005 shall be equipped with a Type IA FDR.」 2. B-17917 機係於 1988/1/25 製造，其最大起飛總重為 75,000 公斤以上，所裝用之 FDR 為 Type I，故不

1

頁數/章節/段落/行數	調查報告草案內容	建議修正	理由
	置」三參數。我國民航監理機關若能參照 ICAO 第六號附約第 9 版之標準及建議措施（SARPs），將 32 項必要紀錄參數增加為 78 項（TYPE 1A），國內民航業者的飛航資料分析計畫將有更多參數可用以監控及預防起降階段可能發生的飛安異常事件，例如：航機著陸期間與跑道夾角、彈跳落地、著陸點/著陸距離、不對稱或過大反推力、不對稱煞車、主輪及鼻輪間之著陸時間、著陸後使用煞車操控（煞車踏板、煞車壓力、各主輪轉速）等，亦有助於本會衡偏出跑道飛航事故調查。		受 Type IA FDR 新規定之影響
第 115 頁致交通部民用航空局 6.	6. 督導立榮重新檢視飛航資料紀錄器之年度檢查程序及其感應裝置的校準作業，以確保飛航資料紀錄器所記錄參數之正確性。（ASC-ASR-12-XX-XXX）	建議刪除。	1. Brake Pressure FDR 參數資料依立榮維護計劃 31-31-00-01 規定每年檢查 1 次，檢查時距符合要求。該 FDR 資料前一次

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頁數/章節/段落/行數	調查報告草案內容	建議修正	理由
			檢查時間為 2010/10/14，當時檢查情況正常。 2. B-17917 RH Brake Pressure Transducer PN: IBA103G93 已於 2011/5/15 更換。 3. 立榮已於 2011/5/13 檢查其它航機 Brake Pressure FDR 參數資料，檢查情況正常。
第 103 頁/2.10.1 近場臺管制作業/ 第 2 段	依據航管錄音抄件，1227:19 時該機回覆近場臺桃南席管制員「descend and maintain five thousand eva eight zero six we are ready for approach」，當時該機高度約 10,000 呎，距 06 跑道頭 17.6 浬。1229:27 時管制員呼叫「eva eight zero six turn right heading zero two zero maintain three thousand until established cleared	依據航管錄音抄件，1227:19 時該機回覆近場臺桃南席管制員「descend and maintain five thousand eva eight zero six we are ready for approach」，當時該機高度約 10,000 呎，距 06 跑道頭 17.6 浬。1229:27 時管制員呼叫「eva eight zero six turn right heading zero two zero maintain three thousand until established cleared i l s runway zero six approach」，當時該機高度 5,886 呎，距 06 跑道頭直線距離 14.9 浬，高於	1. 報告中述及『依據航管錄音抄件，1227:19 時 BR806 回覆近場臺桃南席管制員「descend and maintain five thousand eva eight zero six **we are ready for approach**」，當時該機高度

3

頁數/章節/段落/行數	調查報告草案內容	建議修正	理由
	i l s runway zero six approach」，當時該機高度 5,886 呎，距 06 跑道頭 14.9 浬，高於下滑道約 1,000 呎。(略) 以上有關引導航空器進場之規定，引導航空器攔截進場航道時，攔截高度不得高於下滑道，1229:27時近場臺管制員許可BR806進場時，該機攔截ILS之高度高於下滑道約1,000呎，未符合飛航管理程序之規定。	下滑道約 1,000 呎。(略) ~~以上有關引導航空器進場之規定，引導航空器攔截進場航道時，攔截高度不得高於下滑道，1229:27時近場臺管制員許可BR806進場時，該機攔截ILS之高度高於下滑道約1,000呎，未符合飛航管理程序之規定。~~	約 10,000 呎，距 06 跑道頭 17.6 浬』。管制員當時已考量該機之高度與距離，遂未立即給予進場指示，而係以 270、310、020 等航向雷達引導方式增加其距跑道頭之飛行距離及下降高度空間。後於 1229:23 時再次與 BR806 確認「eva eight zero six confirm ready for approach」，該機回覆「**affirm** eva eight zero six」，由於該機第 2 度回覆準備好進場，管制員依當時航機位置判斷，復考量航機下降率之安排取決於駕駛員操作，遂於 1229:27 時頒發進場許可予 BR806。 2.另依飛航管理

頁數/章節/段落/行數	調查報告草案內容	建議修正	理由
			程序所述，GP(滑降臺)之有效距離為 10 浬，管制員頒發許可時，該機位於 06 跑道東側，尚未攔上 LLZ，參考 ASDE 畫面 1229:55 該機之 TRACK MILE 約 16 浬，高度 5,100 呎，並未如報告所述高於 GP 1,000 呎。(依 MSTS 數據資料 1229:57.476 顯示亦為 5,100 呎) 3. 管制員所看畫面與航機儀表顯示高度並未完全相同，且頒發進場之依據係以航機距跑道頭之飛行距離作為考量，建請修正文字。
第 109 頁/3.2 與風險有關之發現/ 第 3 段	臺北近場臺桃南席管制員許可 BR806 進場時，該機攔截 ILS 之高度高於下滑道約 1,000 呎，且未提供航空器相關距離資料，增加駕駛員進場操作之風	臺北近場臺桃南席管制員許可 BR806 進場時，~~該機攔截 ILS 之高度高於下滑道約 1,000 呎，且~~未提供航空器相關距離資料供駕駛員參考~~，增加駕駛員進場操作之風險~~。	1. 依正副駕駛員訪談紀錄、立榮航空航務手冊、組員訓練手冊或操作手冊，均未有提及或記載，

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頁數/章節/段落/行數	調查報告草案內容	建議修正	理由
	險。		管制員所提供之航空器相關距離資料為駕駛員進場操作所必需/參考之資訊。 2.依據航跡圖顯示，於 1227:19 時 BR806 回覆近場臺桃南席管制員「 **we are ready for approach**」，當時該機高度約 10,000 呎，距 06 跑道頭 17.6 浬。管制員當時已考量該機之高度與距離，遂未立即給予進場指示，而係以 270、310、020 等航向雷達引導方式增加其距跑道頭之飛行距離及下降高度空間。後於 1229:23 時再次與 BR806 確認「eva eight zero six confirm ready for approach」，該機回覆「**affirm** eva eight zero six」，由於該機

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頁數/章節/段落/行數	調查報告草案內容	建議修正	理由
			第 2 度回覆準備好進場，管制員依當時航機位置判斷，復考量航機下降率之安排取決於駕駛員操作，遂於 1229:27 時頒發進場許可予 BR806。 3.另，GP(滑降臺)之有效距離為 10 浬，管制員頒發許可時，該機位於 06 跑道東側，尚未欄上 LLZ，參考 ASDE 畫面 1229:55 該機之 TRACK MILE 約 16 浬，高度 5,100 呎，再依照該機 FDR 資料顯示其航跡經管制員引導後，在 TULIP 點高度 2890 呎，並未如報告所述高於 GP 1,000 呎。(依 MSTS 數據資料 1229:57.476 顯示亦為 5,100 呎) 4.故所謂「該機

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頁數/章節/段落/行數	調查報告草案內容	建議修正	理由
			攔截 ILS 之高度高於下滑道約 1,000 呎」，經比對並非事實；另有關「且未提供航空器相關距離資料，增加駕駛員進場操作之風險。」更無積極事證足以支持，純屬臆測之語。

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本頁空白

附件清單

1. MD-90 AIRCRAFT MAINTENANCE MANUAL
2. 座艙語音紀錄抄件
3. 飛航資料紀錄解讀參數
4. 立榮航空公司第 20 版航務手冊
5. 立榮航空公司第 2 版 MD-90 飛航組員訓練手冊
6. 立榮航空公司「安全資訊系統手冊 附表 2.6 Flight Analysis Event-MD90」

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飛航事故調查報告

中華民國 100 年 5 月 12 日，立榮航空公司執行 BR 806 班機任務，MD-90 型機，國籍標誌及登記號碼 B-17917，於桃園機場落地時偏離跑道

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