國家運輸安全調查委員會

重大運輸事故

調查報告

中華民國 107 年 2 月 5 日

內政部空中勤務總隊

UH-60M 型機

編號 NA-706

自蘭嶼機場起飛後墜海

報告編號：TTSB-AOR-19-09-001

報告日期：民國 108 年 9 月

依據中華民國運輸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。

中華民國運輸事故調查法第 5 條：

運安會對於重大運輸事故之調查，旨在避免運輸事故之再發生，不以處分或追究責任為目的。

國際民航公約第 13 號附約第 3 章第 3.1 節規定：

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

摘要報告

民國 107 年 2 月 5 日，內政部空中勤務總隊（以下簡稱空勤總隊）一架 UH-60M 型直昇機，編號 NA-706，執行由蘭嶼機場至臺東豐年機場之病患後送任務，機上載有正駕駛員、副駕駛員、機工長各 1 人，另有病患、病患家屬及護理人員各 1 人，共計 6 人。事故機約於 2348 時自蘭嶼機場起飛約 81 秒後，與航管失去聯絡，事故機雷達光點亦自航管雷達銀幕上消失。

經水下偵搜結果，2 月 9 日於蘭嶼外海偵測獲得事故機飛航紀錄器之水下定位信標訊號。經進一步精確定位後，3 月 5 日於蘭嶼機場西方外海約 2 浬，水深約 1,000 公尺處，由水下遙控無人載具發現及認定確係事故機殘骸，並於 4 月 12 日將其打撈上岸。經檢視事故機殘骸，駕駛艙及尾段遺失，機上 2 人罹難，4 人失蹤。

依據中華民國運輸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，運安會為負責本次飛航事故調查之獨立機關。受邀參與本次調查之機關（構）包括：交通部民用航空局、空勤總隊、國防部陸軍司令部。

本事故「調查報告草案」於 108 年 6 月完成，依程序於 108 年 6 月 25 日經飛安會第 80 次委員會議初審修正後函送相關機關（構）提供意見；經彙整相關意見後，調查報告於 108 年 9 月 6 日經運安會第 3 次委員會議審議通過後，於 108 年 9 月 24 日發布調查報告。

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 16 項，改善建議共計 7 項，如下所述。

壹、調查發現

<u>與可能肇因有關之調查發現</u>

1. 飛航組員對事故當時飛航環境之威脅管理、狀況警覺及溝通決策能力不夠充分，且對航機系統瞭解程度不足。於夜間、風向不定狀況下，未使用適當起飛模式起飛，於起飛過程中亦未能維持安全之爬升姿態及速度、且於遭遇亂流時未能即時判讀高度及速度之變化而採行正確之修正操作，並可能伴隨有空間迷向之現象，最後於低高度狀況下，推機頭改正過低之空速時，因未注意當時高度且使用過當之馬力及俯角，致造成航機於可操控之狀態下墜海。

<u>與風險有關之調查發現</u>

1. 事故機自蘭嶼起飛後約 23 秒即遭遇順風，並逐漸增強，瞬間最大曾達 40 浬/時，並兼具有風切與亂流現象，但仍在航機安全操作限制範圍內，且相關操控數據亦未顯示航機有異常現象。
2. 事故當時之飛航環境存在暗適應及空間迷向之條件。
3. 空勤總隊未編撰該型機完整之標準作業程序；事故飛航中飛航組員亦未完全依照現行相關規定執行應有之檢查程序及呼叫，容易遺漏相關操作之程序。
4. 空勤總隊未能完整規劃相關飛航組員之訓練，影響飛航組員之資格能力及飛航安全。
5. 空勤總隊未妥善安排 UH-60M 型機之訓練資源，於換裝先進機種未規劃充分之地面學科，且模擬機之訓練時數不足，影響飛航組員相關系統之熟悉程度，不易達成預期訓練效益。
6. 空勤總隊相關手冊並無與夜航及儀器飛行時間相關之規定及最低要求。
7. 空勤總隊無具體完整之組員資源管理訓練教材，無法達成組員合作訓練之目的。
8. 空勤總隊事故當時之任務作業程序及手冊未訂定夜間執行傷患運送

任務之天氣標準，影響飛航安全。

其他調查發現

1. 空勤總隊未依照該航務手冊之規定裝置水上浮具。
2. 夜間飛航時，目的地機場夜間跑道邊燈對飛航中跑道之識別、障礙物隔離、進場及落地均大有助益。
3. 事故機「FD COUPLE」、FDR 1 之「Cyclic Longitudinal」、FDR 1 及 FDR 2「Collective Trim」參數、FDR 1 及 FDR 2「Yaw trim posn」等參數之紀錄有誤。
4. 飛行員於夜間飛行期間配戴夜視鏡，有助於對外界地形、地物之參考。
5. 飛航組員相關飛航證照，符合現行空勤總隊相關之規定，無證據顯示飛航組員於該次飛航中曾受任何酒精藥物之影響。
6. 本次事故與航機之載重平衡及航機系統無關。
7. 依據中央氣象局蘭嶼氣象站 2 月 5 日 2300 時至 2 月 6 日 0000 時之風向風速觀測紀錄，此時段最大陣風為風向 040 度，風速 68 浬/時。

貳、改善建議

致內政部空中勤務總隊

1. 加強飛航組員威脅管理、狀況警覺、溝通決策能力、航機系統瞭解程度之訓練，並訂立儀器飛航及夜航訓練需求及標準。（TTSB-ASR-19-09-001）

2. 檢視 UH-60M 型機飛航組員訓練計畫之完整性及訓練資源，以落實相關飛航組員之訓練成效。（TTSB-ASR-19-09-002）

3. 檢視航務管理手冊、任務作業程序內容之一致性及完整性，以利相關飛航任務執行之安全。（TTSB-ASR-19-09-003）

4. 考量訂定夜間執行傷患運送任務之天氣標準及 UH-60M 型機標準作業程序之必要性，以利相關任務之執行。（TTSB-ASR-19-09-004）

5. 規劃具體完整之組員資源管理訓練教材，以利飛航任務之執行。（TTSB-ASR-19-09-005）

6. 檢視整合式載具健康管理系統(IVHMS)，有關「FD COUPLE」、FDR 1 之「Cyclic Longitudinal」、FDR 1 及 FDR 2「Collective Trim」參數、FDR 1 及 FDR 2「Yaw trim posn」等參數之正確性，以利相關飛航資料之判讀。（TTSB-ASR-19-09-006）

<u>致交通部民用航空局</u>

1. 重新考量蘭嶼機場夜間緊急醫療起降需求，強化跑道燈光辨識及引導功能。如未能改善跑道建設需求，則應強化夜間直昇機停機坪之規劃及作業程序。（TTSB-ASR-19-09-007）

目錄

表目錄

圖目錄

英文縮寫對照簡表

ADC	air data computer	空氣資料電腦
AQC	pilot aircraft qualification course	飛行員訓練
AWOS	automated weather observation system	自動氣象觀測系統
AFCS	automatic flight control system	自動飛行控制系統
APU	auxiliary power unit	輔助動力單元
CBIT	continuous built-in test	持續內建測試
CFIT	controlled flight into terrain	操控下接近地障
CVR	cockpit voice recorder	座艙語音紀錄器
EFIS	electronic flight instrument system	電子飛航儀表系統
EGI	embedded GPS inertial navigation	嵌入式全球定位系統/慣性導航
EICAS	engine instrument and crew alert system	發動機指示及組員警示系統
FCC	flight control computer	飛行控制電腦
FDR	flight data recorder	飛航資料紀錄器
FD	flight director	飛航導引
FMS	flight management system	飛航管理系統
FPS	flight path stabilization	飛行路徑穩定
HUMS	health and usage monitoring system	健康及使用監控系統
IBIT	initiated built-in test	初始內建測試
IPC	instructor pilot course	飛航教師訓練
IVHMU	integrated vehicle health management unit	整合式載具健康管理單元
LRU	line replaceable unit	現場可更換件
MFD	multifunction display	多功能顯示器

MPFR	solid-state multi-purpose flight recorder	固態式多用途飛航紀錄器
MTPC	Maintenance Test Pilot Course	維修試飛員訓練
PF	pilot flying	操控駕駛員
PM	pilot monitoring	監控駕駛員
PFD	primary flight displays	主要飛航顯示器
VOR	VHF Omni Range	特高頻多向導航臺
SAS	stability augmentation set	穩定增益系統
SOP	Standard Operating Procedures	標準作業程序

本頁空白

第 1 章　事實資料

1.1 飛航經過

民國 107 年 2 月 5 日，內政部空中勤務總隊（以下簡稱空勤總隊）一架 UH-60M 型直昇機，編號 NA-706，執行由蘭嶼機場至臺東豐年機場(以下簡稱豐年機場)之病患後送任務，機上載有正駕駛員、副駕駛員、機工長各 1 人，另有病患、病患家屬及護理人員各 1 人，共計 6 人。事故機約於 2348 時自蘭嶼機場起飛約 81 秒後，與航管失去聯絡，事故機雷達光點亦自航管雷達銀幕上消失。

經水下偵搜結果，2 月 9 日於蘭嶼外海偵測獲得事故機飛航紀錄器之水下定位信標訊號。經進一步精確定位後，3 月 5 日於蘭嶼機場西方外海約 2 浬，水深約 1,000 公尺處，由水下遙控無人載具發現及認定確係事故機殘骸，並於 4 月 12 日將其打撈上岸。經檢視事故機殘骸，機首及尾段遺失，機上 2 人罹難，4 人失蹤。

事故機之駐地位於豐年機場，飛航組員約於 2220 時接獲執行該任務之指示，於完成任務前整備後，即至機前進行飛行前提示、飛行前檢查及開車程序。事故機約於 2309 時起飛，機上載有正駕駛員、副駕駛員、機工長各 1 人，由正駕駛員坐於右座擔任操控駕駛員（pilot flying, PF），副駕駛員坐於左座擔任監控駕駛員（pilot monitoring, PM），起飛時蘭嶼機場之能見度尚未到達執行緊急任務(含搜救、緊急醫療等)夜間目視飛航之標準。

事故機起飛後，保持航向 220 度離場，之後轉向 100 度航向出海。出海後轉向 150 度航向，保持約 700 呎高度，加速至真空速 120 浬/時，使用飛航管理系統（flight management system, FMS）功能定向目的地。2316 時航管告知飛航組員天氣轉好，符合夜間目視飛航標準。2329 時，事故機與蘭嶼塔臺聯繫，塔臺告知事故機，機場能見度

為 5 公里，1,000 呎稀雲，1,800 呎裂雲，可以繼續進場。2333 時事故機向蘭嶼塔臺報告目視機場，塔臺告知事故機停機位置為 1 號停機坪。於進場落地過程中，約於 2337:32 時，距地高度約 115 呎、真空速約 47 浬/時，產生警示燈號，並伴隨有「FD COUPLE FAIL」及「FLT DIR FAIL」之訊息，飛航組員並未口頭報出及討論該警示訊息之內容。上述訊息約於 2337:41 時消失，當時距地約 134 呎、真空速約為 35 浬/時。事故機隨後於 2338:47 時安全於蘭嶼機場落地，並順利滑行至 1 號停機坪等待接收病患。由豐年機場至蘭嶼機場之飛航軌跡如圖 1.1-1。

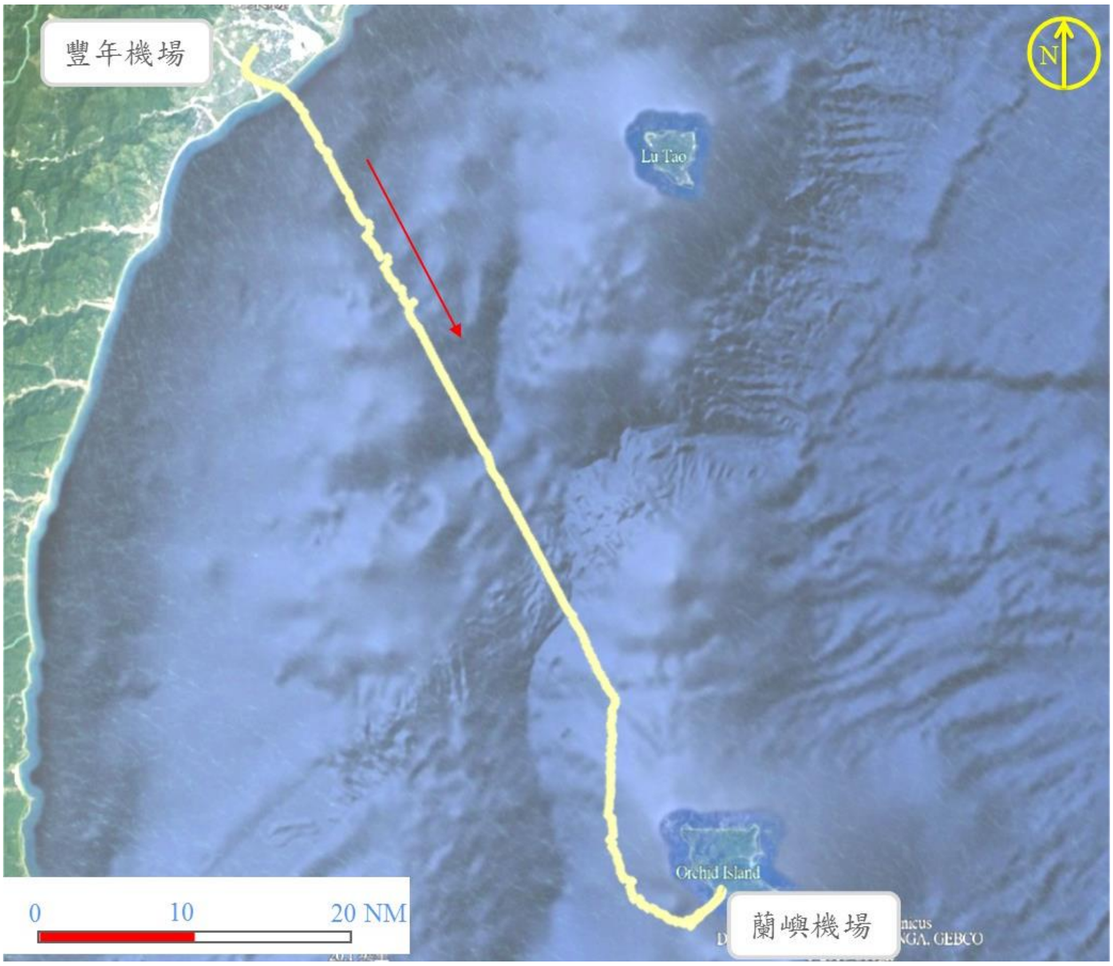


圖 1.1-1 豐年機場至蘭嶼機場飛航軌跡圖

事故機於地面等待病患到達前，飛航組員曾討論起飛之操作程序，並決定由正駕駛員操作事故機起飛，到達安全高度後再由副駕駛員接

手，副駕駛員同時提及起飛時可使用重飛（go around）模式。該次任務，載運之人員含病患、病患家屬及護理人員各 1 人，飛航組員於確認載運之人員已進艙並完成安全檢查後，於 2348:36 時，PF 操作事故機起飛，集體桿配平係於手動（collective trim disengaged）狀態，迴旋桿配平係於自動（cyclic trim engaged）狀態。

2348:55 時，事故機距地面高度 74 呎，真空速 53 浬/時，為爬升狀態。2348:56 時，距地面高度約 100 呎、真空速由 53 浬/時降低至 47 浬/時，「FD COUPLE FAIL」及「FLT DIR FAIL」之警示訊息及警示燈再度出現，飛航組員亦未討論該警示訊息之狀況。該警示訊息及燈號於 2348:59 時消失，當時雷達高度約 123 呎，真空速約 50 浬/時，期間發動機之扭力值由約 85%改變至 103%。之後事故機保持 600 至 700 呎/分之爬升率，並持續爬升加速。

2349:09 時，PF 將集體桿配平改為自動操作（collective trim engaged），約於 2349:14 時，PM 呼叫：「空速結合」，PF 並叫：「…沒關係，這是亂流[1]」，當時真空速約為 95 浬/時，集體桿之位置約為 16%，發動機之扭力值約為 75%。之後將集體桿配平改回手動（collective trim disengaged）操作，約 2349:20 時，PM 回應：「現在是正爬升率，沒關係」，此時雷達高度約 197 呎，真空速約 106 浬/時，爬升率約 192 呎/分，PF 將集體桿之位置回收至約 4%位置，發動機之扭力值降至約 56%，姿態由俯角轉為仰角。

2349:28 時，PF 又將集體桿配平改為自動操作模式，此時事故機之仰角約為 5 度並持續上升中，發動機之扭力值約為 50%，並持續降低。至 2349:37 時，雷達高度約 256 呎，真空速約 74 浬/時，爬升率約 224 呎/分，仰角約 20 度，集體桿位置降低至-34%，發動機之扭力值約降低至 10%。2349:42 時，事故機雷達高度約 287 呎，真空速由 53 浬/時降低至 49 浬/時，PF 呼叫：「…空速減、推頭…」，2349:44 時，

[1] 此期間垂直加速度瞬間曾達 2.1g

警示燈號再次亮起，「FD COUPLE FAIL」及「FLT DIR FAIL」之訊息亦同時出現，飛航組員也未呼叫及討論該警示訊息。當時雷達高度約 290 呎，此時集體桿配平為自動模式，而迴旋桿配平由自動操作模式改為手動操作模式，真空速 41 浬/時，事故機由爬升狀態改為平飛並開始有下降率。

於 2349:45 時，PF 將迴旋桿配平改為手動操作，集體桿配平仍為自動操作模式，事故機之仰角約由 22 度至 15 度並持續下掉。PF 將集體桿提起至約-22%之位置，發動機之扭力上升至約 27%，並開始持續增加。該警示燈號及失效訊息於 2349:50 時消失，雷達高度約 250 呎，真空速約 50 浬/時增加中，下降率約 560 呎/分，此時迴旋桿約為 8%之位置。

PM 於 2349:49 時呼叫：「空速、空速」，PF 則回應：「空速未到，推頭…」，並呼叫幫我看高度。2349:51 時，PF 將集體桿配平改為手動操作模式，並提起至約-3%位置，扭力增加至約 45%。2349:54 時，雷達高度約 133 呎，真空速約 74 浬/時，下降率已增加為約 2,100 呎/分，PF 提起集體桿位置至 15%，扭力增加至約 70%，迴旋桿為手動操作、位置向前最大到達-11.5%。2349:56 時，真空速約 92 浬/時，雷達高度約 55 呎，下降率約 2,200 呎/分，扭力約 90%，約 0.6 秒後，低高度警示音啟動，當時之集體桿及迴旋桿之操作模式均於手動狀態，事故機仍以約 20 度之俯角向下飛航。約 1 秒後（2349:57 時），事故機之飛航資料紀錄器（flight data recorder, FDR）及座艙語音紀錄器（cockpit voice recorder, CVR）之紀錄停止。事故機自蘭嶼起飛後飛航軌跡如圖 1.1-2。

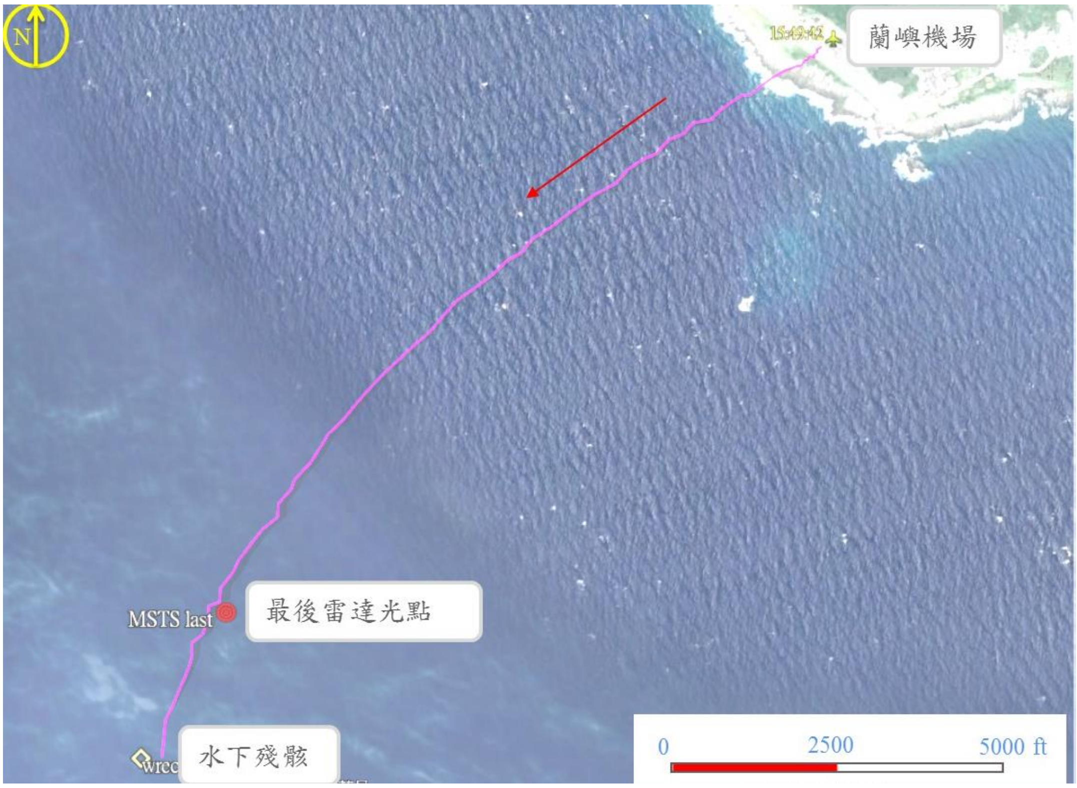


圖 1.1-2 事故前飛航軌跡圖

1.2 人員傷害

事故機傷亡統計如表 1.2-1。

表 1.2-1 傷亡統計表

傷亡情況	飛航組員	機工長	乘客	其他	小計
死亡[2]	2	1	3	0	6
重傷	0	0	0	0	0
輕傷	0	0	0	0	0
無傷	0	0	0		0
總人數	2	1	3	0	6

[2] 民用航空法第 98 條：因航空器失事，致其所載人員失蹤，其失蹤人於失蹤滿六個月後，法院得因利害關係人或檢察官之聲請，為死亡之宣告。

1.3 航空器損害

航空器全毀。

1.4 其他損害情況

無其他損害。

1.5 人員資料

1.5.1 駕駛員經歷

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	53	48
進入公職日期	民國 101 年	民國 99 年
航空人員類別	正駕駛	副駕駛
檢定項目	UH-60M	UH-60M
發證日期	102 年 06 月 24 日	102 年 07 月 16 日
到期日期	107 年 08 月 20 日	107 年 03 月 20 日
體格檢查種類 檢查日期	乙類駕駛員 106 年 04 月 24 日	乙類駕駛員 106 年 05 月 10 日
總飛航時間	3,506 小時 05 分	2,089 小時 25 分
事故型機飛航時間	148 小時 25 分	216 小時 20 分
最近 12 個月飛航時間	104 小時 05 分	187 小時 10 分
最近 90 日內飛航時間	19 小時 50 分	21 小時 00 分
最近 30 日內飛航時間	06 小時 40 分	12 小時 20 分
最近 7 日內飛航時間	1 小時 30 分	1 小時 00 分
事故前 24 小時飛航時間	0 小時 30 分	0 小時 30 分
事故前休息時間	8 小時以上	8 小時以上

1.5.1.1 正駕駛員

正駕駛員為中華民國籍，曾為旋翼機軍事飛行員，曾飛機型有TH-55、S-70C、UH-1H 及 UH-60M 等型機。民國 101 年 7 月進入空勤總隊，同年 11 月 16 日完成 UH-1H 型機之副駕駛訓練，開始擔任該型機之副駕駛員。正駕駛員曾於民國 105 年 11 月 3 日赴美國RESICUM 公司接受 S-70i[3] 型機之機種轉換、飛航教師及檢定機師訓練，分別於次年 1 月 15 日、2 月 6 日及 2 月 20 日完成 S-70i 型機之正駕駛、飛航教師及檢定機師訓練。該員於美接受 S-70i 型機相關訓練之詳細訓練紀錄則未獲得。

經檢視正駕駛員之年度訓練及檢定紀錄摘要如後；民國 102 年至104 年擔任 UH-1H 型機副駕駛期間，其年度訓練及考核之建議及講評，需加強之課目摘要如下：學科之瞭解程度、組員資源管理、自轉操作技巧、基本儀器操作、高高度起降操作、陸上偵查程序及精確滯空之穩定性等。正駕駛員擔任 UH-60M 型機正駕駛/飛航教師期間，106 年度年度訓練及檢定紀錄之建議及講評摘要如下：低高度/高高度滯空操作需穩定柔和、開試關車程序及系統熟悉度需加強、高山起降航線規劃需多練習、高高度起降需注意進場角度及速度等。

正駕駛員最近一次夜間目視飛航之日期為民國 107 年 1 月 26 日。依據正駕駛員自海軍擔任飛行官期間，實施夜間目視 227 小時 50 分鐘、夜間儀器 70 小時 30 分鐘，合計夜航總時間 298 小時 20 分鐘；另統計自民國 101 年 11 月進入空勤總隊任職至事故發生前之飛行時間紀錄，該員夜航總時間為 17 小時 40 分鐘；含 11 小時夜間目視時間及 6 小時 40 分鐘之夜間儀器時間，其中 UH-60M 型機之夜間目視時間為 1 小時 55 分鐘，無 UH-60M 型機之夜間儀器時間。

正駕駛員最近一次體檢日期為民國 106 年 4 月 24 日，於國軍高

[3] S-70i 為 UH-60M 型機之民用型。

雄總醫院岡山分院接受空勤人員體檢。體檢表「適合航空體檢標準」欄內，註記為:「適合/第乙類」。正駕駛員於事故當日，執行每日任務提示前酒精測試，測試結果：酒精值為零。

1.5.1.2 副駕駛員

副駕駛員為中華民國籍，曾為旋翼機軍事飛行員，曾飛機型有TH-55、UH-1H、S-70C 及 AS-365N 等型機。民國 99 年 3 月進入空勤總隊。同年 6 月 30 日完成 AS-365N 型機之副駕駛訓練，開始擔任該型機之副駕駛員。民國 103 年 11 月 10 日完成 AS-365N 型機之正駕駛訓練，開始擔任該型機之正駕駛員。副駕駛員曾於民國 105 年 11 月 3 日赴美國 RESICUM 公司接受 S-70i 型機機種轉換訓練，於民國 106 年 1 月 18 日返國。該員於民國 106 年 2 月 6 日起接受 UH-60M 型機之副駕駛訓練，於民國 106 年 3 月 21 日完成副駕駛員訓練。

經檢視副駕駛員相關訓練及檢定紀錄摘要如後；副駕駛員民國 103 年至 105 年擔任 AS-365 型機正駕駛員期間，年度訓練及考核之建議及講評，需加強之課目摘要如下：高山起降之偵查須注意下降率及馬力、滾行操作/馬力檢查操作應避免粗猛、滯空操作修正量、尾旋翼失效操作、定點操作之穩定度等課目。副駕駛員 106 年度擔任 UH-60M 型機副駕駛年度訓練及檢定紀錄則無異常建議及講評。

副駕駛員在美接受 S-70i 型機轉換訓練期間，實機飛行訓練共計 8 架次，其中目視起飛、目視操作、目視進場、緊急程序處置、飛航導引操作（flight director operations）及飛航導引系統不及格之架次為 4 架次。

副駕駛員最近一次夜間目視飛航之日期為民國 107 年 1 月 8 日。依據副駕駛員自民國 99 年 3 月至事故發生前之飛行時間紀錄，該員夜航總時間為 203 小時 45 分鐘；含 179 小時 45 分鐘夜間目視時間及 24 小時之夜間儀器時間，其中 UH-60M 型機之夜間目視時間為 14 小

時，UH-60M 型機之夜間儀器時間為 1 小時。

副駕駛員最近一次體檢日期為民國 106 年 5 月 10 日，於國軍高雄總醫院岡山分院執行空勤人員體檢。體檢表「適合航空體檢標準」欄內，註記為:「適合/第乙類」。副駕駛員於事故前，執行每日任務提示前酒精測試，測試結果：酒精值為零。

1.5.2 駕駛員事故前 72 小時活動

有關駕駛員事故前 72 小時活動資料，係由與事故機飛航組員共勤之其他飛航組員提供。事故機飛航組員於事故當日下午返回駐地開始擔任備勤任務，前 2 日係休假返家，組員居家相關活動則未獲得。

正駕駛員：

2 月 03 日： 休假在家。

2 月 04 日： 休假在家。

2 月 05 日： 1630 時返隊開始擔任備勤任務。

副駕駛員：

2 月 03 日： 休假在家。

2 月 04 日： 休假在家。

2 月 05 日： 1630 時返隊開始擔任備勤任務。

1.6 航空器資料

1.6.1 航空器與發動機基本資料

事故機基本資料如表 1.6-1。

表 1.6-1 航空器基本資料表

航空器基本資料表（統計至民國 107 年 2 月 4 日）	
國籍	中華民國
航空器登記號碼	NA-706
機型	UH-60M
製造廠商	美國塞考斯基飛機公司（Sikorsky）
出廠序號	12-27294
出廠日期	民國 105 年 1 月 07 日
接收日期	民國 105 年 7 月 16 日
所有人	中華民國陸軍
使用人	內政部空中勤務總隊
航空器總使用時數	315 時 24 分
航空器總落地次數	457 次
上次定檢種類	30D/40H
上次定檢日期	民國 107 年 1 月 14 日
上次定檢後使用時數	11 時 24 分
上次定檢後落地次數	18 次
最大起飛重量	22,000 磅
最大落地重量	22,000 磅

事故發動機基本資料詳表 1.6-2。

表 1.6-2 發動機基本資料表

發動機基本資料表(統計至民國 107 年 2 月 4 日)		
製造商	GE ENGINE SVCS DIST., LLC	
編號/位置	No. 1/左	No. 2/右
型別	T700-GE-701D	T700-GE-701D
序號	GE-E903876	GE-E903877
製造日期	民國 104 年 6 月 24 日	民國 104 年 6 月 24 日
發動機經歷紀錄器 LCF1	245	226
發動機經歷紀錄器 LCF2	868	720
發動機經歷紀錄器 INDEX	565	1922
發動機經歷紀錄器 HOURS	465 時	423 時

1.6.2 維修相關紀錄

檢視事故機自接收後至事故前之飛機檢查與保養紀錄表，事故前最後一次定檢及結構重大檢修項目執行紀錄，1、2 號發動機滑油消耗狀況皆無異常；2 號發動機於民國 106 年 12 月 30 日及民國 107 年 1 月 4 日曾發生啟動時發動機 Ng（氣體產生器轉速）無指示之狀況，該狀況於民國 107 年 1 月 9 日，由承接空勤總隊 UH-60M 型機商維業務之漢翔公司維修人員更換啟動器，並執行地面動力測試後，至本次事故發生前未再出現，其餘維護保養記錄無其他航機系統異常發現。

依據空勤總隊 UH-60M 型機航空器維護計畫手冊，檢視事故機前一個月之每次飛行前（before every flight）檢查、每日第一次飛行前（before first flight）檢查、飛行後檢查（post flight check）以及每日預防檢查（preventive maintenance daily）紀錄，經與事故機前一個月任務派遣記錄及整合式載具健康管理單元（integrated vehicle health management unit, IVHMU）維保系統飛航時間紀錄對照無異常發現，紀錄詳如附錄 1。

檢視事故機飛航安全作為訊息（aviation safety action message）、飛航維護作為訊息（aviation maintenance action message）及飛行安全（safety of flight）紀錄無異常發現。適航指令（airworthiness release）有 11 項持續管制中。

依據事故機階段檢查紀錄，該機於總使用時數 304 小時執行 40 小時/30 日定期檢查作業，無異常發現。

檢視事故機於事故前一個月之整合式載具健康管理系統（integrated vehicle health management unit, IVHMS）維修監控紀錄，共計有 19 項「Exceeded」及 61 項「Caution」之維修參考訊息，詳如附錄 2；針對前述維修參考訊息，經查詢空勤總隊做法，係依據美軍 AWR1726 及 H-60 condition based maintenance manual 執行檢視，其餘

規範外項目係採先觀察再視狀況維修方式管制。

1.6.3 自動飛航控制系統

自動飛行控制系統（automatic flight control system, AFCS）包含：安定面（stabilator）、配平（trim）、穩定增益系統（stability augmentation set, SAS）、飛行路徑穩定（flight path stabilization, FPS）及飛航導引（flight director, FD）等五部分，AFCS 系統功能為協助駕駛員飛航時增強直昇機之穩定和操控性能。

安定面位置可依據直昇機集體桿、空速、俯仰率及橫向加速度之感測訊號，透過電動控制之致動器調整，以增進直昇機操作之飛行穩定度；SAS 可提供直昇機在俯仰、滾轉和偏航軸上暫態偏側時之修正；直昇機在飛行路徑穩定模式時，配平/FPS 裝置可提供控制定位、力量梯度功能以及基本自動駕駛功能；FD 可提供駕駛員三軸操控選項提示並顯示在主要飛航顯示器（primary flight display, PFD）上，亦可供駕駛員輸入相關操控量之選擇，及直接進入結合模式，以進行相關自動飛航控制之功能。

1.6.3.1 飛航導引系統

飛航導引系統包含位於正駕駛員和副駕駛員儀表板之飛航導引/顯示控制面板（display control panels），位於正駕駛員和副駕駛員迴旋桿手柄之重飛（GO ARND）及遙控備用開關（remote standby, RMT SBY），以及 2 具獨立的飛行控制電腦（flight control computer, FCC），其中 1 號 FCC 位於後機身之航電艙內，2 號 FCC 位於機鼻艙內；飛航導引/顯示控制面板（FD /DCP）詳如圖 1.6-1。

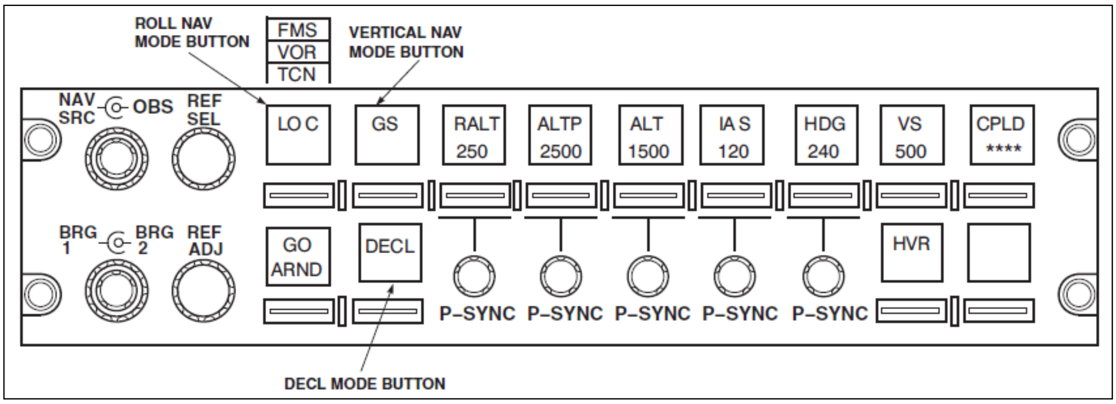


圖 1.6-1 飛航導引/顯示控制面板

FD 操作模式計有：雷達高度保持（radar altitude hold, RALT），氣壓高度預設（barometric altitude preselect, ALTP），氣壓高度保持（barometric altitude hold, ALT），空速保持（airspeed hold, IAS），航向選擇（heading select, HDG），垂直速度保持（vertical speed hold, VS），特高頻多向導航臺（VHF omni range, VOR），ILS 左右定位臺（localizer, LOC），ILS 背向航道（back course, BC），ILS 下滑道（glide slope, GS），儀器降落系統減速（ILS deceleration），重飛（go around, GA），FMS 長距離導航（long range navigation, LNAV），FMS 垂直導航（vertical navigation, VNAV），滯空保持（hover hold, HVR），備用（RMT STBY）等 16 種，操作者可由正、副駕駛之飛航導引/顯示控制面板，設定所需操作模式。有關重飛（GO ARND）模式之功能，係經由 FD 面板之之按鈕開關或迴旋桿上之按鈕致動後，航機將自行加速至 70 浬/時，並以 750 呎/分之爬升率爬高至預設之高度。

當任一具 FCC 在耦合操作模式時，其會提供俯仰、滾轉和集體桿指令予自動飛行控制系統，驅動自動駕駛飛行的配平致動器。FD 同時會在正駕駛員和副駕駛員在以耦合（coupled）或分離（decoupled）模式操作時，於多功能顯示器（multifunction display, MFD）之 PFD 提供接合（engaged）模式之指令提示。

作用中之 FD 指示及其模式會顯示於姿態及航向指示器（attitude

direction indicator, ADI）右上方，同一時間只可有一套耦合之 FD（FD1 或 FD2），綠色燈號顯示 FD 耦合之狀態，指出自動駕駛當時接合到那一套 FD（如圖 1.6-2）；當自動駕駛未耦合至 FD，或來自 FD 的資訊無法決定是否進入耦合之狀態時，綠色燈號顯示之 FD 耦合狀態提示就會消失，同時導致 FD COUPLE FAIL 和/或 FLT DIR FAIL 之警示出現。另飛航中於 FD 耦合狀態下，如空速低於 50 浬/時，FD COUPLE FAIL 及 FLT DIR FAIL 之訊息及警示燈均會出現。

依據該型機操作手冊，MFD 之發動機指示及組員警示系統（engine instrument and crew alert system, EICAS）以橘色顯示出現前述 2 種警示說明如下：

- 顯示「FD COUPLE FAIL」時，表示 FD 曾耦合至 AFCS，但因失效致解除（Indicates that flight director was coupled to AFCS, but has been decoupled due to a failure.）；
- 顯示「FLT DIR FAIL」時，表示一具或多具 FD 之功能被解除接合（Indicates that one or more flight director functions has been disengaged.）。

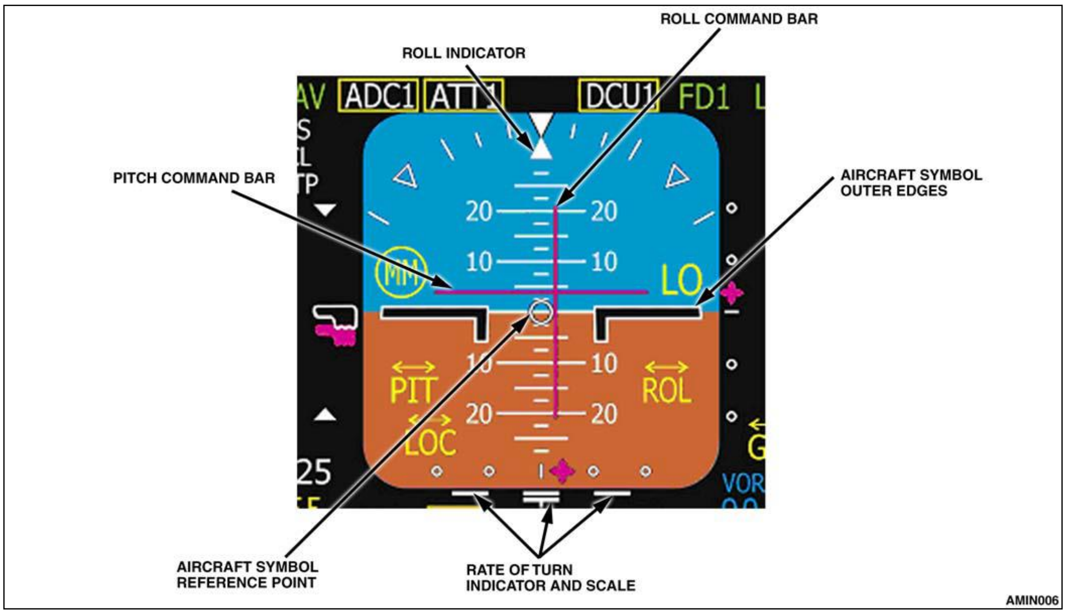


圖 1.6-2 作用中之 FD 指示及其模式之顯示

FD 處理來自導航和飛行儀表的訊號，以產生航機對俯仰、滾轉或集體桿軸做動之控制指令，此控制指令允許直昇機在飛行路徑穩定控制下：朝需求的方向飛行、到達選定的航向、進行儀降進場、保持在固定的高度和/或空速、以及進行程式化的減速和下降來到達預定的空速和高度。FD 同時可提供雷達高度保持模式、位置或速度保持模式以及爬升模式，雷達高度模式可將直昇機保持在選定的距離地面以上（above ground level, AGL）高度，FD 系統方塊圖如圖 1.6-3。

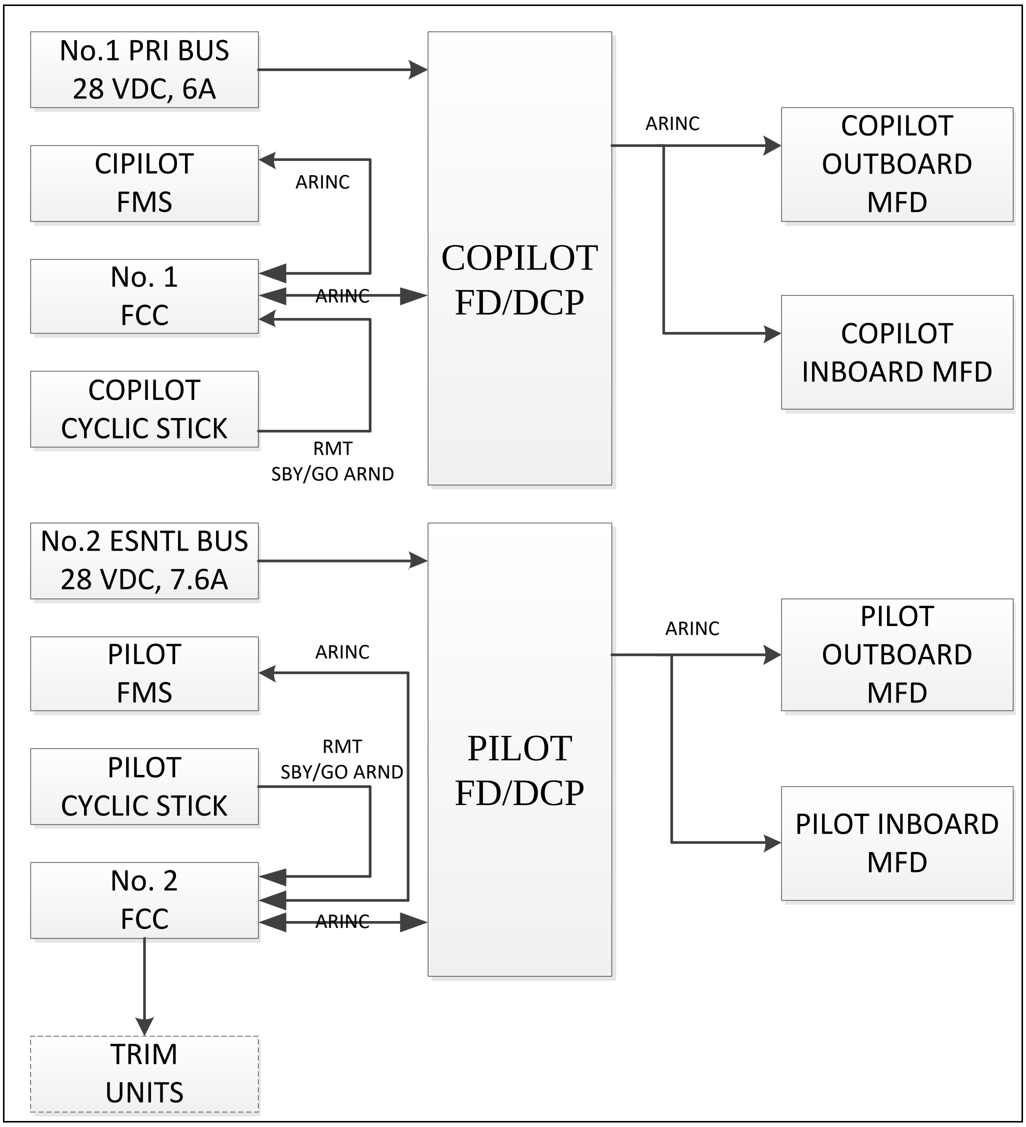


圖 1.6-3 飛行指示套件方塊圖

與 FD 界面之組件包含：

- 數位式自動飛行控制單元，橫向、縱向及垂直加速度計
- 慣性導航/GPS，1 號 及 2 號 EGIs
- 空氣資料電腦（air data computer, ADC）系統，1 號 及 2 號 ADCs
- 雷達高度系統，接收-傳送器
- 飛行管理系統（FMS），含正駕駛和副駕駛。
- 飛行任務顯示系統（flight mission display set），電子飛航儀表系統（electronic flight instrument system, EFIS）接線盒及 MFDs

1.6.4 整合式載具健康管理系統

IVHMS 包含：FDR、CVR、健康及使用監控系統（health and usage monitoring system, HUMS）以及水下定位信標等 4 部份；IVHMU 具備一片容量為 1GB 之記憶卡，透過直昇機數據傳輸網路，IVHMU 接收來自資料傳輸套件（data transfer set）PCMCIA 卡傳送之 HUMS 資料，IVHMU 再將 IVHMS 資料回傳到 DTS PCMCIA 卡內之維修目錄。HUMS 和 CVR / FDR 之資料下載則各自獨立。

HUMS 功能區分為使用監控和健康監控，使用監控包括操作使用、超標監控及直昇機操作範圍辨識（regime recognition）；健康監控包括旋翼軌跡及平衡、機械診斷、軸承監控及發動機震動監控。HUMS 運用安裝於直昇機各重要部位之加速度計、溫度感測器、轉速計及光學追踪器，以追蹤及監控特定之溫度值、震動值、脈衝輸入界面、定時參考以及通用頻率輸入界面等，再透過資料匯流排及駕駛艙區域麥克風被記錄到 HUMS。

1.6.5 載重與平衡

依據事故機本次飛航之載重平衡表及飛航計畫，其載重及平衡相關資料如表 1.6-3。

表 1.6-3 載重及平衡相關資料表

實際零油重量	13,695 磅
最大起飛總重	22,000 磅
實際起飛總重	15,195 磅
起飛油量	1,500 磅
航行耗油量	400 磅
最大落地總重	22,000 磅
實際落地總重	14,795 磅

1.7 天氣資料

1.7.1 天氣概述

事故當日 2000 時亞洲地面天氣分析圖顯示高壓中心 1032 百帕位於湖北，近似滯留（詳圖 1.7-1），臺灣受此高壓影響，地面盛行偏東北風，臺灣海峽及東南部離島機場有強陣風。根據日本 Himawari-8 氣象衛星 2350 時紅外線衛星雲圖（詳圖 1.7-2），雲帶位於臺灣及東部海域，蘭嶼上空雲頂高約 12,000 呎。中央氣象局 2350 時都卜勒氣象雷達回波圖（詳圖 1.7-3）顯示事故區域無降水回波。

民航局臺北航空氣象中心於事故前後無顯著危害天氣資訊（SIGMET）及低空危害天氣資訊（AIRMET）發布，有效時間 2 月 6 日 0200 時之低層顯著天氣圖（SIGWX CHART，詳圖 1.7-4）顯示台灣東南部海域有層積雲裂雲，雲幕高 2,000 呎。

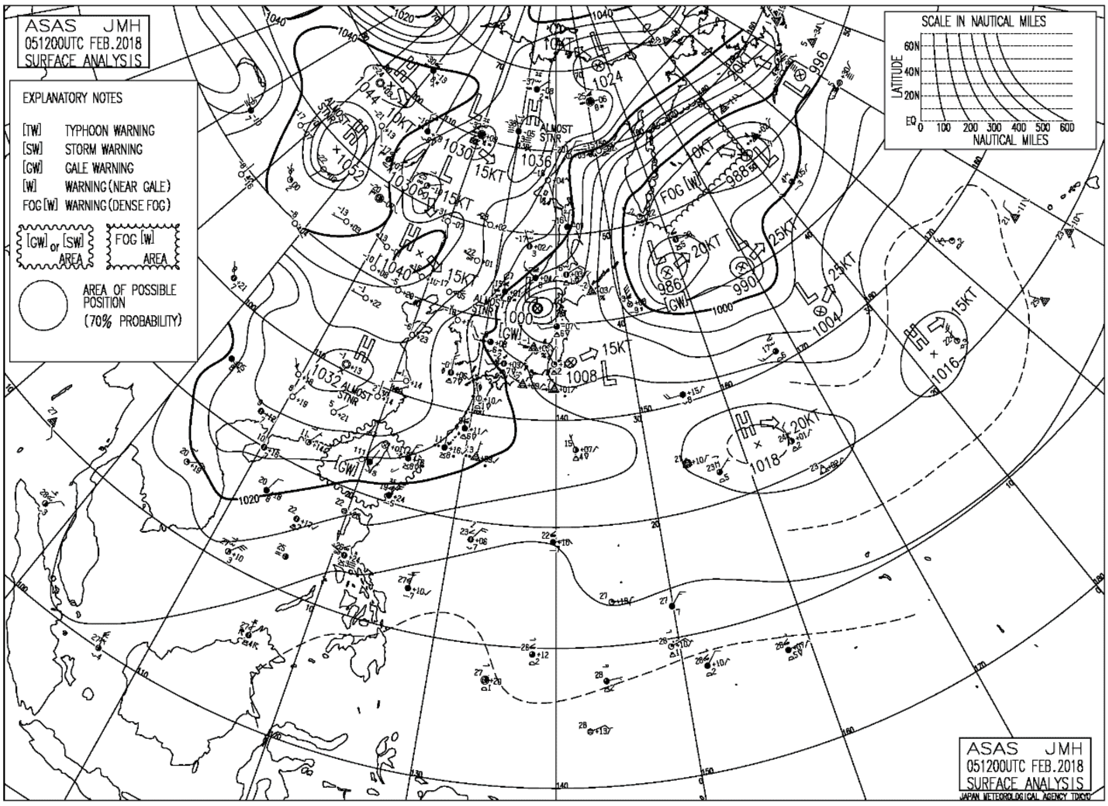


圖 1.7-1 2000 時亞洲地面天氣分析圖

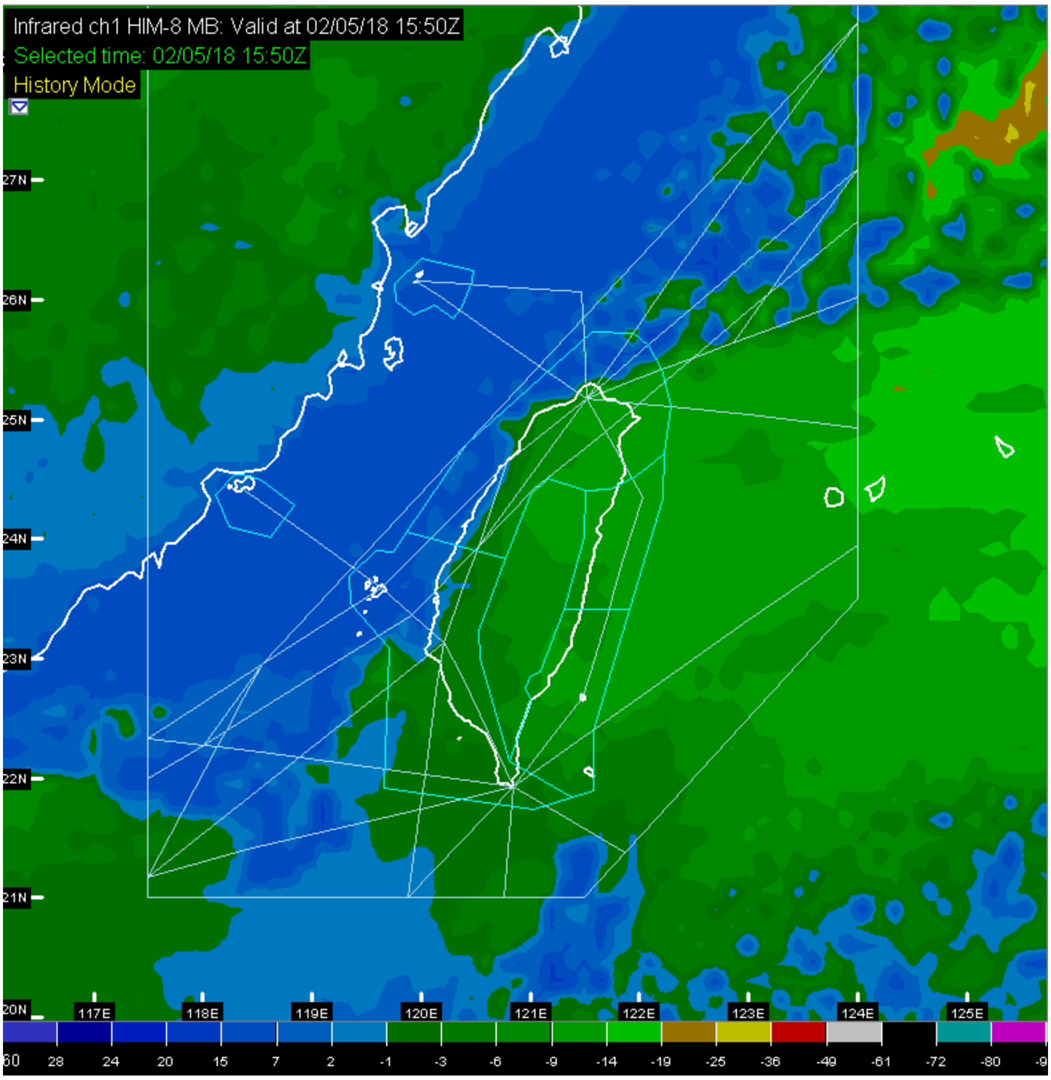


圖 1.7-2 2350 時紅外線衛星雲圖

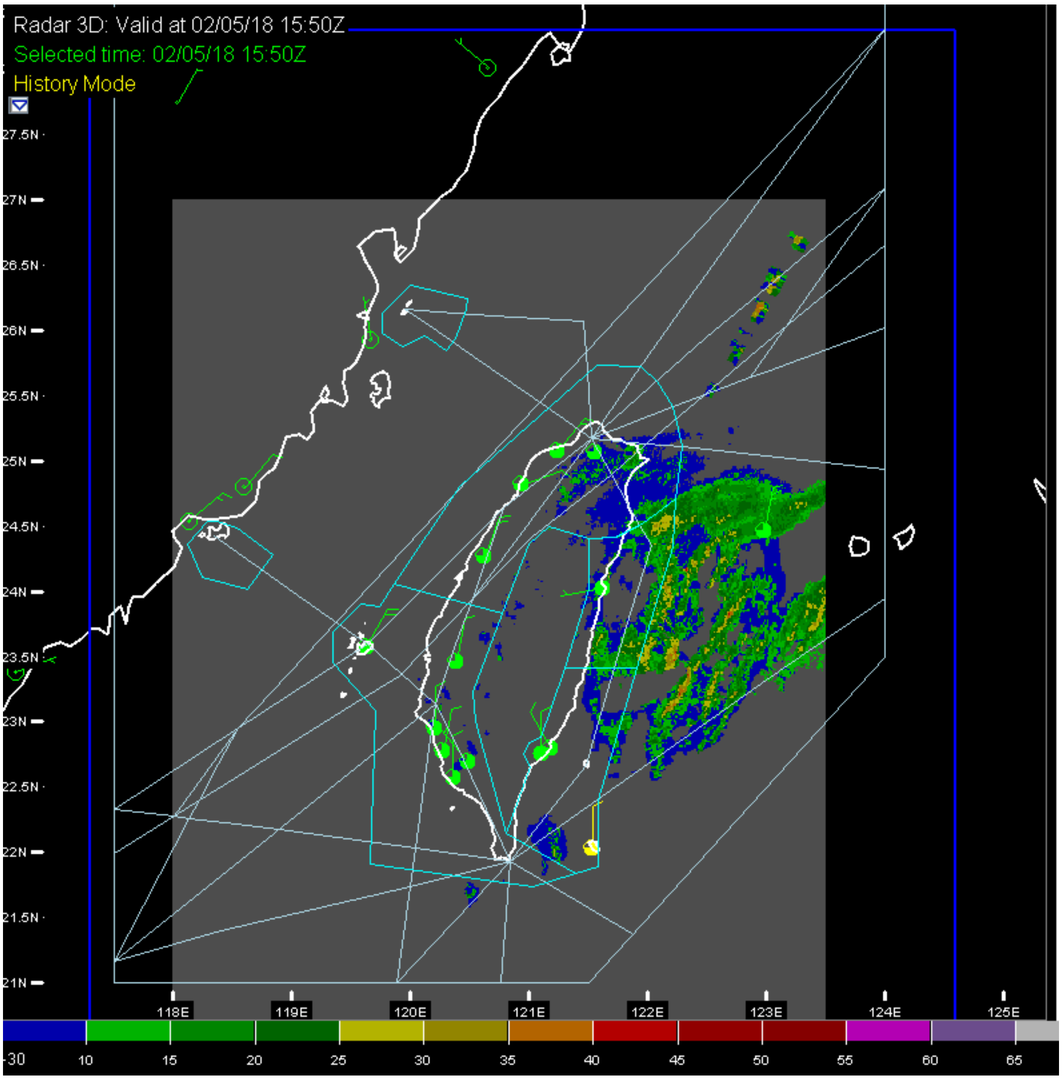
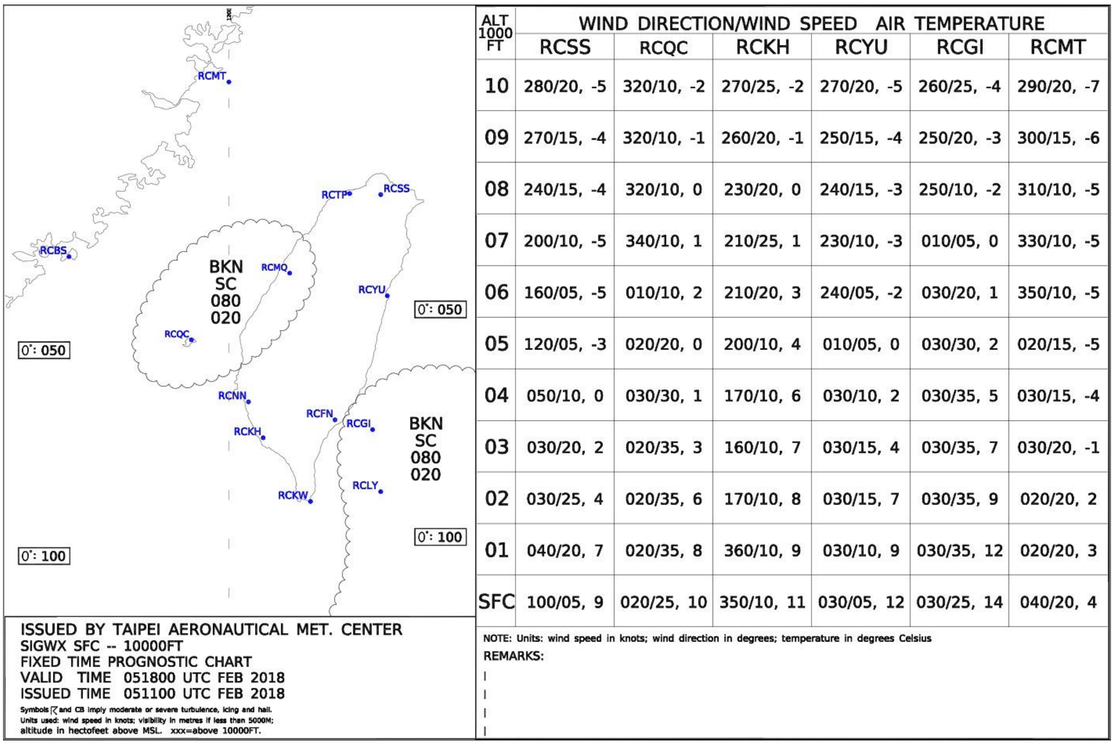


圖 1.7-3 2350 時都卜勒氣象雷達回波圖



ALT 1000 FT	WIND DIRECTION/WIND SPEED AIR TEMPERATURE					
	RCSS	RCQC	RCKH	RCYU	RCGI	RCMT
10	280/20, -5	320/10, -2	270/25, -2	270/20, -5	260/25, -4	290/20, -7
09	270/15, -4	320/10, -1	260/20, -1	250/15, -4	250/20, -3	300/15, -6
08	240/15, -4	320/10, 0	230/20, 0	240/15, -3	250/10, -2	310/10, -5
07	200/10, -5	340/10, 1	210/25, 1	230/10, -3	010/05, 0	330/10, -5
06	160/05, -5	010/10, 2	210/20, 3	240/05, -2	030/20, 1	350/10, -5
05	120/05, -3	020/20, 0	200/10, 4	010/05, 0	030/30, 2	020/15, -5
04	050/10, 0	030/30, 1	170/10, 6	030/10, 2	030/35, 5	030/15, -4
03	030/20, 2	020/35, 3	160/10, 7	030/15, 4	030/35, 7	030/20, -1
02	030/25, 4	020/35, 6	170/10, 8	030/15, 7	030/35, 9	020/20, 2
01	040/20, 7	020/35, 8	360/10, 9	030/10, 9	030/35, 12	020/20, 3
SFC	100/05, 9	020/25, 10	350/10, 11	030/05, 12	030/25, 14	040/20, 4

NOTE: Units: wind speed in knots; wind direction in degrees; temperature in degrees Celsius

REMARKS:

圖 1.7-4 2 月 6 日 0200 時之低層顯著天氣圖

1.7.2 地面天氣觀測

中央氣象局蘭嶼氣象站（位於蘭嶼機場 31 跑道頭東北方約 1.35 浬，高度 324 公尺，詳圖 1.7-5）民國 107 年 2 月 5 日 2300 時至 2 月 6 日 0000 時每分鐘平均風向風速觀測紀錄如圖 1.7-6，風向為北北東風，風速約 28 至 45 浬/時；此時段最大陣風為風向 040 度，風速 68 浬/時。

豐年機場地面天氣觀測紀錄如下：

民國 107 年 2 月 5 日 2300 時：風向 360 度，風速 9 浬/時，風向變化範圍 310 度至 040 度；能見度大於 10 公里；稀雲 2,500 呎，密雲 5,000 呎；溫度 12℃，露點 7℃；高度表撥定值 1024 百帕；趨勢預報—無顯著變化；備註—高度表撥定值 30.26 吋汞柱。

蘭嶼機場地面天氣觀測紀錄如下：

2 月 5 日 2300 時機場例行天氣報告：風向不定，風速 13 浬/時，陣風 29 浬/時；能見度 3,500 公尺；小雨；稀雲 800 呎，裂雲 1,200 呎，密雲 2,500 呎；溫度 15℃，露點 11℃；高度表撥定值 1022 百帕；趨勢預報—無顯著變化；備註—13 跑道風向不定，風速 6 浬/時，陣風 17 浬/時；高度表撥定值 30.20 吋汞柱，逐時降水量 6.2 毫米。

2 月 5 日 2317 時機場特別天氣報告：風向不定，風速 12 浬/時，陣風 27 浬/時；能見度 5,000 公尺；附近有陣雨；稀雲 1,200 呎，裂雲 1,800 呎，裂雲 3,000 呎；溫度 15℃，露點 11℃；高度表撥定值 1022 百帕；趨勢預報—無顯著變化；備註—13 跑道風向不定，風速 10 浬/時，陣風 24 浬/時；高度表撥定值 30.20 吋汞柱。

2 月 6 日 0010 時機場特別天氣報告[4]：風向不定，風速 11 浬/時，陣風 32 浬/時；能見度 5,000 公尺；附近有陣雨；稀雲 1,200 呎，裂雲 1,800 呎，裂雲 3,000 呎；溫度 15℃，露點 11℃；高度表撥定值 1022 百帕；趨勢預報—無顯著變化；備註—13 跑道風向不定，風速 6 浬/時，陣風 19 浬/時；高度表撥定值 30.20 吋汞柱。

蘭嶼機場地面自動氣象觀測系統（automated weather observation system, AWOS）設置於跑道兩端附近，如圖 1.7-5 所示。民國 107 年 2 月 5 日 2340 時至 2355 時 31 跑道及 13 跑道每秒之瞬時風向風速分別如圖 1.7-7 與圖 1.7-8 所示。

[4] 此筆天氣觀測紀錄為接獲事故通報後之另加天氣觀測。

圖 1.7-5 蘭嶼氣象站與蘭嶼機場 AWOS 位置圖

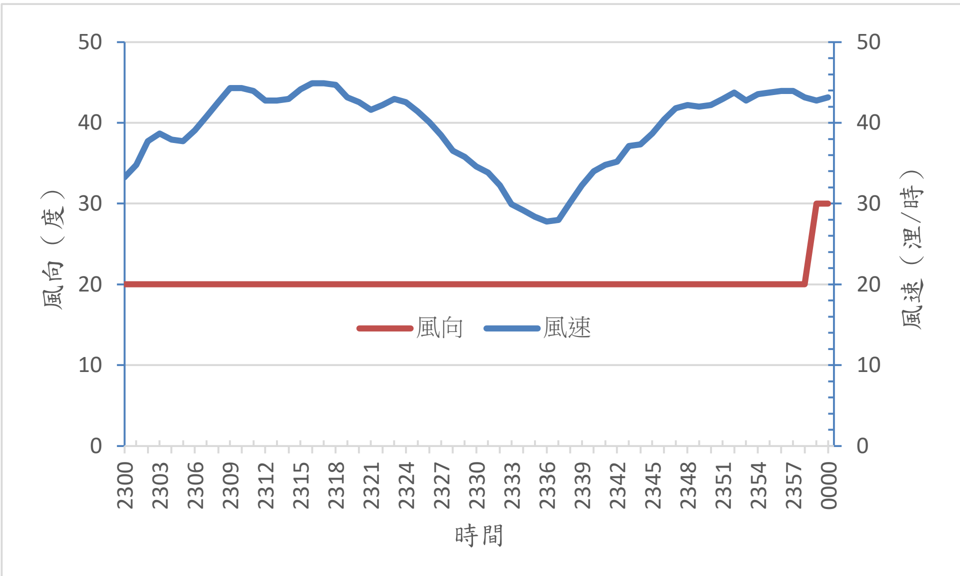


圖 1.7-6 蘭嶼氣象站風向風速紀錄

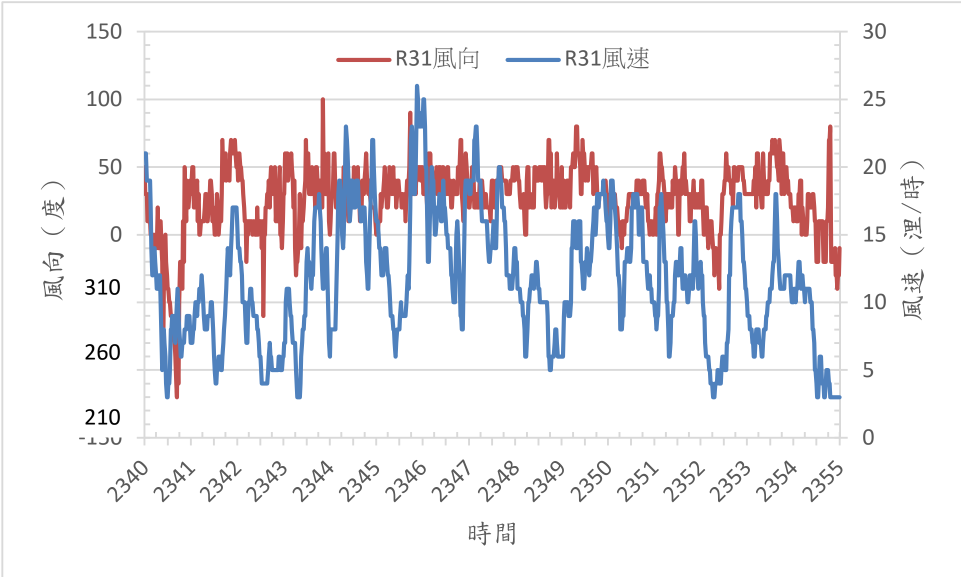


圖 1.7-7 蘭嶼機場 31 跑道 AWOS 瞬時風向風速

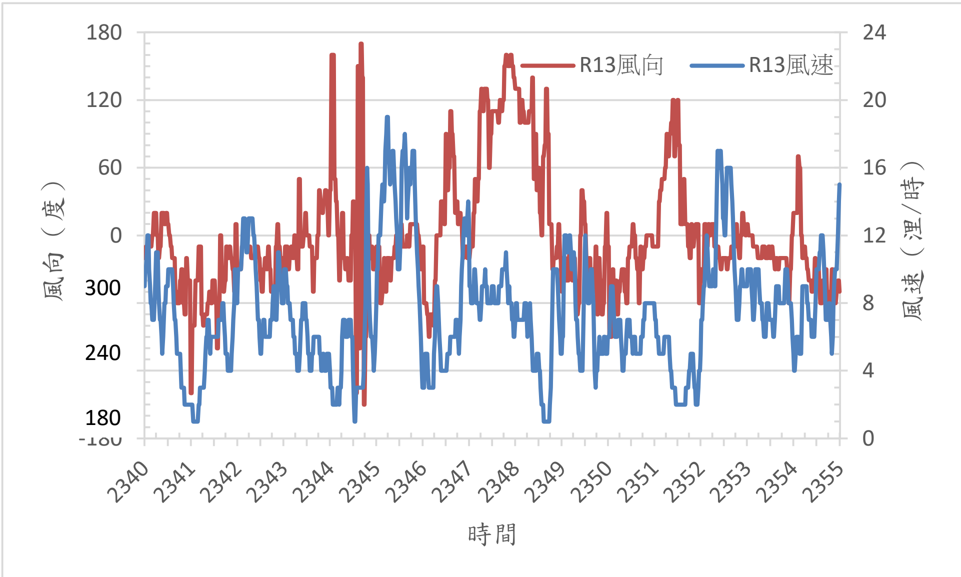


圖 1.7-8 蘭嶼機場 13 跑道 AWOS 瞬時風向風速

1.7.3 天氣規定

空勤總隊第 9 版之航務管理手冊，附件八訂有訓練、維飛天氣放行標準表（如表 1.71）：

表 1.7-1 空勤總隊訓練、維飛天氣放行標準表[5]

任務類型區分	單機		多機	
1. 維飛任務	晝間	夜間	晝間	夜間
1-1 階檢及故障排除維飛	3200M/1000F	N/A	N/A	N/A
2. 訓練任務	晝間	夜間	晝間	夜間
1-2 一般及組合訓練飛行	3200M/1000F	5000M/1500F	3200M/1000F	N/A
3. 支援任務	晝間	夜間	晝間	夜間
4. 公路巡邏	5000M/1000F	N/A	5000M/1000F	N/A
5. 海岸巡邏	5000M/1500F	5000M/1500F	5000M/1500F	5000M/1500F
6. 演習	3200M/1000F	N/A	3200M/1000F	N/A
7. 刑案支援	3200M/1000F	5000M/1500F	3200M/1000F	5000M/1500F
8. 環保空偵	3200M/1000F	N/A	3200M/1000F	N/A
8. 行政專機	3200M/1000F	5000M/1500F	3200M/1000F	5000M/1500F
9. 經核定之專案任務	3200M/1000F	5000M/1500F	3200M/1000F	5000M/1500F

該天氣標準表內容，除維飛及訓練任務外，尚包含有執行海岸巡邏、刑案支援、行政專機及經核定之專案任務等夜間之天氣標準。

1.8 助、導航設施

無相關議題。

[5] 表中 M 為公尺，F 為呎。

1.9 通信

無相關議題。

1.10 場站資料

1.10.1 空側基本資料

蘭嶼機場代碼為 RCLY，機場標高 44 呎，磁差 3°（2004），機場消防第 3 級，配備 1 輛消防車，裝載總水量為 1,500 加侖，航空器故障最大移離能力為 DO-228 型機。蘭嶼機場因地形障礙而為特殊機場。

蘭嶼機場跑道為水泥混凝土鋪面，無緩衝區，無清除區，長 1,132 公尺、寬 24 公尺，跑道方向為 13/31，跑道地帶宣告長 1,248 公尺、寬 40 公尺，如圖 1.10-1。

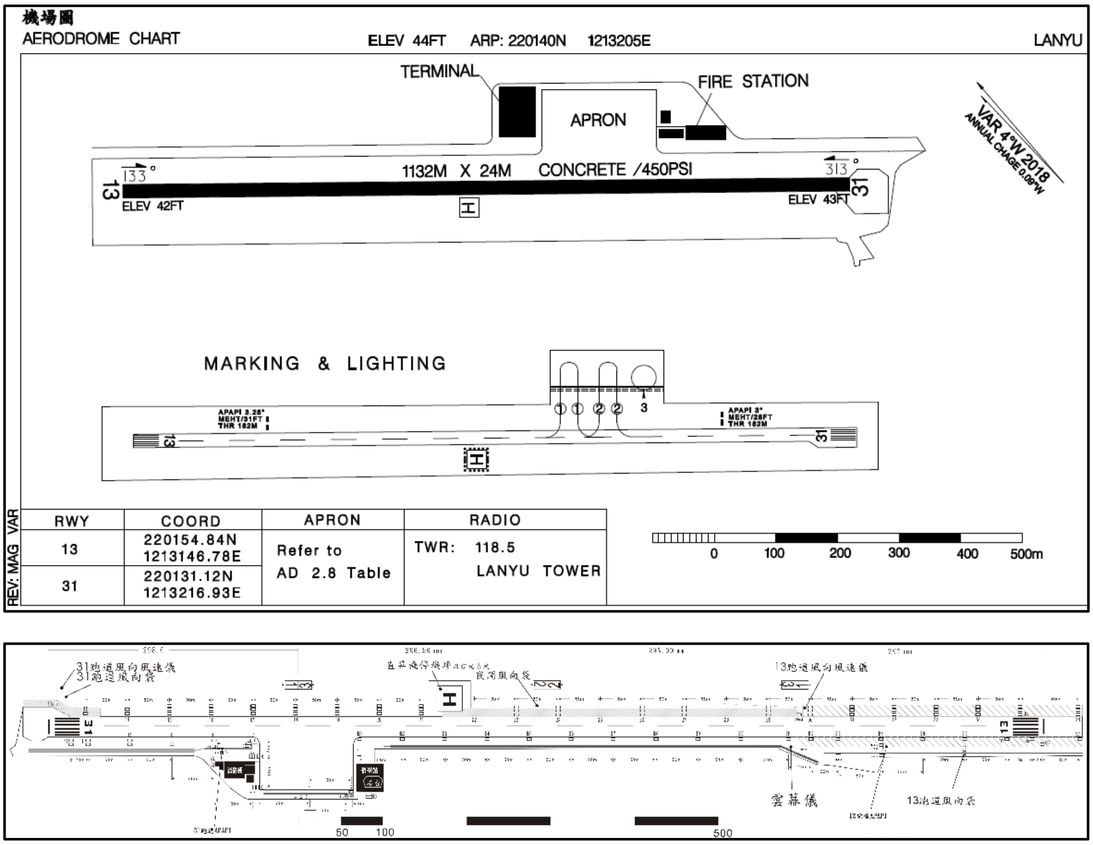


圖 1.10-1 蘭嶼機場圖

1.10.2 機場相關設施

蘭嶼機場塔臺配置機場燈[6]，13/31 跑道各配置一具目視進場滑降指示燈[7]（APAPI）；機場跑道南側有一水泥混凝土鋪面之直昇機降落區，長 30 公尺，寬 30 公尺，進離場方向各具一夜用風向袋，4 邊共 20 具高架式週邊燈[8]（如圖 1.10-2、圖 1.10-3），另外在 31 跑道 AWOS[9]、13 跑道 AWOS、13 跑道風向袋及直昇機坪夜間風向袋[10]各裝置一具障礙燈。

該機場停機坪共有 3 個停機位，航廈 2 樓面對機坪裝有兩具機坪照明燈[11]，開關操作由機場航務組人員控制，照明狀況如圖 1.10-4 所示。

事故機落地時，該機場包括直昇機起降場所有燈光皆為開啟狀態。

依航空站人員訪談紀錄及民航局函復本會直昇機起降場作業內容如下：

1. 蘭嶼機場為日間目視機場，直昇機均以目視飛航進行操作，依據飛航指南第二部第 1.2.2 節目視飛航限制之規定，直昇機於蘭嶼機場夜間起降，僅限救災、救難及緊急醫療等任務使用。
2. 蘭嶼機場若有直昇機執行夜間緊急醫療後送任務時，由塔臺

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[6] 製造商 Hali Brite；型別 HBM 150/2；頻率 12 RPM rotation, 24 flashes/minute；顏色白、綠兩色；規格 150W。

[7] 製造商 ADB/SAFEGATE 型號 PU3L。

[8] 製造商 CROUSE-HINDS；型別 40943-Y-116-14；尺寸 140mm*140mm*336mm；燈罩顏色黃色；規格 116W。

[9] 製造商 CROUSE-HINDS；型別 40940-R-116；尺寸 130mm*224mm；燈罩顏色黃色；規格 116W。

[10] 製造商 CROUSE-HINDS；型別 40940-R-116；尺寸 130mm*224mm；燈罩顏色紅色；規格 116W。

[11] 製造商 POLAR lites；型別 E-40(單端)複金屬燈泡；規格 MH-400W。

與駕駛員溝通落地方式，最近 5 年直昇機夜間均使用機場停機坪起降，並無夜間使用直昇機起降場之紀錄；

3. 夜間無人在機坪指揮直昇機起降，事故機落於 1,2 號停機坪標線間，停止時機首面對航廈方向；
4. 航空站沒有直昇機夜間緊急醫療之標準作業程序，相關作業係依空側作業巡場程序進行。

圖 1.10-2 蘭嶼機場直昇機降落區

圖 1.10-3 蘭嶼機場直昇機降落區周邊燈

圖 1.10-4 蘭嶼機場停機坪照明燈及塔臺

1.11 飛航紀錄器

事故機裝置固態式多用途飛航紀錄器（solid-state multi-purpose flight recorder, MPFR），含兩項原始資料（FDR 及 CVR）。製造商為 Curtiss-Wright Defense Solutions 公司，件號及序號分別為 D51631（ISS.01）及 A06890-001。

飛航紀錄器取得後，使用紀錄器原廠提供之程序，進行清洗、拆解、烘乾及原始資料下載[12]，紀錄器拆解狀況如圖 1.11-1。該型飛航紀錄器之防撞毀記憶體單元（crash survivable memory unit,）內記憶體模組序號為 090817-01（Rev. H），經拆解紀錄器，將其取出並烘乾後，觀察外觀完好。

[12] 使用原廠之 Crash Damage Recovery Equipment (CDRE)。

圖 1.11-1 紀錄器拆解狀況

1.11.1 座艙語音資料

該具 MPFR 的座艙語音原始資料具備 2 小時記錄能力，共 4 軌語音資料，聲源分別來自正駕駛員麥克風、副駕駛員麥克風、廣播系統麥克風及座艙區域麥克風。該具 MPFR 座艙語音下載情形正常，錄音品質良好，4 軌語音實際記錄長度為 2 小時 3 分 38 秒，包括事故機豐年機場起飛至蘭嶼機場落地，蘭嶼機場起飛至發生事故等過程。為因應本次事故製作之抄件，時間約為 40 分鐘(2309:26.0 時至 2349:58.3 時)，事故機自蘭嶼機場起飛至事故發生前抄件摘要如表 1.11-1。

表 1.11-1 事故前 CVR 抄件摘要

Hh	mm	ss	發話源	內容
23	48	31.2	正駕駛員	左右上方 clear
23	48	32.0	副駕駛員	okay 沒有問題 go
23	48	33.6	正駕駛員	Okay
23	48	37.8	副駕駛員	okay 左邊 clear

23	48	39.7	機工長	尾旋翼 clear
23	48	40.8	副駕駛員	嘿 尾旋翼 clear
23	48	43.0	正駕駛員	okay 好
23	48	44.1	副駕駛員	okay 馬力好 馬力好
23	48	45.5	正駕駛員	okay
23	48	47.2	副駕駛員	好
23	48	47.5	正駕駛員	兩四洞 好 維持兩四洞
23	48	49.7	副駕駛員	嘿好
23	48	50.7	正駕駛員	兩四五兩四六
23	48	52.4	正駕駛員	okay torque 可以
23	48	53.1	副駕駛員	欸　高度上升
23	48	54.7	正駕駛員	okay
23	48	57.2	副駕駛員	沒關係
23	48	58.1	正駕駛員	沒有關係　好　高度一二五　好繼續爬升
23	49	02.2	副駕駛員	Okay
23	49	02.8	正駕駛員	我全關掉好啦
23	49	04.4	副駕駛員	好
23	49	05.5	正駕駛員	看儀表飛 兩五洞 兩四洞
23	49	10.7	副駕駛員	okay 好
23	49	13.0	副駕駛員	空速結合
23	49	14.1	正駕駛員	好 … 唉唷 沒關係　這是亂流啊
23	49	18.0	副駕駛員	對沒有問題
23	49	19.7	副駕駛員	ok 現在是正爬升率沒有關係
23	49	21.5	正駕駛員	Okay
23	49	25.9	蘭嶼塔臺	空勤拐洞六　請問預計朗島的時間
23	49	28.8	副駕駛員	塔臺預計朗島時間五分鐘後
23	49	31.6	蘭嶼塔臺	roger 朗島呼叫

23	49	33.3	副駕駛員	roger 朗島呼叫拐洞六
23	49	35.8	正駕駛員	okay 兩三洞 okay 先被 先保持
23	49	40.6	副駕駛員	okay 好
23	49	41.9	正駕駛員	來空速 空速減 欸推頭 推頭 高度四十 推頭
23	49	49.1	副駕駛員	空速 空速
23	49	50.4	正駕駛員	空速還沒有到
23	49	52.2	正駕駛員	推頭 哇唉唷唉唷
23	49	54.4	正駕駛員	注意幫我看高度
23	49	55.7	副駕駛員	高度 下降率
23	49	56.2	正駕駛員	對對對對對
23	49	56.6	CAM[13]	（雷達高度提示聲響）
23	49	57.3	正駕駛員	對對對
23	49	58.3		CVR 停止記錄

本事故之時間基準係以高雄近場臺時間為準，並依其提供之錄音抄件內容，分別根據紀錄器記錄之關鍵事件參數將座艙語音及飛航資料與其時間同步。

13 cockpit area microphone。

1.11.2 飛航資料

該具 MPFR 飛航資料共儲存 13 小時 1 分 42 秒原始資料，共記錄 447 項飛航參數。MPFR 的飛航資料區分為第一套航電系統（FDR 1）及第二套航電系統（FDR 2），該機自豐年起飛至蘭嶼，FDR 1 及 FDR 2 部分解讀結果詳如圖 1.11-2 及圖 1.11-3。依據 FDR 2 相關飛航參數解讀概要摘錄如下：

1. MPFR 未記錄風速、風向及指示空速。
2. 事故當日，有 FDR 1 及 FDR 2 有 2 項飛航參數均曾出現故障狀態之紀錄，包括：「FD COUPLE FAIL」、「FLT DIR FAIL」。另 5 項飛航參數全程作動之紀錄為：「INS Degraded Nav Ready -EGI 1」、「INS Degraded Nav Ready - EGI 2」、「AFCS Trim」、「AFCS SAS Trim」、「AFCS FD Uncoupled」。
3. 2304 時，飛航資料開始記錄。
4. 2309:34 時，事故機由豐年機場起飛，修正海平面氣壓（QNH）30.26 inHG/1,024.6 mbar。從豐年機場至蘭嶼機場飛行過程中，發動機相關參數、飛航操控相關參數均正常。
5. 2310:20 時，事故機雷達高度 107 呎、真空速（true airspeed）57 浬/時、地速 49.3 浬/時、爬升率 608 呎/分。
6. 2312:48.5 時，事故機雷達高度 963 呎、真空速 108 浬/時、地速 115 浬/時、爬升率 96 呎/分。根據 CVR 抄件，此時高雄近場臺管制員告知駕駛員臺東高度表撥定值 1024。
7. 2315:38 時，事故機修正海平面氣壓 30.26 inHG/1,024.6 mbar、雷達高度 1,002 呎、真空速 119.4 浬/時、地速 130.5 浬/時、爬升率 416 呎/分、俯角 0.9 度、水平升降舵 3.9 度。
8. 2333:19 時，事故機修正後氣壓高度 843 呎、雷達高度 770 呎、真

空速 100.9 浬/時、地速 118.3 浬/時；根據 CVR 抄件，此時駕駛員表示可目視蘭嶼機場。

9. 2333:35 時，事故機修正後氣壓高度 831 呎、雷達高度 754 呎、真空速 99.6 浬/時、地速 117.3 浬/時；此時機距離蘭嶼機場 4.5 浬。

10. 2335:27.7 時，事故機修正後氣壓高度 611 呎、雷達高度 523 呎、真空速 104.4/時、地速 87 浬/時；根據 CVR 抄件，此時正駕駛員發話內容為：「現在這高度六百 慢慢減速到八十」。

11. 2338:19 時，事故機雷達高度低於 50 呎，「low altitude warning」作動，根據 CVR 抄件，座艙亦出現警告聲響。

12. 2338:47 事故機安全降落於蘭嶼機場 1 號及 2 號停機坪中間，航向 312 度。

13. 2347:31 時，事故機之修正海平面氣壓（QNH）30.26 inHG/1,024.6 mbar。

14. 2348:36 時，事故機主輪離地，雷達高度 1 呎，發動機相關參數、飛航操控相關參數均正常。事故機之修正海平面氣壓（QNH）30.26 inHG/1,024.6 mbar。根據 CVR 抄件，蘭嶼塔臺隨後許可事故機起飛，並告知高度表撥定值 1022。

15. 2348:54 時，修正後氣壓高度 138 呎（1,024.6 mbar）、雷達高度 64 呎、真空速 48.6 浬/時、地速 25.3 浬/時、航向 243.3 度，發動機相關參數、飛航操控相關參數均正常。

16. 2348:57 時至 2348:59 時，此 3 秒期間，「FD COUPLE FAIL」及「FLT DIR FAIL」參數顯示 3 秒後消失。

17. 2349:13 時，修正後氣壓高度 290 呎、雷達高度 200 呎、真空速 95.4 浬/時、地速 114.3 浬/時、航向 234.4 度、爬升率 512 呎/分、俯角 9.3 度、水平升降舵 8.9 度；左/右發動機 NP 轉速及扭力分

別為 100.3%|100.3%，74.9%|75.8%。

18. 2349:14 時至 2349:42 時，此期間事故機由俯角轉為仰角姿態，最大仰角達 22.2 度，發動機相關參數、飛航操控相關參數均正常。

19. 2349:43 時至 2349:50 時，此 8 秒期間，「FD COUPLE FAIL」、「FLT DIR FAIL」、「Master Caution Pilot」、「Master Caution Copilot」四項參數顯示 8 秒後消失，發動機相關參數、飛航操控相關參數均正常。此期間基本參數紀錄如下：

分:秒	真空速 (浬/時)	地速 (浬/時)	修正氣壓高度 (呎)	雷達高度(呎)	升降率 (呎/分)	俯仰角 (度)	水平升降舵 (度)
49:43	44.5	72.8	372	289	+64	+11.6	17.3
49:44	41.5	71.0	372	290	+16	+6.7	21.2
49:45	41.3	70.8	369	288	0	+3.5	26.2
49:46	40.4	71.8	371	286	-96	-0.2	29.2
49:47	39.8	74.0	366	283	0	-4.5	30.9
49:48	40.5	77.0	359	278	-112	-10.2	32.1
49:49	39.1	80.8	346	266	-304	-14.2	33.7
49:50	47.8	85.3	322	249	-560	-18.1	34.2

20. 20.2349:51 時至 2349:57.9 時，最後 1 秒顯示「low altitude warning」；此 8 秒期間基本參數紀錄如下：

分:秒	真空速(浬/時)	地速(浬/時)	修正氣壓高度(呎)	雷達高度(呎)	升降率(呎/分)	俯仰角(度)	水平安定面(度)	坡度(度)
49:51	54.8	91.5	294	233	-800	-21.9	33.1	-6.5
49:52	59.1	98.3	257	198	-1,072	-26.9	30.4	-5.6
49:53	67.0	107.0	219	167	-1,456	-31.1	28.4	-6.6
49:54	73.8	115.0	176	133	-2,112	-28.5	26.4	-4.9
49:55	83.8	124.0	139	95	-2,416	-25.1	23.3	-3.8
49:56	91.6	132.5	103	55	-2,224	-20.5	20.3	-7.4
49:57.9	100	140.5	53.8	24	-2,128	-21.1	13.5	-12.1

21. 事故機 FDR 1 及 FDR 2 紀錄有關經緯度飛航軌跡相對差異比較如下：

日期	飛行任務	FDR 1 & FDR 2 軌跡最大相對差異
01/19	RCFN→RCLY→RCFN	20 公尺
01/24	RCFN→ RCGI→RCLY→RCFN	50 公尺
01/25	RCFN→玉山北峰→ RCFN	20 公尺
01/26	RCFN→玉山北峰→ RCFN	20 公尺
02/03	RCFN→RCLY→RCFN	20 公尺

02/05	RCFN→RCLY	75 公尺 → 62 公尺
02/05	RCLY→ ACCIDENT	50 公尺 → 160 公尺

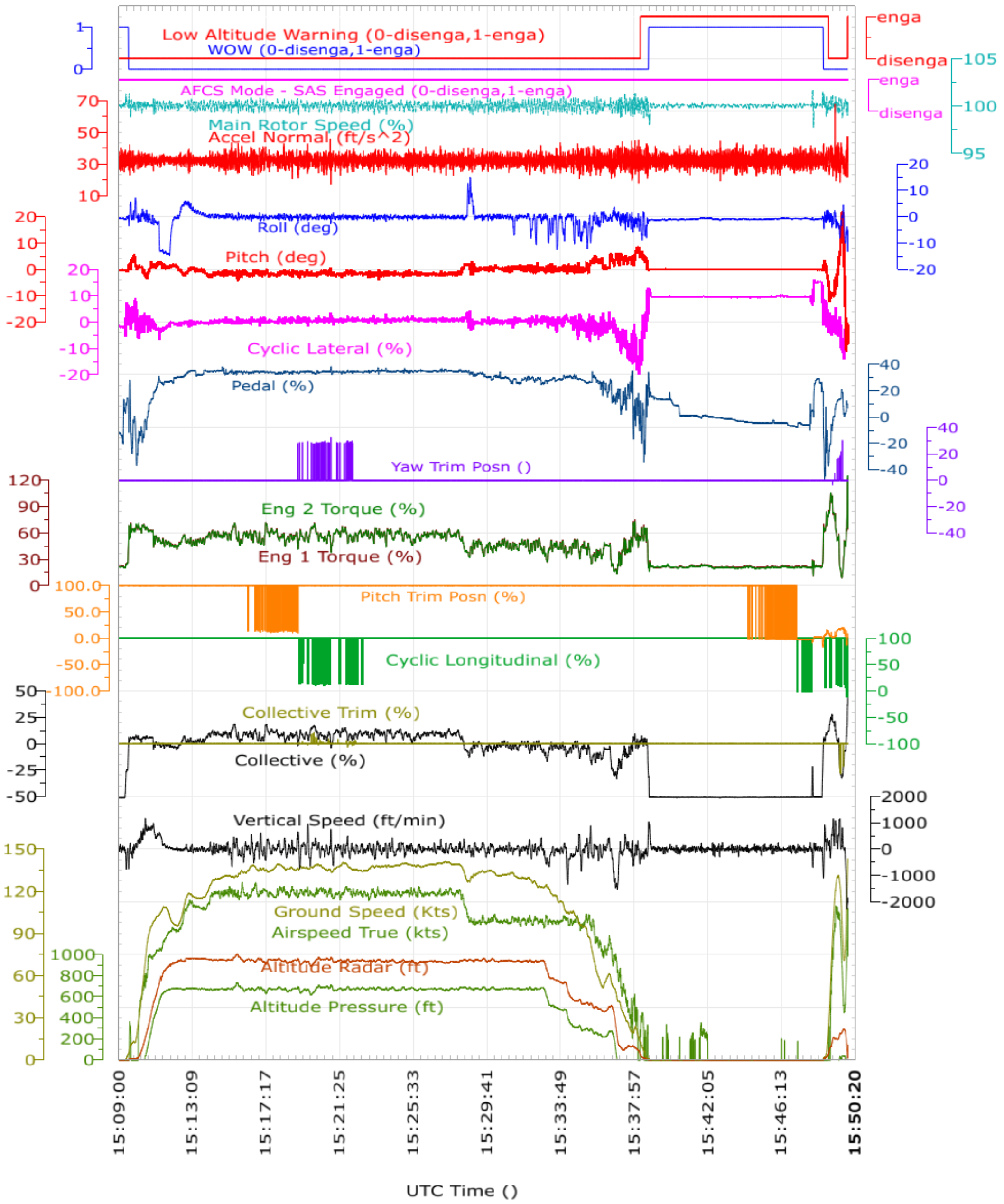

圖 1.11-2 FDR 1 部份參數

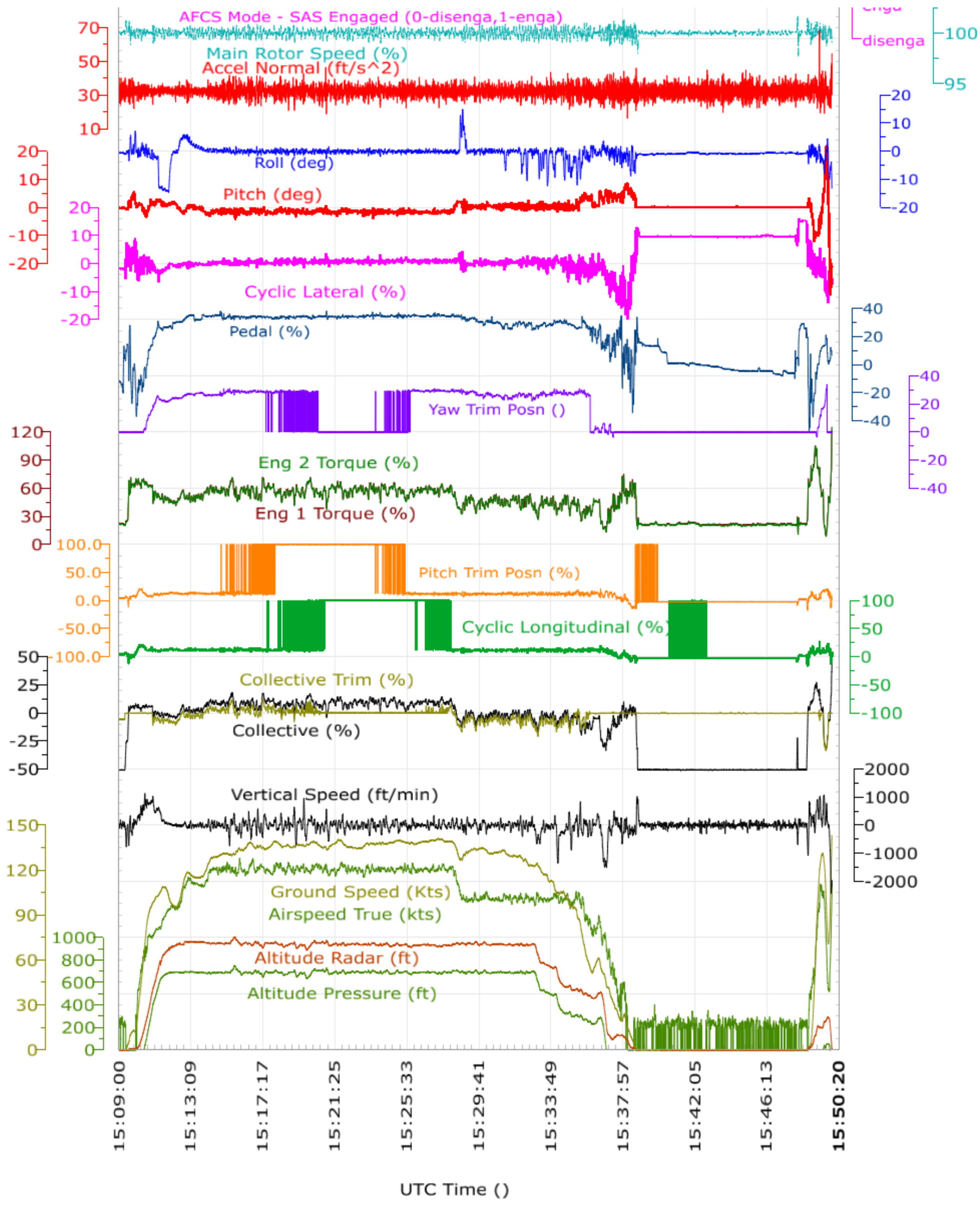

圖 1.11-3 FDR 2 部份參數

1.11.3 飛航紀錄器相關法規

我國民用直昇機的飛航紀錄器安裝法規，係依據民航局頒布之航空器飛航作業管理規則[14]，並同時參照 ICAO Annex 6 Part III[15]之標準

14 飛航作業管理規則，附件十二 飛航紀錄器

15 Part III — International Operations — Helicopters. 4.3 Flight Recorders

及建議，相關內容摘錄如下：

- *4.3.1.2.2 All helicopters of a maximum certificated take-off mass of over 7,000 kg, or having a passenger seating configuration of more than nineteen, for which the individual certificate of airworthiness is first issued on or after 1 January 1989 shall be equipped with a Type IV FDR*[16]*.*
- *4.3.1.2.3* ***Recommendation.—*** *All helicopters of a maximum certificated take-off mass of over 3,175 kg, up to and including 7,000 kg, for which the individual certificate of airworthiness is first issued on or after 1 January 1989, should be equipped with a Type V FDR*[17]*.*
- *4.3.2.1.3 All helicopters of a maximum certificated take-off mass of over 7,000 kg for which the individual certificate of airworthiness was first issued before 1 January 1987 shall be equipped with a CVR.*
- *4.3.4.3 Continued serviceability*

Operational checks and evaluations of recordings from the flight recorder systems shall be conducted to ensure the continued serviceability of the recorders.

- ***4.3.4.4 Flight recorders electronic documentation***

Recommendation.— *The documentation requirement concerning FDR parameters provided by operators to accident investigation authorities should be in electronic format and take account of industry specifications.*

ICAO Annex 6 Part III 內容律定最大起飛總重 7,000 公斤以上之民用直昇機應裝置座艙語音紀錄器及 Type IV 型飛航資料紀錄器，必

[16] Type IV FDR 必要紀錄參數 30 項

[17] Type V FDR 必要紀錄參數 15 項

要紀錄參數為 30 項，詳附錄 3。

參考美國聯邦航空總署（FAA）技術文件[18]（FAA-2010-0982），該文件規範美國境內之民用運輸類直昇機、空中救護直昇機，及民用普通類直昇機的營運規定內容為：要求直昇機業者按此文件安裝飛航紀錄器，並評估發展直昇機類別的飛航作業品質保證系統（flight operational quality assurance, FOQA）或飛航資料監控（flight data monitoring, FDM）的可行性與必要性，以提升直昇機之飛航安全。

1.11.4 蘭嶼機場監控攝影機紀錄

事故發生後，本會取得蘭嶼機場 4 具監控攝影機的影像紀錄，檔案編號分別為 ch-1、ch-2、ch-3、ch-4，詳圖 1.11-4。經交叉比對，將影像畫面與 FDR 時間同步。以下節錄編號 ch-2 監控攝影機畫面說明如下：

1. 2347:44.3 時，事故機獲得塔臺起飛許可後，位於蘭嶼機場 1 號及 2 號停機坪中間（如圖 1.11-5）。
2. 2348:51 時，事故機起飛後飛過跑道護欄上方（如圖 1.11-6）。
3. 2348:50 時至 2349:57 時，事故機飛航軌跡的光點套疊圖，如圖 1.11-7。
4. 2349:57 時，事故機飛航軌跡的光點消失。

NA-706 飛航軌跡的光點消失位置與監控攝影機套疊圖，最後參考方位 233 度（如圖 1.11-8）。

[18] Docket No.: FAA-2010-0982. Helicopter Air Ambulance, Commercial Helicopter, and Part 91 Helicopter Operations. 14 CFR Parts 91, 120, and 135, Federal Register on 02/21/2014 and available online.

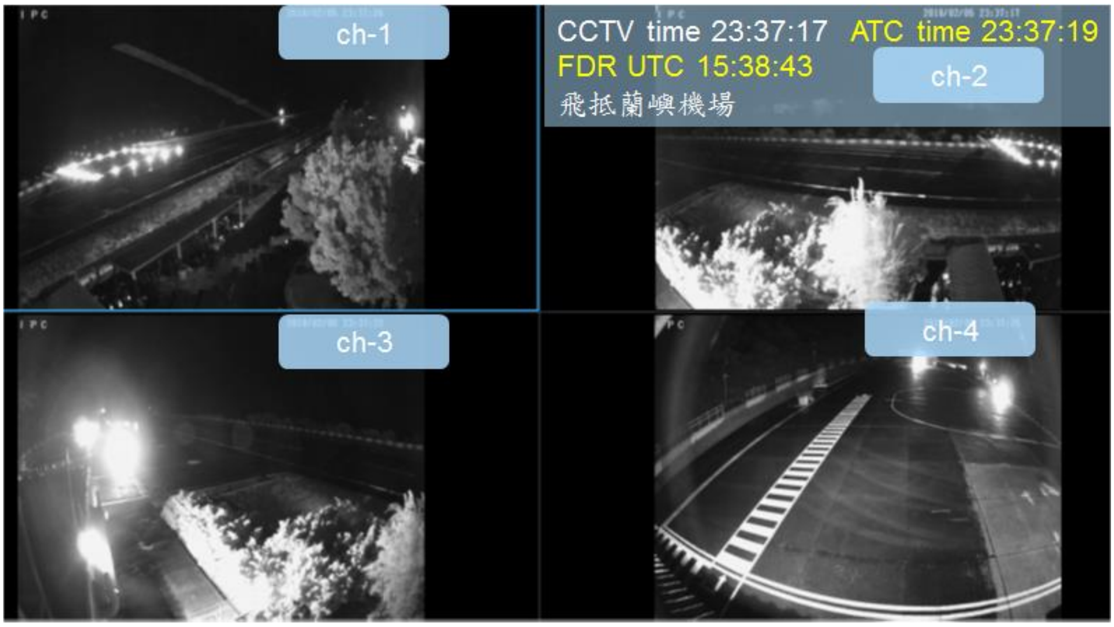

圖 1.11-4 蘭嶼機場四具攝影機的影像紀錄

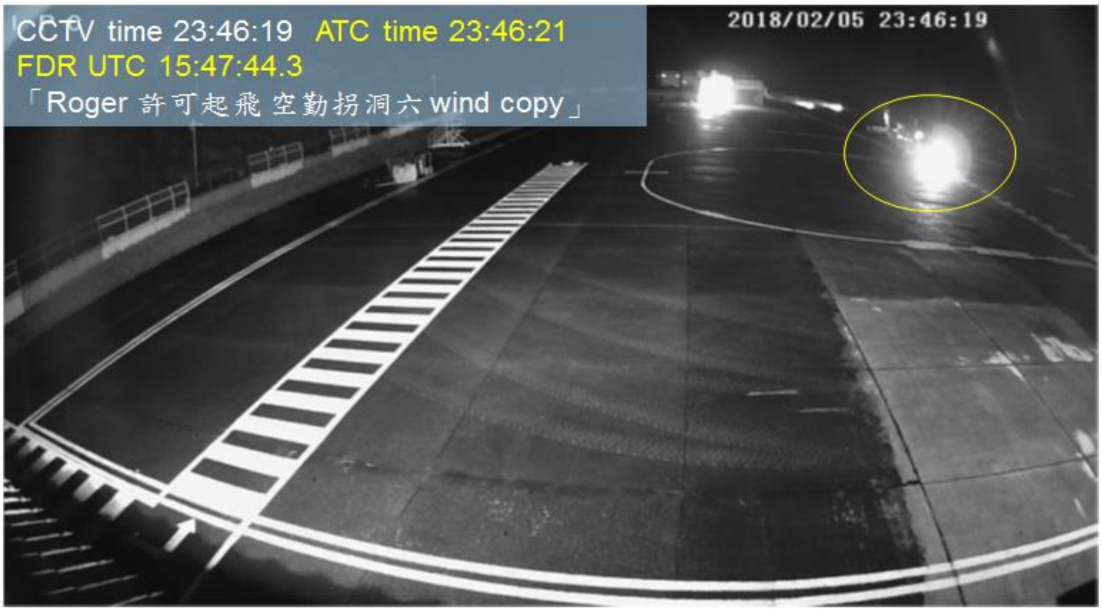

圖 1.11-5 攝影機畫面（FDR UTC 1547:44.3）

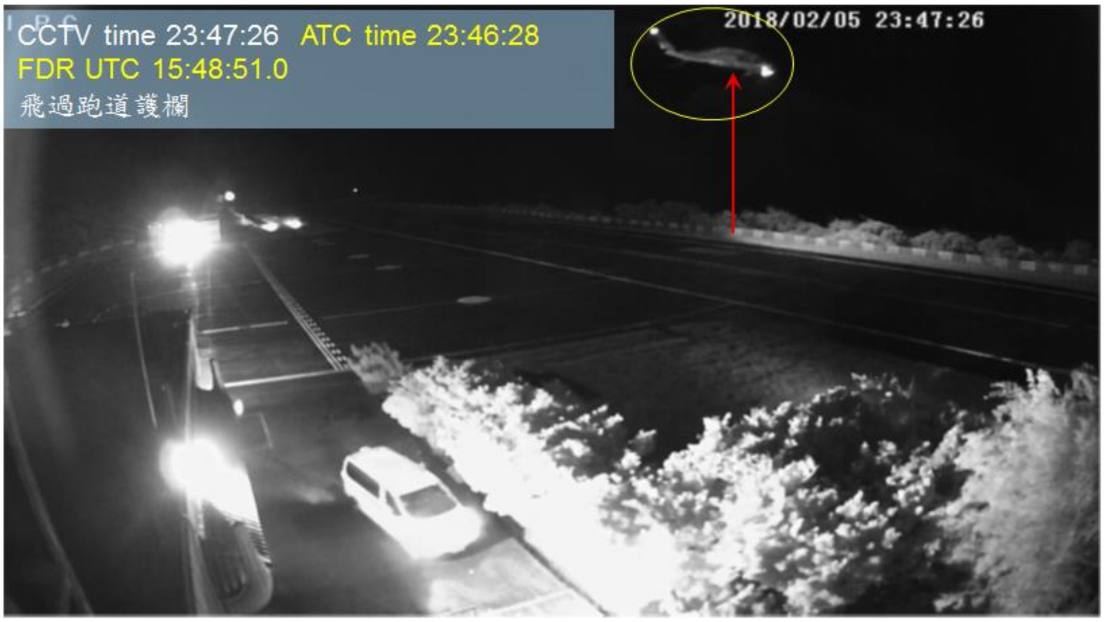

圖 1.11-6 攝影機畫面（FDR UTC 1548:51.0）

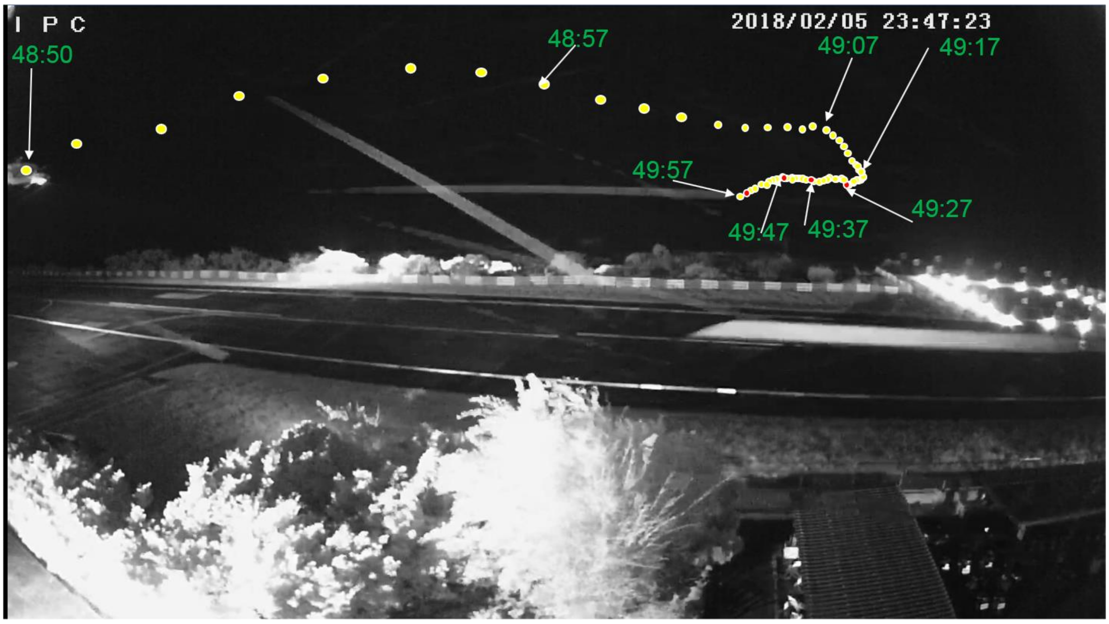

圖 1.11-7 攝影機畫面之 NA-706 光點套疊圖

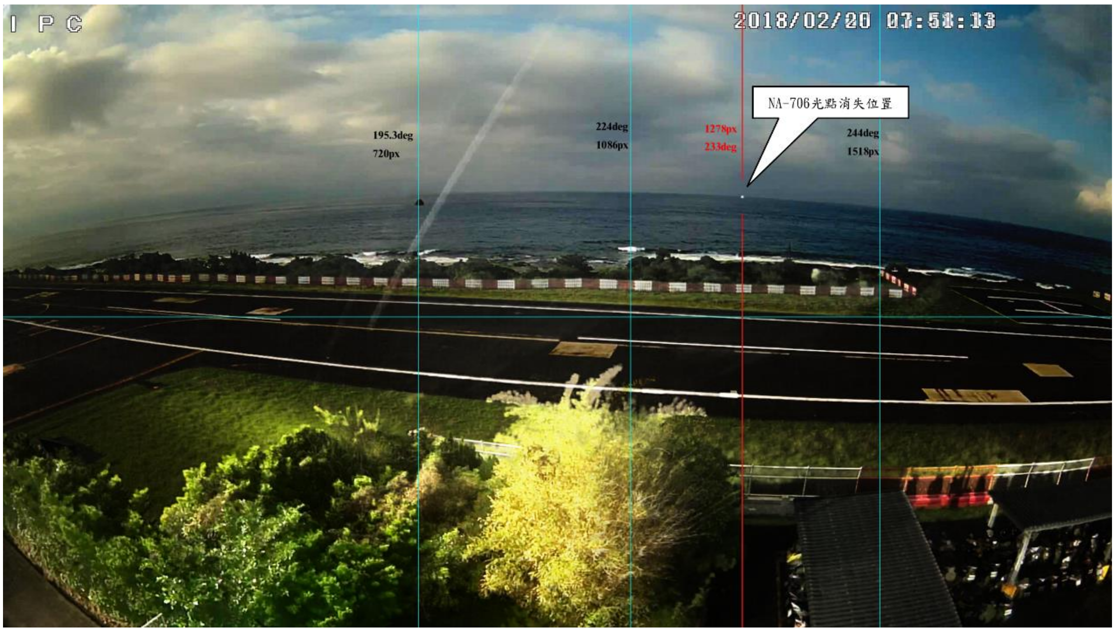

圖 1.11-8 攝影機畫面套疊圖

1.12 航空器殘骸與撞擊資料

1.12.1 航空器機身結構

依據 UH-60M 型機機體維護手冊（TM 1-1520-280-23&P, Dated 30 April 2016 Distribution D, Change 8），該型直昇機機體結構分成 6 個組成件：駕駛艙（cockpit）、客艙（cabin）、轉接段（transition section）、尾錐（tail cone）、尾旋翼派龍（tail rotor pylon）、主旋翼派龍（main rotor pylon）等，結構組合圖如圖 1.12-1 所示。其機身為半硬殼式（semi-monocoque）構造，機身結構主要材質為鋁合金，防火牆及部分裝置使用鈦合金或合金鋼。

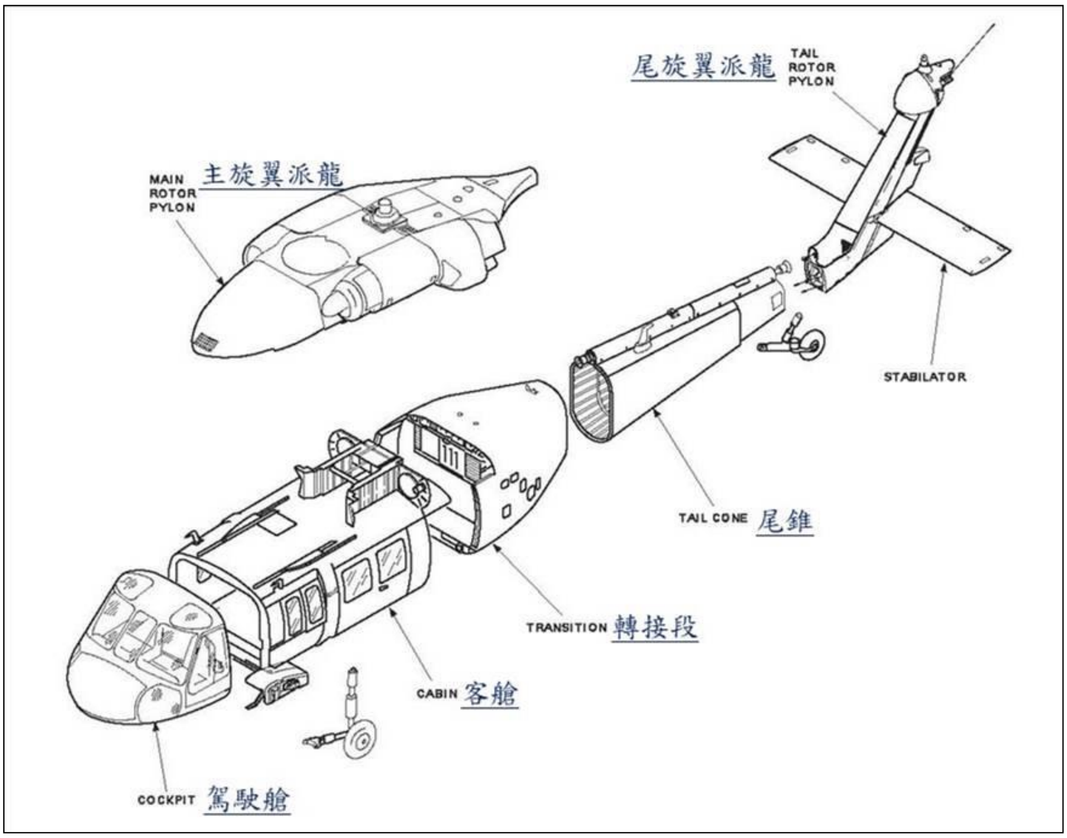

圖 1.12-1 UH-60M 型機體結構組合圖

1.12.2 殘骸偵蒐與打撈計畫

NA-706 事故機殘骸偵蒐與打撈計兩大階段，工作重點項目及期程說明如表 1.12-1。

表 1.12-1 事故機殘骸偵蒐與打撈之工作重點項目及期程說明表

工作階段	工作重點項目	主要設備
殘骸偵蒐 水下定位發報器訊號水面定位	以航管雷達消失點為中心，探測 2.5 公里 X2.5 公里區域的 37.5 kHz 訊號。	手持式水下聽音器、拖曳式聲納、兩艘海巡署艦艇(35 噸、100 噸)
殘骸偵蒐 水下定位發報器	依據水面偵蒐結果，探測 1.0 公里 X1.0 公里區	拖曳式聲納 (1,500 公尺)、多波束測深儀

訊號水下定位及海底地形探測	域的水深分布，以及 37.5 kHz 訊號強度分布。	（3,000 公尺）、水下無人載具（1,500 公尺）、寶拉麗絲號（275 噸）
<u>殘骸偵蒐</u> 水下目標物定位與拍照	依據 37.5 kHz 訊號強度分布，使用水下指向性聲納及水下無人載具下潛約 950 公尺至 1,000 公尺海床，尋找殘骸並完成拍照任務。	拖曳式聲納、水下指向性聲納（6,000 公尺）、水下無人載具、寶拉麗絲號
<u>殘骸打撈</u> 水下殘骸綑綁	依據水下定位及拍照結果，製作特殊工具及程序綑綁主殘骸。	水下無人載具、寶拉麗絲號
<u>殘骸打撈</u> 水下殘骸打撈及運送	使用寶拉麗絲號的吊掛裝備，由水下無人載具攜帶一條 1,200 公尺繩索及 D 型套環至水下。 殘骸出水前約 50 公尺，再將吊掛裝備的另一端套環轉至海歷 145 號平台船。	水下無人載具、寶拉麗絲號、海歷 145 號平台船、水下無人載具、三艘海巡署艦艇（35 噸、50 噸、100 噸）
<u>殘骸打撈</u> 遺體之處理程序紀錄器保全程序	殘骸打撈上岸，經遺體處理後，進行殘骸清洗，再拆除飛航紀錄器。 其他主殘骸運回高雄旗津後上岸運至北部。	海歷 145 號平台船

1.12.3 主殘骸打撈

民國 107 年 3 月 4 日，本會專案調查小組使用水下無人載具，於蘭嶼西南外海約 2 浬，水深 963 公尺處發現主殘骸，座標為東經 121 度 30 分 49 秒，北緯 22 度 00 分 21 秒，並未發現駕駛艙及尾旋翼，詳圖 1.12-2。事故機主殘骸分布集中，機首航向約 220 度、呈現翻覆姿態。經水下無人載具繼續往東北 200 公尺內搜索，均未發現其他殘骸。

民國 107 年 4 月 12 日，本會專案調查小組完成 NA-706 主殘骸打撈、遺體處理、殘骸清洗、取出飛航紀錄器等工作，詳圖 1.12-3。4 月 13 日下午約 1600 時，由海歷 145 號平台船將 NA-706 主殘骸運抵高雄旗津，詳圖 1.12-4。

圖 1.12-2 主殘骸外觀圖（A 為左側邊；B 為機首部位）

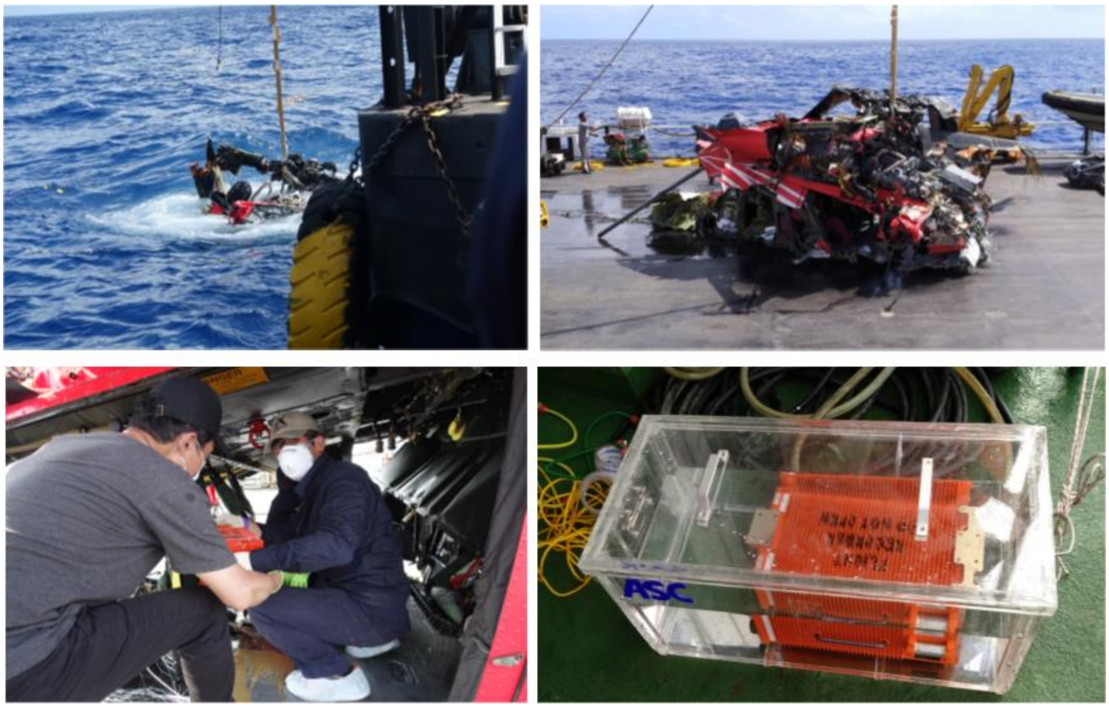

圖 1.12-3 主殘骸出水與拆解黑盒子外觀圖

圖 1.12-4 主殘骸運抵高雄旗津之外觀圖

1.12.4 殘骸運送與儲存

事故機主殘骸於民國 107 年 4 月 12 日打撈出海面後，置放於配合作業之平台船上隨即運送至高雄港，4 月 13 日下午抵達國立高雄科技大學旗津校區碼頭，經清洗檢查與現場蒐證後，於 4 月 13 日夜間進行殘骸吊掛、捆綁、固定與轉運作業，4 月 14 日清晨運抵位於台北松山機場之空勤總隊第一大隊棚廠存放，殘骸吊掛、運送與儲存作業相關照片如圖 1.12-5 所示。

殘骸吊掛作業　殘骸吊掛至平板車

細綁殘骸與覆蓋帆布　殘骸抵達於松山機場空勤棚場

圖 1.12-5 殘骸吊掛、細綁、運送與儲存作業

1.12.5 航空器撞擊資料

事故機主殘骸經初步檢視，僅剩客艙、機身轉接段及主旋翼派龍等結構，駕駛艙未尋獲；駕駛艙與客艙連接處機身結構嚴重塌陷受損（詳圖 1.12-6），右側機身破損嚴重，左側機身大致完整（詳圖 1.12-7），尾錐及尾旋翼派龍未尋獲（詳圖 1.12-8），4 片主旋翼均呈現撞擊

破損特徵。

其他殘骸包括：上派龍滑蓋（民國 107 年 2 月 27 日，民眾於蘭嶼野銀部落海灘撿獲尺寸約 60 公分 X45 公分）；左貨艙門（民國 107 年 2 月 28 日，漁民於綠島南寮漁港附近海域撿獲，尺寸約 210 公分 X80 公分）；右貨艙門（民國 107 年 4 月 28 日，漁民於高雄外海撿獲，尺寸約 200 公分 X80 公分）。

圖 1.12-6 事故機殘骸照片

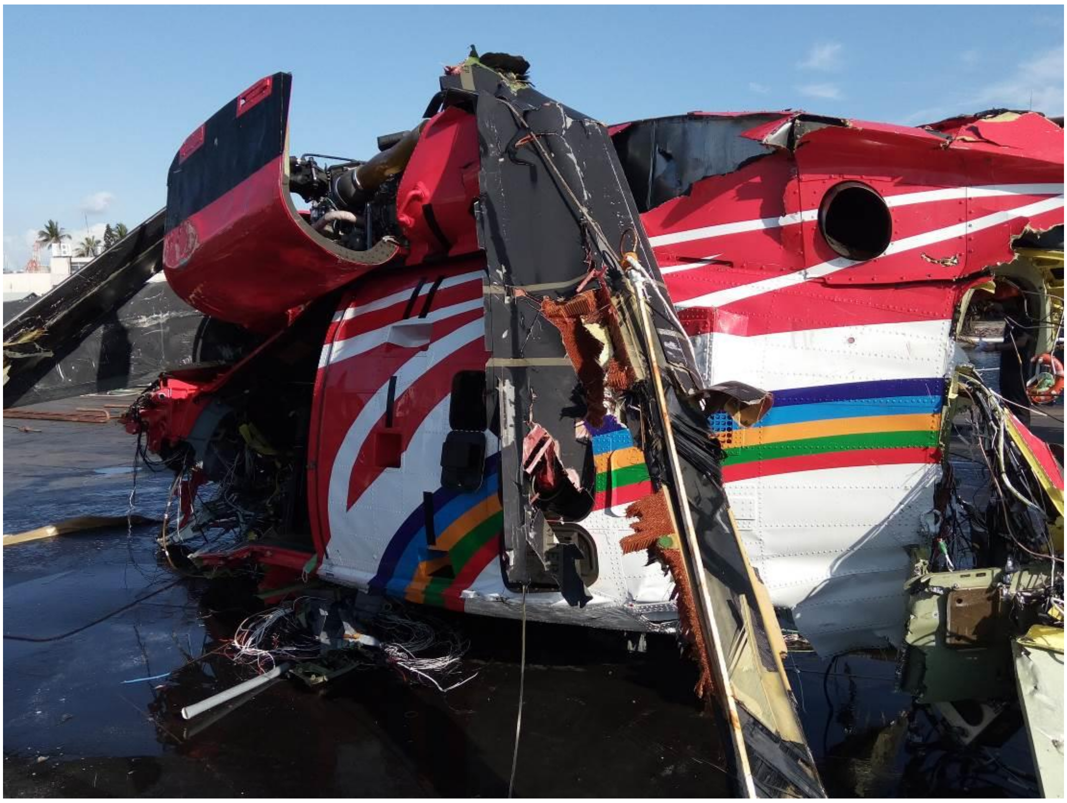

圖 1.12-7 左側機身照片

圖 1.12-8 斷裂之後機身照片

事故機主殘骸經外觀檢查（檢查區域及順序如圖 1.12-9 所示），相關檢查結果如下：

1. 機鼻區域①：未發現飛機機鼻及駕駛艙殘骸，2 具 EGI 及 2 號 FCC 均未發現。
2. 駕駛艙左側區域②：左側前半部全部毀損，駕駛艙儀表板、中央廊板、副駕駛艙門、座艙地板及座椅之殘骸均未發現；僅餘部分上方廊板及副駕駛頭頂上方之斷路器面板；左發動機進氣口罩變形、左發動機本體尚稱完整、管路變形或脫落；檢視滑油液面，內部仍有滑油存量。
3. 客艙上方區域③：飛機艙頂滑動門未發現；飛操混合器前面之飛操連桿殘骸未發現；1 號發電機主體未發現，附件機匣破裂變形；2 號發電機主體嚴重破損，附件機匣破裂變形；輔助動力單元（auxiliary power unit, APU）仍在安裝位置，APU 艙門輕微變形；旋翼煞車主體已變形；主傳動箱及短軸仍在位，接合處呈現破裂或變形；主旋翼自翼根約 1/3 部位處斷裂，4 片主旋翼剩餘之翼面均嚴重損壞破裂；主旋翼紅邊之心軸斷裂，主旋翼紅邊及黃邊之變矩控制連桿斷裂；附件齒輪傳動系統破裂。
4. 客艙內部區域④：左側機工長座椅、機工長窗及周圍結構、座艙地板及左起落架殘骸均未發現；3 具 ADC 均未發現；機腹結構、貨物吊掛及前段地板殘骸未發現；左貨艙門上半部毀損，緊急釋放手柄在鎖定位置；貨艙艙頂板大部尚存；檢視航電艙，僅餘 1 號及 2 號 DCU（data concentrator unit）、1 號 FCC 等裝備。
5. 機身左側區域⑤：尾傳動軸第 2 區以後之機身殘骸未發現；中間齒輪箱殘骸未發現；尾傳動軸第 2、3、4 節外部磨損，各節之接合處破裂及變形；1 號油箱主體仍在安裝位置，剩餘燃油已於撈起殘骸時抽除。

6. 尾旋翼派龍區域⑥：尾旋翼、尾齒輪箱、左右水平尾翼、垂直安定面及尾輪之殘骸均未發現。
7. 機身右側區域⑦：2 號油箱主體、APU 滑油壓力檢視視窗及相關結構均未發現；僅存部分無線電天線。
8. 駕駛艙右側區域⑧；右側前半部全部毀損，駕駛艙儀表板、中央廊板、副駕駛艙門、座艙地板及座椅之殘骸均未發現；僅餘部分上方廊板及正駕駛頭頂上方之斷電器面板；右貨艙門、右側機工長座椅、機工長窗及周圍結構、座艙地板及右起落架等殘骸均未發現；右發動機進氣口罩前半部結構脫落未發現，主體嚴重變形；右發動機本體尚稱完整、管路變形或脫落；檢視滑油液面，內部仍有滑油。

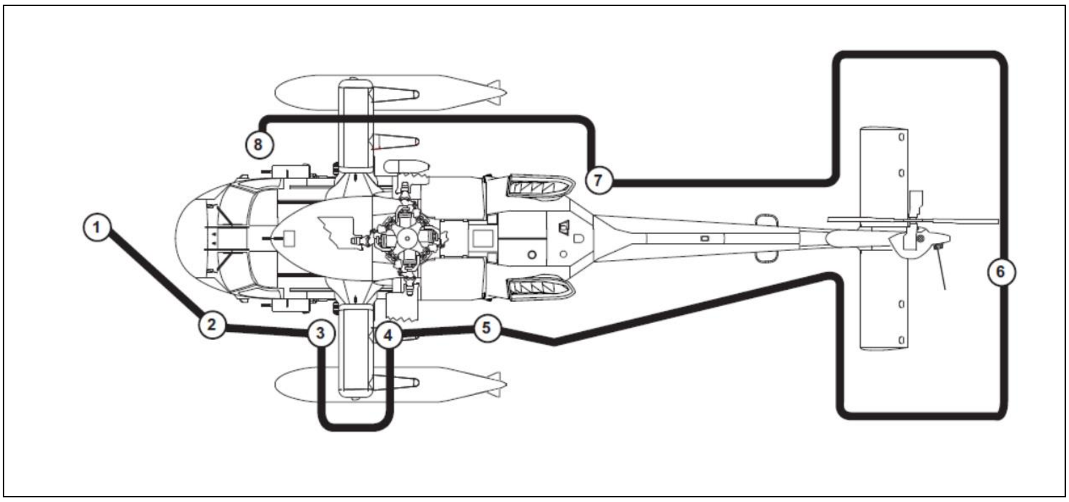

圖 1.12-9 外部檢查區域及順序

1.13 醫療與病理

無相關議題。

1.14 火災

無相關議題。

1.15 生還因素

事故機機載人員僅尋獲坐於客艙最後一排最右側座位的 1 名病患家屬及客艙最後一排左側座位第 2 位的 1 名護理師，事故機客艙安全帶均為 4 點式，卡入固定，由中央轉盤解除，病患家屬安全帶呈現 4 點繫緊狀態，護理師安全帶呈現腰部 2 點為繫緊狀態，肩部 2 點未繫縛，另病患家屬仍著救生衣。

客艙中最後一排最左側座位設有 1 具救生艇，呈現未使用狀態，如圖 1.15-1 所示。

圖 1.15-1 事故機救生艇及客艙座椅安全帶繫縛狀態

1.16 測試與研究

1.16.1 殘骸掃描

事故機殘骸於民國 107 年 4 月 13 日運抵國立高雄科技大學旗津校區碼頭，初步檢視事故機殘骸後，執行掃描作業（圖 1.16-1）。殘骸

掃描區域分為左後主機身、前機身、右側機身、上機身等部位。取得多組點雲資料後，依照幾何特徵拼接成單一點雲資料，點雲數高達兩千多萬點。事故機殘骸之 3D 數位模型如圖 1.16-2 至圖 1.16-5 所示。

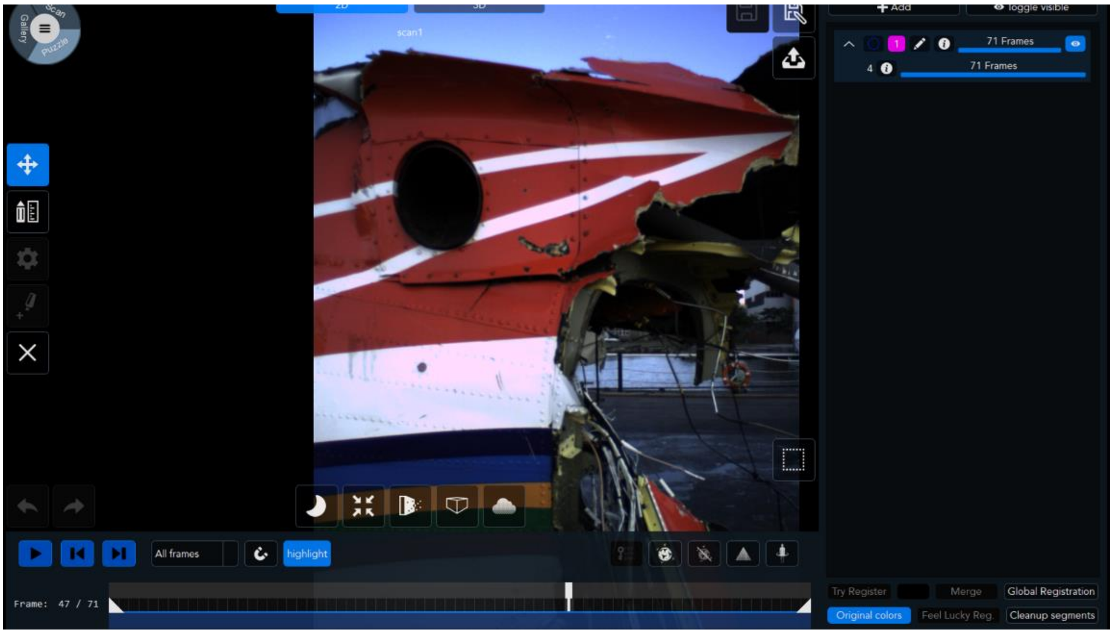

圖 1.16-1 事故機殘骸掃描作業

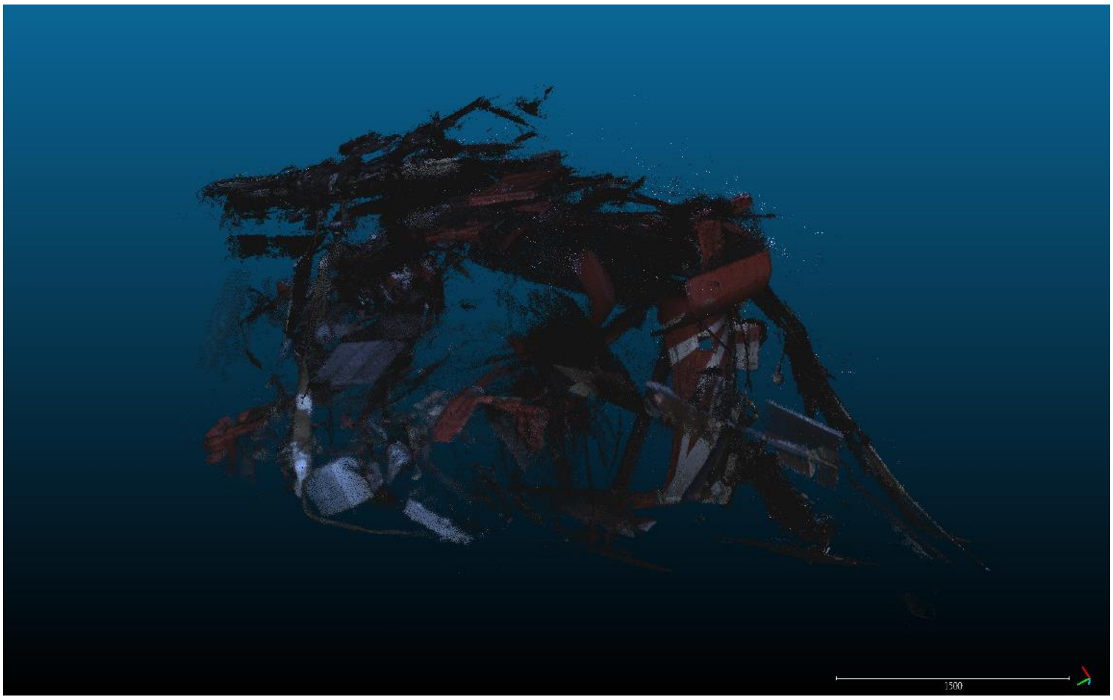

圖 1.16-2 事故機殘骸前視圖

圖 1.16-3 事故機殘骸左視圖

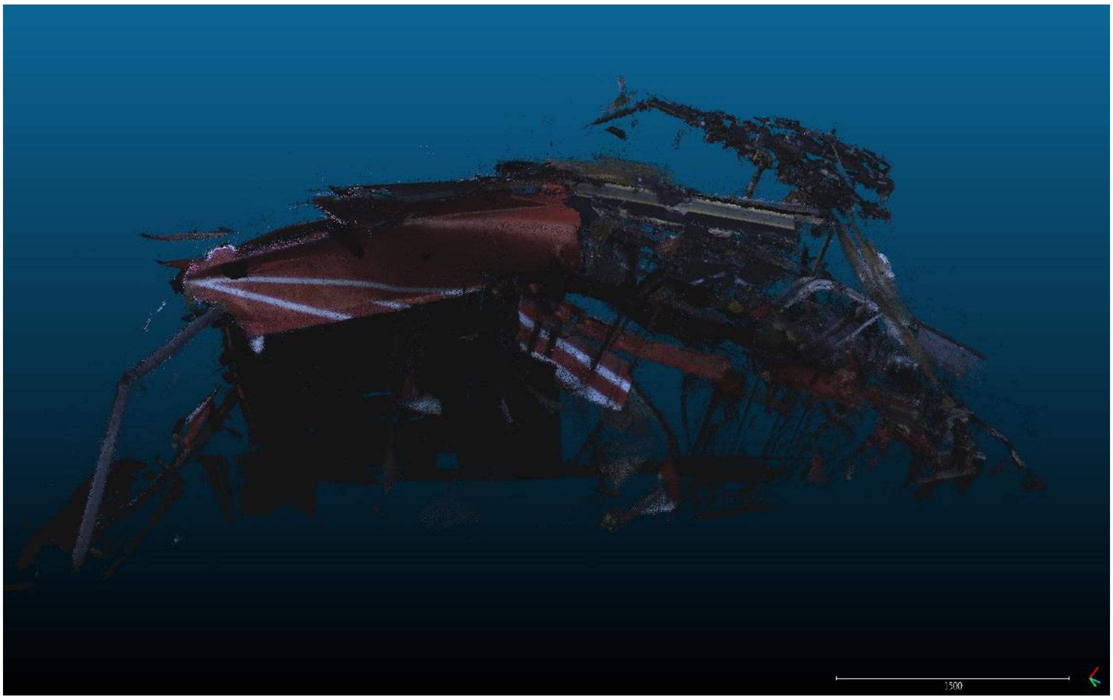

圖 1.16-4 事故機殘骸右視圖

圖 1.16-5 事故機殘骸上視圖

事故機殘骸經掃描後製成 3D 數位模型，該殘骸數位模型與 UH-60M 型機模型疊合比對結果如圖 1.16-6 至圖 1.16-8，估算所撈獲主殘骸及其對應航機之位置比率，撈獲之殘骸大約占整體事故機 50 %，另剩餘未撈獲殘骸主要為駕駛艙、尾錐及尾旋翼派龍。

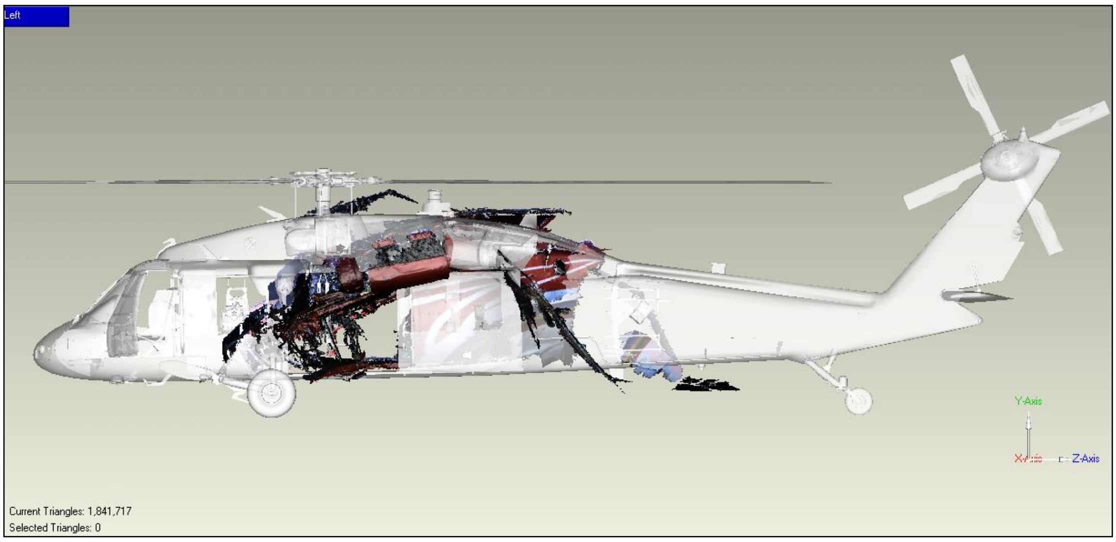

圖 1.16-6 事故機殘骸與原始模型比對之左視圖

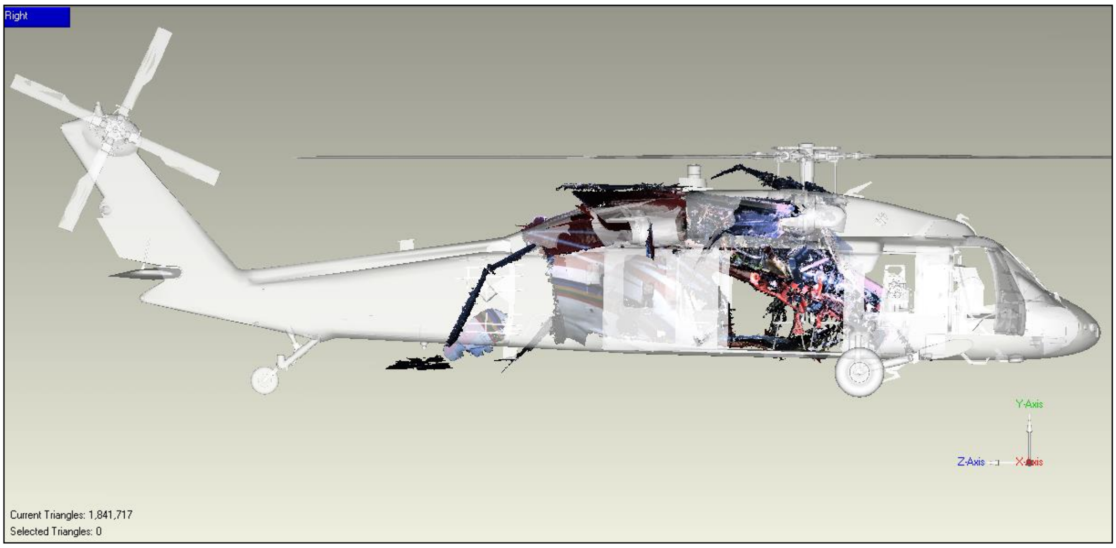

圖 1.16-7 事故機殘骸與原始模型比對之右視圖

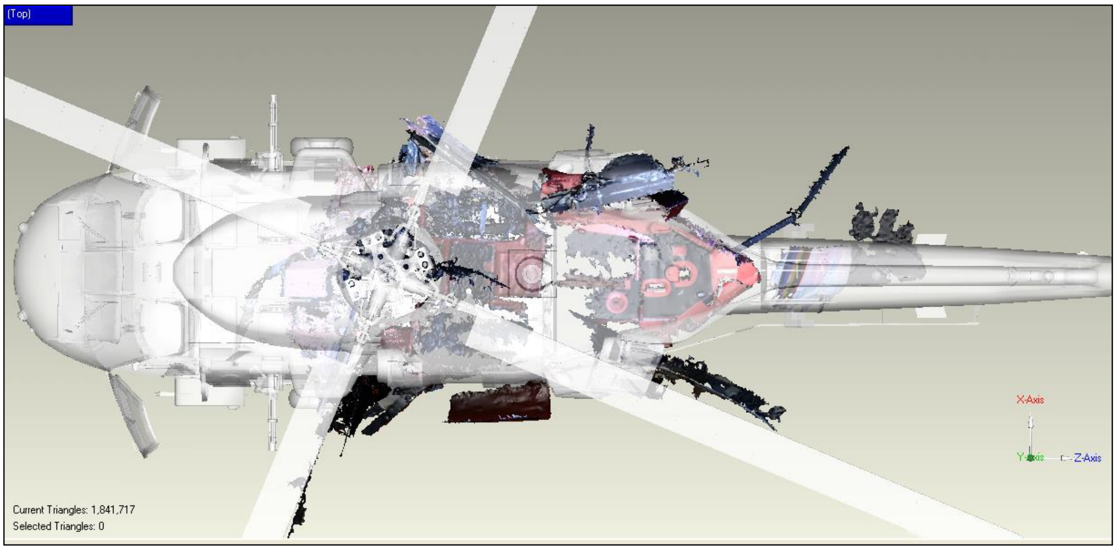

圖 1.16-8 事故機殘骸與原始模型比對之俯視圖

1.16.2 模擬機測試

本次事故執行之模擬機測試共計 2 次，以事故機 FDR 資料為參考，使用陸軍航空第六 O 二旅現役 UH- 60M 型之全功能模擬機(FFS)，由該部現役資深 UH-60M 型機飛行教官執行操作。測試主要目的為：模擬事故機最後 81 秒之飛航狀態，比對測試結果以瞭解當時之飛航狀況（有風及靜風之影響）、事故機於不同風速狀態下正常起飛之狀

況、事故機墜毀前最後 19 秒之操作驗證以評估事故機墜毀狀態至改出所需時間、高度及 FD/DCP 警示訊息測試。詳細之執行計畫及測試報告如附件。相關測試結果重點如下：

1. 模擬航機最後 81 秒之操作發現：

- 順風風速超過 50 浬/時，航機離地後無法操控。
- 設定順風 40 浬/時（含）以下，可模擬出趨近事故機最後 81 秒之飛航狀態。
- 不同順風之操作對扭力之影響不大，扭力如低於 30%，則扭力隨順風增加約有 10%之變化。
- 相同馬力設定下，靜風時之速度較有順風時為大，順風 40 浬/時之操作，其速度之變化最大可減少約 20 浬/時。
- 航機爬升之高度會隨順風風速加大而減低，最大值約發生於 35 秒時。
- 於 FD couple 狀態下，當空速低於 50 浬/時，會有 FD 警示訊號出現。

2. 正常起飛測試結果：

- 於風向 040 度、風速 40 浬/時以下之設定狀況，無論以手控或重飛模式操作，航機均可順利起飛及爬升，超過上述風向/風速設定,起飛過程中操控負荷甚大,航機不易操控。
- 於風向/風速設定超過 040 度、45 浬/時，航機無論以手控或重飛模式操作，均無法安全滯空及起飛。
- 順風之大小會影響爬升率及馬力之設定，但於 40 浬/時內之順風無操作上之問題。
- 於 40 浬/時內之順風狀態下，模擬結果顯示以手動操作方式起飛後 30 秒內之高度均可到達 500 呎以上,速度最小則為約 70 浬/時。

3. 大角度下降測試結果：

- 自靜風及 50 浬/時順風下，模擬事故機最後 19 秒之飛航狀態，於 1,000 呎高度進入，於 15 秒內消失之高度約為 600 呎至 800 呎間。

4. 無論 FD Coupled 設於正/副駕駛側，當減速至 48 浬/時，正/副駕駛 MFD 上”FD COUPLE FAIL”及”FLT DIR FAIL”訊息均會產生，空速加至 50 浬/時以上後，需經駕駛員執行 FCC reset 後訊息才會消失。
5. 如將正副駕駛兩邊同時 FD Uncoupled，航機加減速通過 50 浬/時上下，MFD 上並不會出現任何與 FD COUPLE 相關訊息。
6. 同時將 AFCS 控制面板上之 SAS1 & 2、TRIM、FPS 及 BOOST 置於關閉位置，MFD 上將會產生 SAS OFF、BOOST SERVO OFF、FLT DIR FAIL 及 FD COUPLE FAIL 等訊息。航機操控困難。
7. 將 AFCS 控制面板上之 TRIM 開關置於關閉狀態，駕駛員表示操縱桿變輕，操縱量需減小，接著關閉 SAS 兩套系統，MFD 上產生 SAS OFF 訊息，但無 FD 相關訊息產生，航機仍可操控。

1.16.3 暗適應測試

為驗證事故機飛航組員，於事故當時是否受現場燈光影響，本會擬定飛航組員暗適應測試計畫，利用蘭嶼機場現有夜間燈光設施，模擬事故當時之燈光，挑選本會及空勤總隊飛行人員執行相關靜態及動態測試。相關測試結果如下：

1. 靜態測試結果：受測人員由強光轉向黑暗之海面後計時，平均能辨識跑道西側、距測試人員位置 67 公尺之圍欄時間約為

6 秒，而平均可辨識天地線時間則為 46 秒。

2. 滯空動態測試時，航機自滯空轉向全黑之海面，適應時間為 30 至 50 秒。離場後目視外界之時間約為 45 秒，離場時之目視適應時間為約為 23 秒。
3. 於動態測試，依照所測得時間，可得知黑鷹直昇機機內儀表燈光及起飛離場時，採用手動或自動起飛模式，將影響飛行人員對外目視適應時間長短。
4. 飛行過程中，若交互檢查聚焦於座艙內，抬頭目視座艙前方黑暗海面及無燈光景物時，約需 2 至 3 秒，才能辨識出前方外界狀況。
5. 執行動態測試期間，律定正駕駛員不受測，全程執行儀器飛行，期間分別以手動及自動起飛模式，均可正常操控航機。

1.16.4 夜航燈光測試

本測試之主要目的在測試日間目視機場，於夜間操作時有跑道燈光及無跑道燈光情形下：目視機場之距離/狀況、到場時之目視狀況（機場跑道辨識）、進場航線時之目視狀況、機場航線操作之目視狀況及相關操作困難度。本次測試使用使用 UH-60M 型直昇機，利用望安機場之現有設施，由臺中清泉崗機場起飛前往馬公機場，終昏後起飛前往望安機場執行測試，相關測試結果如下：

1. 於機場跑道燈光強度設定為 1 之狀況下，距機場 8.9 浬可清晰辨識機場之特徵。於機場燈光關閉之狀況距機場 1.9 浬始能大略辨識機場特徵。
2. 機場旋轉燈對機場之辨識幫助不大。
3. 於開啟機場跑道燈光狀況下，可明顯辨識機場之物理特性，機場之景深及障礙物之位置均可判斷，測場及進場操作均無問題。
4. 於關閉機場跑道燈光（機場航廈及機坪燈光保持開啟）狀況

下，不易辨識機場之物理特性，且航廈及機坪燈光會影響進場操作之判斷，於進入跑道上空後才可辨識跑道之邊線。

5. 進場落地過程中發現跑道西側有兩根天線，未安裝警示燈光，夜間於關閉跑道燈光狀態下，航機進場如偏向西側，高度低時容易撞及天線。
6. 於關閉機場跑道燈光（機場航廈及機坪燈光保持開啟）狀況下，使用夜視鏡進場，相關操作與白天相同。

1.16.5 風場數值模擬

蘭嶼地形主要為山地，僅沿海地區地勢較低，機場位於蘭嶼西南側近山腳處之海邊，北邊距最高之紅頭山（海拔 552 公尺，1,811 呎）約 1.62 浬；10 月至 4 月蘭嶼盛行東北風，機場正處於山之背風面，因此常發生低空風切及亂流現象。本會委託國立台灣大學資源與災害研究中心進行事故地區風場數值模擬，報告詳附錄 4，估算該機飛行之區域，風向為北北東風，平均風速最大約 36 浬/時，水平及垂直風切強度為中度風切。

1.17 組織與管理

1.17.1 飛航作業相關規定

1.17.1.1 飛航作業

空勤總隊第 9 版之航務管理手冊，與飛航作業相關之規定包含第 50 條、第 51 條及第 67 條如下：

第八章飛航作業

第五十條 一般規定

……。

依據最新天氣測報，如已知目的地機場及其備用機場於預計到達時間，其天氣未達最低飛航限度者，駕駛員應中止向該目的

地機場飛航。如於飛航中，除緊急情況外，應即中止進場及降落。

……。

第五十一條 操作手冊

一、各機型手冊內容應包括：正常(標準)、不正常，緊急操作程序，機型系統詳細說明，特種課目操作程序，飛航規定，各檢查程序，操作範圍與限制，相關使用檢查表，以及因時、地之不同，訂定異同之程序。

二、操作手冊之編審與修訂經本總隊核備後，始得頒佈實施。三、飛航組員應依據操作手冊及飛航手冊中之各項規定、標準及限制操作航空器不得逾越之。

四、具飛航教師資格以上人員應依據飛機原製造之相關廠商所訂之航機操作手冊、程序，檢查表，配合本隊之需要，在不違背相關法規原則下，制訂該機型操作手冊及檢查手冊。

第六十七條 越水飛航

越水飛航之直升機飛航於下列情形之一時，應裝置永久或可快速完成設置之浮具，以確保水上迫降作業之安全：

一、一級或二級性能直升機以一般巡航速度飛越距陸岸達10分鐘以上者。

二、三級性能直升機於自動旋轉滑翔距離或安全迫降距離超過陸岸距離者。

……

1.17.1.2 座艙分工規定

空勤總隊第 9 版之航務管理手冊第三章，有關飛行人員座艙分工之規定如下：

第十七條 座艙規定

……

飛行人員座艙分工：

一、操控飛行員（Pilot Flying）：負責操控並維持飛機之姿態、航路、高度、空速與安全及機外障礙物清除等，執行監控飛行員讀出項次並覆誦。

二、監控飛行員（Pilot Monitoring）：負責航管通話、抄錄許可等資訊、讀出檢查手冊檢查項次並確認，完成操控飛行員（PF）要求事項；負責讀出各儀表指數，協助機外障礙物清除，並於每次起飛

（落地）前，完成起飛（落地）前檢查。每15 至30 分鐘執行油量計算一次。

………

1.17.1.3 任務作業程序及風險評估

空勤總隊第 9 版之航務手冊附件六，勤務項目(八)，訂有直昇機空中救護-轉診與緊急救護任務作業程序。其重點包含任務受領、飛行前檢查、座艙檢查、發動機啟動、滑行及起飛前檢查、起飛及爬升、任務執行、返航、落地及關車等，並訂有 PF、PM 等之職掌（詳如附錄 5)。該任務作業程序於任務受領階段，亦訂有對任務風險因子評估之項目。

民航局頒佈有關飛航組員標準作業程序（Standard Operating Procedures, SOP）民航通告之編號為 AC120-014A，說明 SOP 的背景、基本概念及其哲理，是公認的飛航安全基礎。該通告第 3 頁第 6 項則明確指出依據研究操控下接近地障（controlled flight into terrain, CFIT）事故中幾乎 50%肇因於飛航組員沒能遵行 SOP，或是未建立恰當的 SOP；有關該通告標準操作程序範本重點如附錄 6。

1.17.1.4 目視起飛程序

美國陸軍於 2012 年 5 月 22 日出版之飛行訓練手冊（Aircrew Training Manual, ATM）第 4-50 及 51 頁有關目視起飛之內容摘要如下：

目視起飛之方式概分為：恆定角度、垂直、水平加速及滾行起飛 4 種，其中共通之程序為：1.操作航機滯空配平於距地面 50 呎或指定之高度。2.估算飛機傳導升力之速度，以協助確定起飛方式。3.依航機總重、可用馬力及距障礙物距離，以決定起飛方式。有關恆定角度起飛之程序為：

增加馬力，建立滯空狀態。推桿加速並避開障礙物，繼續加速至所需爬升空速並保持航向。超越飛行路徑中的障礙物，並獲得所需的爬升率。視需要調整迴旋桿以停止加速並保持所需的爬升空速。保持起飛馬力，至加速最小單發動機之空速，之後視需要調整馬力，以維持所需的爬升率或既定之爬升狀態。

1.17.1.5 操作程序及限制

依據該型機原廠於 2014 年 9 月 1 日出版之飛航操作技術手冊（Technical Manual），第 8 章為正常操作程序，內容包含：起飛前檢查、發動機啟動前檢查、駕駛艙檢查、滑行前檢查、滑行檢查、滯空檢查、起飛及起飛後檢查等；第 8.33 節內容係規定儀器飛航時應確認開啟空速管加溫電門。

該手冊第 5.2 節內容，側向/向後飛行限制：滯空之側風及順風限制為 45 浬/時。側飛/後飛入之風速不得超過 45 浬/時。（原文：*Sideward/rearward flight limits. Hovering in winds greater than 45 knots from the sides or rear is prohibited. Sideward/Rearward flight into the wind, when combined with wind speed shall not exceed 45 knots.*）

1.17.2 人員訓練規定

空勤總隊第 9 版之航務管理手冊第四章，有關飛行人員之訓練第 18 條及第 19 條相關規定如下：

第十八條 飛行人員訓練與依據

一、飛行人員訓練區分新進人員、機種轉換、差異、升等、恢復資格、特種（專精、精進）訓練、熟飛、模擬機、常年訓練等。

二、有關各類人員訓練資格、內容、時數及考核檢定等規定，本總隊（航務組）應訂定「飛行人員訓練手冊」，以為所屬各單位訓練之依循。

三、……。

四、……。

第十九條 一般規定

一、本總隊所屬各勤務大隊執行相關飛行訓練，應依訓練手冊所載學、術科內容，擬定訓練計畫，陳報核准後實施。

………

四、飛行人員應落實「任務裝備操作」及「組員資源管理」等訓練，必要時以模擬機熟練操作技能，以利任務遂行。

五、……。

六、為安全達成任務，各組員應依個人職責、裝備操作手冊，並掌握外界情況，通力合作；有關各任務執行要領，參考民航局飛航組員標準操作程序（SOP）之規範，訂定本總隊空勤任務作業程序（詳如附件六），要求所屬空勤人員，了解程序及乘員分工，並納入年度施訓課目，以執行有效的訓練。

七、……。

依據空勤總隊第 7 版之飛行人員訓練手冊內容，該總隊訓練之種類包括：新進駕駛員訓練、機種轉換訓練、差異訓練及升等訓練（含正駕駛訓練、飛航教師訓練及檢定機師訓練）等；其中機種轉換訓練規定：具有其他機種副駕駛以上資格者，完成機種轉換訓練後，得以機種之副駕駛任用之。UH-60M 型機之學科訓練時數最低為 15 小時，術科時數不得低於 10 小時。

有關正駕駛升等訓練之資格：規定總飛行時數需達 1,200 小時以上，該機種副駕駛飛行時數需達 100 小時以上，且儀器時間在 100 小時以上、夜航時間 50 小時以上、吊掛時間 50 小時以上、山區或海上飛行 50 小時以上；總飛行時數未達 1,200 小時以上，該機種副駕駛飛行時數需達 300 小時以上，且儀器飛行時間在 100 小時以上、夜航時間 50 小時以上、吊掛時間 50 小時以上、山區或海上飛行 50 小時以上。UH-60M 型機正駕駛升等之學科訓練時數最低為 15 小時，術科時數則不得低於 10 小時。

有關飛航教師升等訓練之資格：規定總飛行時數需達 1,500 小時以上，該機種正駕駛飛行時數需達 100 小時以上，且儀器時間及夜航

時間需在 100 小時以上；總飛行時數未滿 1,500 小時者，該機種正駕駛飛行時數需在 500 小時以上，且儀器時間在 100 小時以上、夜航時間 100 小時以上、山區飛行時間 100 小時以上、海上飛行時間 50 小時以上。UH-60M 型機飛航教師升等之學科訓練時數最低為 15 小時，術科時數則不得低於 10 小時。UH-60M 型機飛航教師升等之學科訓練時數最低為 15 小時，術科時數則不得低於 10 小時。

有關檢定機師升等訓練之資格：規定曾任或現任飛航教師（IP）5 年以上經歷者，飛行總時間須達旋翼機 3,000 小時以上；固定翼機 4,000 小時以上（新引進之機種，經該製造廠授權之飛航訓練單位完成訓練，並經簽證合格者，不在此限），2 年內無飛航違規及無因技術錯誤造成之意外事件者。檢定機師之培育則以檢定實務經驗與研討交流為主，內容應包含如何做好檢定機師的工作及其責任、如何執行飛航組員之鑑測及不正常動作之預防、檢核表格之填寫等。

1.17.3 飛行訓練計畫

1.17.3.1 原廠訓練計畫

依據該型機原廠 SIKORSKY Training Academy 提供之資料，UH-60M 型機之飛行訓練概分為：初始資格訓練（initial qualification training）、換裝訓練（transition training）、飛航教師訓練（instructor pilot training）及維修試飛員訓練（maintenance test pilot training）等。

初始資格訓練之對象為未具備黑鷹直昇機系列飛行資格之直昇機飛行員，參訓人員必須具備直昇機商用飛行員（或同等軍機）資格，並有至少 500 小時以上渦輪軸直昇機飛行時間。訓練時間為 6 週，包含 4 週之地面學科及 2 週之飛行訓練兩階段，飛行訓練並包含有 10 小時之系統整合訓練（system integration training）、20 小時之模擬機及 10 小時之實體機訓練。

換裝訓練之對象為曾具備黑鷹直昇機系列飛行資格（如 S-70 或 UH-60）之直昇機飛行員，參訓人員必須具備直昇機商用飛行員（或同等軍機）資格，至少 500 小時以上渦輪軸直昇機飛行時間且具備黑鷹直昇機系列完訓證明。訓練時間為 4 週，含地面學科及飛行訓練各 2 週，飛行訓練包含有 7 小時之系統整合訓練（system integration training）、10 小時之模擬機及 10 小時之實體機訓練。

以上兩項訓練之相關訓練課目如下：

Phase 1（地面學科）	Phase 2（飛行訓練）
• General Aircraft Overview • Publications • Crew Resource Management • Adverse Weather Operations • Electrical Power System • Powerplant and Related Systems • Fire Protection Systems • Fuel System • Hydraulic Systems • Landing Gear and Brakes • Powertrain • Automatic Flight Control System • Main Rotor/Tail Rotor • Active Vibration Control Systemx • Flight Management System • Integrated Cockpit • Performance Planning	• Flight Preparations • Preflight Procedures • Takeoff and Departure • Inflight Maneuvers • Landings and Approaches to Landings • Flight Director Procedures • Emergency Procedures • Post Flight Procedures

飛航教師訓練之目的係提供日後擔任飛航教師之飛行員，具備足夠之專業及知識於目視狀態下可安全地擔任飛行教學之工作，並於實際飛航中加強組員資源管理應用。參訓人員除須具備黑鷹直昇機系列飛行資格（如 S-70 或 UH-60 等），且須具備其他直昇機飛行教官資格，飛行時間 1,000 小時以上，至少 500 小時以上之機長時間。訓練時間為 2 週之飛行訓練，包含 10 小時之實體機訓練。

維修試飛員訓練必須使參訓者能深入了解航機系統、航機性能、航機操控特性、飛行手冊內容、功能測試程序等之專業及知識，並能具備足夠與其他組員溝通之能力，使其有效測試航機經維修後，相關系統之適航性。具備黑鷹直昇機系列飛行資格(如 S-70 或 UH-60 等)之參訓人員須完成上述該型機換裝訓練，未具備者須完成該型機初始資格訓練。維修試飛員訓練時間為 2 週，包含 10 小時之實體機訓練。

1.17.3.2 我國陸軍訓練計畫

我國陸軍赴美飛行員訓練（pilot aircraft qualification course, AQC），共 10 週，學科時數 755 小時，飛行小時數 36 小時，模擬機 12 小時；飛航教師訓練（instructor pilot course, IPC），共 9 週，學科時數 391 小時，飛行小時數 41 小時，模擬機 9 小時；維修試飛員訓練(maintenance test pilot course, MTPC)；共 8 週，學科時數 371 小時，飛行小時數 26 小時，模擬機 13.5 小時，相關課程內容如附錄 7。

1.17.3.3 美陸軍建議之訓練計畫

依據空勤總隊有關 UH-60M 型直昇機建案計畫相關資料，美國陸軍安援管理辦公室對該總隊飛行員訓練，曾提供 2 次建議：

- 美國陸軍安援訓練管理辦公室於民國 102 年 9 月 12 日建議空勤總隊訓練時程及課程內容（詳如附錄 8）摘要如下：
  1. 飛行員訓練（pilot aircraft qualification course, AQC）共 6 週，34 飛行小時（含模擬機 10.5 小時）；
  2. 組員訓練（crew member course, CMC）共 2 週，8 飛行小時；
  3. 特殊任務訓練（special mission training course, SMT）共 4 週，8 飛行小時（含模擬機 2 小時）；
  4. 空勤 6 項特別裝備訓練（SET, NASC 6 special equipment training course）共 2 週，8 飛行小時；
  5. 飛航教師課程（instructor pilot course, IPC）共 8 週，41 飛

行小時（含模擬機 12 小時）；

6. 維修試飛員訓練（Maintenance Test Pilot Course, MTPC）共 7 週，37 飛行小時（含模擬機 9 小時）。

- 美國陸軍安援訓練管理辦公室於民國 103 年 8 月 13 日建議空勤總隊訓練時數及課程內容（詳如附錄 9）擇要如下：

1. AQC 訓練分為：機種轉換、儀器程序、緊急程序及進階手控飛行，含地面學科、模擬機飛行時數及實機飛行時數，共計約 10 週。
2. IPC 包含地面學科、模擬機飛行及實機飛行時數，共計約 2 週。
3. MTPC 包含地面學科時數、模擬機飛行時數及實機飛行時數，共約 3 週。

課程時數配當如表 1.17-1。

表 1.17-1 課程時數配當表

時間：小時

訓練類別	地面學科	模擬機飛行	實機飛行時數	週數
AQC	196.5	34.5	19	10
IPC	45.0	7.5	5	2
MPC	73.0	4.5	10	3
共計	314.5	46.5	34	15

1.17.3.4 空勤總隊之訓練計畫

針對空勤總隊赴美執行 UH-60M 型機之飛行訓練，美國陸軍安援訓練管理辦公室與空勤總隊簽訂訓練合約之內容：AQC 訓練期程為 8 週，IPC 及 MPC 分別為 2 週及 3 週。並由美陸軍安援辦公室指定合格之訓練機構（場所）執行訓練。

1.17.4 飛行訓練實施經過

空勤總隊 UH-60M 型機之國外飛行訓練共計 2 年 7 梯次。赴美

訓練前，空勤總隊均向美國承包廠商提出課程及飛行時數最低需求，如：要求每位飛行員模擬機訓練 30 小時；每位飛行員 AQC 訓練飛行 24 小時，包含地面學科，不超過 3 個月訓期等條件。

1.17.4.1 第 1 年訓練經過

第 1 年（民國 104 年至民國 105 年）分為 3 梯次，訓練地點為美國佛羅里達州原廠訓練中心（SIKORSKY Training Academy）。

- 第 1 梯次（104/9/22~104/12/02）派遣 6 名學員完成 AQC 訓練，實體機飛行時數 15 小時，模擬機飛行時數 82 小時，另有地面學科 96 小時，結訓後空勤總隊以該機種正駕駛員資格任用，其中 4 名學員留美接續完成 IPC 訓練（104/9/22~105/2/28），該訓練實體機飛行時數 22 小時，模擬機飛行時數 22 小時，及 MPC 訓練，該訓練實體機飛行時數 23 小時，模擬機飛行時數 28 小時，另 2 名學員 AQC 結訓後返國接機，課程內容詳附錄 10。
- 第 2 梯次（105/2/04~105/04/10）派遣 6 名學員完成 AQC 訓練，各科時數與第 1 梯次略同。
- 第 3 梯次（105/4/05~105/08/13）派遣 4 名學員完成 AQC 訓練，另外加入 2 名前期 AQC 學員（105/6/13~105/08/13）一併完成後續 IPC 及 MTPC 訓練。

1.17.4.2 第 2 年訓練經過

第 2 年（民國 105 年至民國 106 年）訓練合約由美國 RESICUM 公司取得，分為 4 梯次，訓練地點為美國佛羅里達及阿拉巴馬州，訓練課程內容如附錄 11。

- 第 1 梯次（105/11/03~106/02/23）派遣 4 名學員完成 AQC 訓練，包含事故機正、副駕駛，該訓練實體機飛行時數為 15 小時，模擬機行時數 20 小時，另有地面學科 3 週。

- 第 2 梯次（106/2/11~106/4/05）派遣 4 名學員完成 AQC 訓練
- 第 3 梯次（106/4/14~106/6/13）派遣 4 名學員完成 AQC 訓練
- 第 4 梯次（106/6/16~106/9/17）：6 月 16 日至 8 月 15 日派遣 4 名學員完成 AQC 後，其中 2 員返國，另 2 員滯美連同國內於 8 月 15 日另派 2 員赴美，於 9 月 17 日完成 IPC 及 MTPC 訓練。

事故機飛航組員即為本年度訓練，第 1 梯次送訓之學員。

1.17.5 組員資源管理訓練

空勤總隊第 7 版之飛行人員訓練手冊，新進駕駛員訓練、機種轉換訓練、差異訓練及升等訓練等章均訂有組員資源管理之訓練項目。

民航局轉頒美國 FAA 有關組員資源管理訓練之民航通告，訓練主題集中於人為因素，包括溝通過程與決策行為：含提示、徵詢/支持/建言、決策與行動、衝突解決、決策品質等。另一主題為團隊建立與維持，包括：人際關係與實務應用、有效的領導/被領導與人際關係，工作負荷管理與狀況警覺、遵循 SOP、減低組員效能的個人因素等，其附件三並定義有適當之訓練主題（詳如附錄 12）。

1.17.6 操控下接近地障

為降低及防制操控下接近地障事故，民航局轉頒美國 FAA/AC 61-134 有關航空器操控下接近地障察覺能力（Controlled Flight into Terrain Awareness）之民航通告，建議航空業者檢視現行相關作業，包括：制/修訂儀器飛航作業、目視低空飛航作業、或限目視飛航之駕駛員於臨界目視天氣或儀器天氣中飛航作業程序、作業手冊及訓練計畫等。（詳如附錄 13）

1.17.7 逐漸惡化之目視環境

歐洲直昇機安全執行小組（EHSIT）為增進直昇機駕駛員能力，曾出版一份「安全考量因素」之訓練宣導手冊，以強化飛航安全（詳如附錄 14）。其中針對駕駛員因逐漸惡化之目視環境（DVE）導致空間迷向而產生之事故擇要敘述如下：下列三種情境之任一種或合併發生，將導致嚴重的意外：

A. 當企圖操控直昇機避開能見度不良區域，亦即企圖以折返、爬升或下降方式避開逐漸惡化之目視環境(DVE)而導致失控。

B. 駕駛員不預期飛入儀器天氣情況(IMC)，轉換為儀器飛行時產生空間迷向或失控。

C. 駕駛員喪失情境認知，導致直昇機在可操控情況下撞擊地面/海面/障礙物或空中相撞。

1.18 其他資料

1.18.1 訪談紀錄摘要

1.18.1.1 UH-60M 型機駕駛員

經訪談數位該型機之資深駕駛員相關敘述摘要如下：

UH-60M 型機之特點：新一代 UH-60 型機之裝備包括導航及 FD、自動飛操、操作功能有明顯提升，具完整導航如 ILS 部分之功能，其架構及終端顯示有很大更新及改變，操控很多元，為達一種目的有多種組合方式，要加強學習。如能充分了解飛機系統，對有效及安全飛行之幫助很大，可避免許多人為疏失。飛此系統複雜之飛機，即使受過正式訓練，但因每個人之背景不同，加上語言及相關障礙，接受程度會不一樣，需要不斷學習及複習方能保持一定之純熟度。也應多飛，但因機隊駐地分散，飛機數量不夠，又要國搜待命，所以能飛行之時間不多，無法充分訓練。

蘭嶼機場之特性：於蘭嶼機場（或綠島）執行任務，因無跑道燈，無法建立立體感，進場時很難判斷落地點之位置，如有跑道邊燈，進場時很容易保持航機與落地點之參考位置。七美望安也是目視機場，但有跑道燈，執行夜間任務時容易很多。如於進場遭遇亂流，更增加操控困難，另蘭嶼跑道兩頭均有山，尤其夜間進場有很大威脅，環境很差，於夜間進場時很不好判斷，如有跑道燈，會容易判斷進場時狀態，大幅減輕操作壓力。另於起飛時，如直接向西脫離，可以保證不會撞到山，但對飛行員來講，從一明亮環境進入一全黑之環境，因為起飛滯空時一定用目視，突然進入全黑，由目視進入儀器，此一轉換過程最容易發生迷向。

有關該型機起飛操作：有很多方式，起飛後空速到 60 浬/時，按結合（plunge）電門以結合空速及高度，之後使用 HOST SW 加速及爬升，到達高度後加速至巡航速度（120）。起飛之原則係先建立安全高度，再加速至 60 浬/時，之後結合自動駕駛飛航。起飛還有其他方式，如按 GO ARND BT 建立 70 浬/時空速、750 呎/分爬升率，但爬升過程中到 60 浬/時，會有一減速之過程，飛行員需特別注意飛機姿態，所以有些人不喜歡用，另外完全使用手動操作也是一種選擇。

有關飛航之天氣標準：起飛機場依照機場之目視規定，目的地機場夜間是 5,000 公尺,雲高 1,500 呎，原來是特種目視（1,600/500），其實除天氣外，航路及預報也要考量。機長還要考量備用油量、機務、轉降機場等，壓力很大。風速限制則沒有明確規定，應該考量。

有關人員訓練部分：對人員訓練來講 100 小時應只是完成換裝，最少 500 小時才能符合正駕駛升訓之條件。新換裝飛機系統又複雜，加上沒飛機可用，所以組員通常飛行時間都不夠，無法有效熟悉飛機之系統及救災環境。目前機隊駐地分散，飛機數量不足，導致訓練效果不如預期。

有關 UH-60M 型機系統設計：是供美陸軍使用，許多特性不適用

於海上任務，如海上使用之航機防腐防鏽需加強，環控系統，用以冷卻及防止低空結霧，雨刷沒有噴水設計，易影響視線。於海上飛行沒有浮筒等。

1.18.1.2 管理階層訪談

經訪談空勤總隊相關管理階層人員，內容摘要如下：

空勤總隊為執行黑鷹直升機接裝，規劃五年接裝訓練，因有執行任務之壓力及人力分配問題，採分梯赴美參加換裝訓練。於完訓返國後，再行針對國內地理環境及任務特性，與消防署特種搜救隊、海巡署特勤隊人員逐批完成各屬性之「任務訓練」。

有關換裝訓練內容，原本由美軍提出之訓練計畫，因為無法突破非軍職人員直接赴美軍方單位施訓，所以採外包方式由合格民間廠商執行，相關訓練內容因有限資源分配及合約問題，有減少狀況，但如選訓具類似型機飛行經驗人員參訓，應可彌補。

因為機型換裝交替，空勤總隊面臨人力及有限資源之限制，且面臨所擔負之 5 大主要核心任務及各項大型演訓、災害防救演練等任務均不能中斷之情況下，確實可能造成人力分派及訓練不足狀況。

1.18.1.3 塔臺人員

管制員對蘭嶼機場主要感覺為：風場較亂，冬天東北季風易造成兩端進場時有順風狀況，且亂流情況較明顯。目前飛航蘭嶼的機型受側風限制較大，同時現使用的跑道曾受颱風破壞造成縮短約 100 公尺。

當日狀況為：事故機於朗島位置報告目視機場進場時，即提供跑道兩端風向風速資訊，目視 NA-706 於停機坪進場落地，機頭朝北狀況穩定。當救護車到達，病患等人完成登機執行離場，受訪者亦感覺事故機無特別異狀，起飛後高度略比塔臺稍高即實施轉向，目視向西

飛航，此時以無線電要求於朗島呼叫，NA-706 亦複誦該項指示無誤並回答大約五分鐘到達朗島，隨即打開塔臺內部燈光實施資料登錄。就在心裡盤算事故機應該回報朗島位置檢視雷達銀幕上發現事故機信號已經消失，隨即聯繫附近站台尋查事故機未果，無線電呼叫亦無回應，隨即開始啟動搜救機制。

該機場主為日間機場，終昏後即不提供起降，唯一例外為夜間需要 EMS 傷患後送。於夜間執行該任務時，航機於進場前會打開 Beacon 燈、直昇機停機坪燈、PAPI 燈、風向袋燈光還有 RAMP 照射燈光，同時消防車輛亦會開燈進入備便狀態。蘭嶼機場並未有跑道燈及各類型進場燈光輔助航機進場操作。

氣象員表示當時能見度為 5,000 公尺，觀測雲幕高度為 1,500 至 1,800 呎裂雲，風向不定，風速約為 26 到 30 浬/時。後續 NA-704 進入搜索時，能見度有下降，同時天氣有略變差趨勢。

1.18.2 NA-706 機之風險評估表及性能計畫資料

依據空勤總隊於事故後提供有關事故機本次任務之飛行操作風險評估表如圖 1.18-1；性能計畫卡如圖 1.18-2。

內政部空中勤務總隊 飛行操作風險評估表

隊別	第三大隊第三隊	起飛點	1. 台東豐年	2. 蘭嶼	3.	4.
日期	2018/02/05 22:31	落地點	1. 蘭嶼	2. 台東豐年	3.	4.
機型機號	UH-60M / NA-706	勤務項目	1. 救護轉診	2.	3.	4.
機組員	P：康萬福 F/O：唐文彥 CE：陳冠宏					

項次	評估項目	尚可		有點困難		很困難	
1	飛機檢修完成之試飛缺點程度	清除		有缺點不影響	V	有缺點有影響	
2	近場導航設備	精確系導航	V	非精確系導航		無導航	
3	飛機導航裝備	ILS		VOR/DME	V	NDB	
4	天氣狀況（離場、航路、到場）及操作地區風速	合於放行（或操作）標準	V	臨界放行（或操作）標準		未達放行（或操作）標準	
5	操作地區（含海域）狀況	良好	V	已知不常去		未知沒去過	
6	落地點狀況	已知且常去	V	週邊有障礙物		障礙物高、狹小、FOD	
7	無線電裝備	有且接收良好	V	發射及接收時有時無		無	
8	飛行員操作經驗及航行管制熟悉程度	良好		尚可	V	困難	
9	機組員身體狀況	精神飽滿	V	精神欠佳		精神不振	
10	飛行操作熟悉度（距上次飛行間隔）	一周內	V	兩周內		三周以上	
11	任務機組員（含共勤人員）配合情況	經常共同執行任務	V	曾經共同執行任務		未曾共同執行任務	
12	本次若係執行落艦任務，請於「是」欄位勾選後，續填下列評估項目;若非，逕跳至21項填寫。□ 是						
13	落艦種類	港內落艦		航行落艦			
14	已知船艦狀況（噸數、落艦區範圍）	已知且常去		船艦週邊有障礙物		障礙物高、落艦區狹小	
15	海象限制（PITCH、ROLL）	海象平穩且良好		PITCH 2度內、ROLL 4度內		PITCH或ROLL超過規範	
16	船艦配備導引設施	完善		未完善;但不影響落艦作業		無導引設施	
17	落艦飛行操作熟悉度	近3月內曾執行過		3~6月內曾執行過		超過6月以上或未曾執行過	
18	配合落艦之船艦及艦上作業人員熟悉度	3~6月內曾執行過		6~12月內曾執行過		1年以上未執行	
19	落艦船隻附近是否有警戒艇戒備	有				無	
20	風險評估結果	尚可	8	有點困難	3	很困難	0
	風險評估處置	尚可──飛行員可接受派遣 有點困難──必須由機長於分組任務提示時敘述 很困難──必須由機長或單位主管（代理人）於提示時加強督導後執行;或提列數據佐證無法執行，並於下方21欄位註記					
21	□ 屬很困難，但仍可執行			□ 屬很困難，無法執行（請備妥數據佐證)			

圖 1.18-1 飛行操作風險評估表

H-60 PERFORMANCE PLANNING CARD

For use of this form, see TC 3-04.33: the proponent agency is TRADOC.

DEPARTURE

AIRCRAFT GWT:	15895 lb	PA: 130 ft / 130 ft		FAT: 12 °C / 12 °C	
STORES WEIGHT:	0 lb	DUAL ENGINE		SINGLE ENGINE	
FUEL WEIGHT:	2200 lb			#1	#2
ZERO FUEL WEIGHT:	13695 lb	ATF: 1.000		ETF: 1.000	ETF: 1.000
TORQUE RATIO		1.000		1.000	1.000
MAX TORQUE AVAILABLE		139 %		139 %	139 %
MAX ALLOWABLE GWT OGE / IGE		22000 lb	22000 lb		
GO/NO-GO TORQUE OGE / IGE		92 %	92 %		
MAX HOVER HEIGHT IGE		OGE ft			
PREDICTED HOVER TORQUE		63 %		125 %	125 %
MIN SE AIRSPEED - IAS - WO/W STORES				3 kts / 3 kts	

REMARKS:

EMER SE IAS		GO/NO-GO TORQUE OGE	30 FT	40 FT	50 FT
kts	kts		102	104	105

Aircraft Configuration:

Engine Type	701D
UES	Installed

CRUISE

PA: 1000 ft	FAT: 10 °C	MAX ANGLE: 60 °			Vne-IAS: 193 kts		
		DUAL ENGINE			SINGLE ENGINE		
					#1		#2
MAX TORQUE AVAILABLE		139 %			138 %		138 %
MIN / MAX - IAS		0 kts	170 kts		4 kts		133 kts
CRUISE SPEED - IAS / TAS		120 kts	120 kts		80 kts		84 kts
CRUISE TORQUE / CONT TORQUE AVAILABLE		58 %	121 %		80 %		120 %
CRUISE FUEL FLOW		932 pph			578 pph		
MAX RANGE - IAS / TORQUE		127 kts	64 %				
MAX END - IAS / TORQUE		62 kts	38 %				
CRITICAL TORQUE		69 %					
MAX ALLOWABLE GWT		22000 lb			22000 lb		
OPTIMUM IAS AT MAX ALLOWABLE GWT		74 kts			74 kts		
MAX R/C - IAS / TORQUE		72 kts	136 %				
MAX ALTITUDE - MSL / MAX END - IAS		20000 ft	55 kts		13600 / 13600 ft / 60 / 60 kts		

TW NASC UH-60M S/N: 1070205-706

圖 1.18-2 NA-706 性能計畫卡

1.18.3 暗適應及空間定向失能

國防部軍醫局於民國 104 年 9 月版之國軍航空醫務教範第 4.8 節內容為飛行與視覺，第 4.9 節內容為空間定向失能（spatial disorientation）。

第 4.8 節內容提及眼內視網膜上的感光細胞分為椎狀細胞和桿狀細胞。錐狀細胞分布在視網膜的中央區，負責日間視覺包括彩色視覺；桿狀細胞則分布在視網膜的周邊，負責夜間視覺。相關內容如下：

………

二、明視覺（Photopic vision）：在晝間及人工照明下，可用明視覺來視物辨色。當觀察一個物體時，將本能的移動眼球使影像落於視網膜之正中凹區。正中凹區為明視覺最敏銳的部分，但正中凹區的錐狀細胞在弱光下無法引起神經衝動，所以在夜間凝視一個物體時，視野中心將出現視盲區域，亦稱為中央盲點。

三、暗視覺（Scotopic vision）：暗視覺由桿狀細胞負責，它不能分辨顏色。由於分布在周邊，故夜間視物必須時常移動眼球，用偏離中心（Off－center）注視法來搜索物體，以免物體影像落於中央盲點，而無法查覺其存在。

四、暗適應（Dark adaptation）：從光亮區進入黑暗區時，眼睛必須慢慢的適應此黑暗環境，最初看不見物體而後逐漸看清，此因含於桿狀細胞內的化學物質（視紫）緩慢地再生，此一過程稱為暗適應，通常約需 15～30 分鐘。

………

第 4.9 節定義人體的空間定向功能的生理結構，主要涉及:（一）視覺系統；（二）內耳前庭系統；（三）本體感覺系統；（四）中樞神經之整合系統等。於三度空間飛行環境中，出現錯誤感受或判斷的原因有可能是生理及心理因素所肇致，因而航醫學界也使用空間定向失能一詞，廣義上含括不同因素所導致的飛行錯覺情況。飛航組員在飛行

中如受飛行天候、地形地貌、飛行動作、座艙設計、生理和心理因素的影響，常發生定向失能的情況。教範中亦提及：防制本體感系統之空間定向錯覺，主要靠飛行員保持不慌不亂的情緒，依照儀器指示操作飛行。在平直飛行一段時間後，慢慢地可以去除錯覺的影響（10 至 20 秒）。另視錯覺之防制，得依賴個體對此相關問題了解與警覺，及增強地面輔助指示系統，以協助個體避免依錯覺操作飛行。故就以上原則，飛行員之儀器飛行經驗及能力，在對抗空間錯覺上，實具有相當正面的作用。錯覺模擬機訓練及飛行前之相關提示，均能使飛行員在面對空間錯覺時，能有較正確的處置做法。其影響空間錯覺的因子，如人為自加之身心壓力、疾病、低血糖，或是目視與儀器飛行交替頻繁、天候不佳、座艙及儀表設計不良等，均應特別改正或避免。

第 2 章　分析

2.1 概述

本事故飛航組員飛航資格符合現行空勤總隊航務管理之規定，事故前 72 小時之休息及活動正常，無證據顯示飛航組員於飛航中曾受任何藥物及酒精影響。航機之載重平衡在限制範圍內；經檢視航機系統、發動機、維修相關紀錄及 FDR 紀錄資料後，無異常發現，顯示本次事故與航機之載重平衡、系統、發動機及維修無關。

本次事故分析之重點包括飛航操作、環境因素、組織管理、機場及飛航紀錄器等項分析如後：

2.2 飛航操作

事故機於蘭嶼機場起飛後約 81 秒即失事墜海，起飛前 PM 曾建議 PF 使用重飛模式，但 PF 起飛操作係使用手控方式（詳細之操作狀況及操作過程如圖 2.2-1），操作過程中曾數次解除及接合集體桿與迴旋桿之配平系統。航機離地後 20 秒（2348:56 時），高度約 100 呎時，速度曾低於 50 浬/時且出現 FD FAIL 之警示訊號，PF 即增加集體桿馬力，使航機持續加速及爬升，此後之 19 秒間（約至 2349:14 時），航機最高加速至約 110 浬/時，但高度僅增加約 150 呎（由 100 呎增至 250 呎）。2349:14 至 2349:26 時之間，航機高度及速度約維持於 200 呎及 110 浬/時左右，PF 曾將馬力漸回收至約 60%。約於 2349:24 時（離地約 48 秒後），PF 開始增加航機之仰角（於約 2349:40 時仰角到達約 20 度），並同時逐漸減低集體桿（降低馬力），於約 2349:37 時達到最低位置。由圖 2.2-1 可看出此期間高度曾上升至約 290 呎，但速度卻快速遞減。航機速度於 2349:42 時減至 48 浬/時並持續下掉（最低至 37 浬/時），而再度出現 FD FAIL 之警示訊號。PF 為改正此一速

度低之現象，於航機距海面僅約 290 呎之高度，以約每秒 4 度之俯角改變率，推頭加速但並未立即使用大馬力（集體桿提起至高位置），航機因俯角增加，速度於約 2349:51 時回復至 50 浬/時以上並繼續加速，之後 PF 仍繼續增加俯角（最大到達 20 度以上），使航機之速度及下降率持續增加。期間 PF 曾呼叫 PM 監看高度及下降率，但並未即時改正其以大俯角向下飛航之狀態，而使下降率瞬間高達 2,400 呎/分以上，致使航機在可操控狀態下，最後以約 100 浬/時、20 度之俯角及超過 2,200 呎/分下降率之狀態墜海。有關本次事故飛航操作之分析如下：

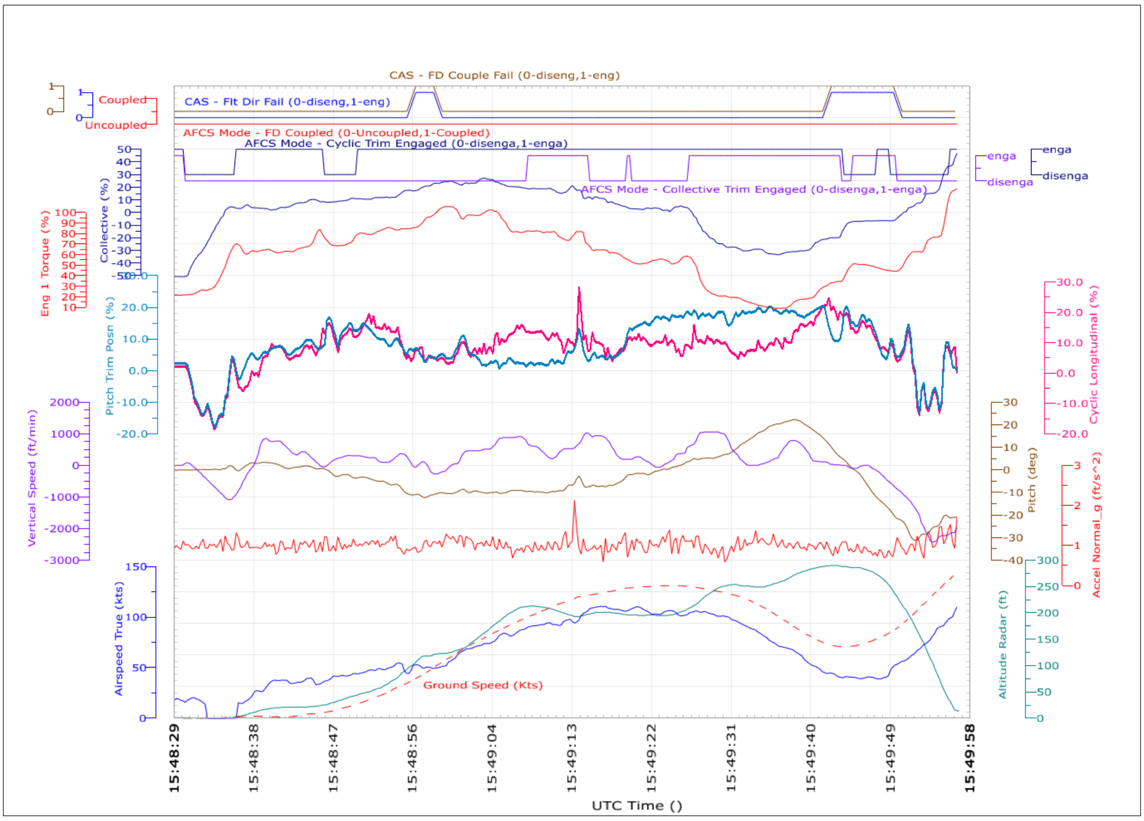

圖 2.2-1 事故機墜海前相關操作

2.2.1 威脅管理及狀況警覺

威脅指在每次飛行期間，會影響工作環境之外界狀況，且必須加以管理者。威脅會增加操作之複雜性且提高風險。常見的例子有：天

氣、地面障礙物、機場狀況、未按程序操作、時間壓力及飛預期之飛航狀態等。威脅管理指於飛行前發揮團隊力量，找出相關威脅及影響飛航安全之因子，予以適切消除及預防，以防止意外事故之發生。

狀況警覺主要在強調飛航組員必須隨時對操作環境保持警覺以及預測狀況發展的重要性，同時飛航組員應具備狀況警覺的實務應用技能，並定期複習及提高狀況警覺之能力。美國 FAA 及民航局發布之組員資源管理內容指出，狀況警覺之實務操作重點包括：準備/規劃/注意/工作負荷分配等；執行任務前必須預判可能面臨之風險及威脅，先期準備必要之措施；飛航中需確認促進執行任務之監看與完成的方法，同時發現及搜尋新資訊並加以反應及準備；機長必須適當地將工作分配給每一名成員，並注意避免任何一人的工作負荷過高，同時必須在高負荷的狀況下安排各項工作的優先順序，預防其他不重要的因素轉移應注意之重點，特別是在危急性的時刻。空勤總隊航務手冊之任務作業程序內亦有規定任務受領時，應評估執行任務相關風險因子，並納入提示內容。

依據空勤總隊提供之飛行操作風險評估表，風險評估結果有點困難之項次為：航機檢修、導航設備、飛行員操作經驗及航行管制熟悉程度 3 項（參考圖 1.18.1），依規定必須由機長於分組任務提示時敘述。該次任務前，未發現飛航組員對該次任務有關風險評估之相關任務提示紀錄。另飛航組員於領受該任務後，提示時未針對可能面臨之風險及威脅，例如：天候之變化、亂流、夜航及低高度飛航潛在之風險及可能發生之狀況進行討論及預作準備。

於前往目的地飛航中，2316 時，航管告知該機蘭嶼機場相關天氣資訊，飛航組員於領知後僅提及天氣差、下雨，並未詳細討論對天候之應變，但曾討論目的地相關夜間之特徵及進場過程中相關參考地標等。於進場落地時，高度約 110 呎時，駕駛艙曾出現 FD FAIL 之警示訊號。該機自豐年至蘭嶼機場落地過程中，曾遭遇天候狀況、落地前並發生 FD FAIL 之警示訊號，但落地後等待過程中，飛航組員並未討

論及預習，於蘭嶼機場再起飛時如遭遇天候變化、亂流時之處置，亦未針對落地前航機出現之警示檢討相關原因及改正措施。

該機於落地後等待過程中，飛航組員曾討論起飛及離場方式；PF 告知 PM，起飛後向左轉向 270，PM 同意並建議使用重飛模式起飛及趕快離開亂流區，PF 則詢問重飛模式之操作方式。期間飛航組員並未相互確認及複習起飛方式及重飛模式之程序，例如起飛時如使用重飛模式，其特性及顯示，如使用手控方式起飛，其操作方式、爬升速度及爬升率等。亦未討論起飛離場過程中相互之分工及應注意事項。事故機當時起飛時 PF 仍以手控操作方式起飛。

上述分析顯示，飛航組員未對該次任務可能面臨之威脅及風險，進行必要之評估及準備，亦未對飛航中發生之異常狀況，檢討其原因並發掘可能潛在之風險，顯示飛航組員對本次任務執行應有之狀況警覺不足。

2.2.2 系統熟悉度

該機配備有 AFCS 及 FD 飛航輔助系統（詳如 1.6.3 節），開啟後可依據航機集體桿、空速、俯仰率及橫向加速度之感測訊號，透過電腦控制，達到自動控制及增進航機操作飛行品質之目的。FD 之操作模式計有：高度保持/預設、空速保持、航向選擇、垂直速度保持、導航、重飛、滯空保持及備用（RMT STBY）等模式，必須深入瞭解其功能、特性、顯示、相互間之連結關係及操作方式，始能於飛航時充分發揮系統效益，有效減輕飛航組員之工作負荷。

依據 CVR 資料，該機起飛後，PF 與 PM 於 2310 至 2339 時之間有關對話摘要（如表 2.2-1），據此通話內容，2310 至 2311 時 PM 呼叫注意空速結合，PM 回應 OK，之後 PM 又問現在是 Couple 嘛對不對，PF 回答我還沒有…。依據系統工作原理，航機之 FD 必須於結合狀態下，空速模式才能結合。另於 FMS 結合後，PF 疑似誤判航向；

於 2328 至 2329 時 PF 呼叫 FMS 解除，但之後 PF 檢查卻發現並未解除；2336 至 2337 時，飛航組員相互確認解除 FD 之結合（使用 Remote Standby 電門），但實際上 FD 仍處於結合狀態，致使駕駛艙於 2337 時產生警示訊號。飛航組員於 2319 時亦因不清楚座艙燈光操作開關之位置，約花 30 秒討論其開啟及操作之方式。

上述狀況，顯示飛航組員對該機之 FD 及 FMS 之功能、顯示、判讀、操作及燈光系統瞭解程度不夠充分。

表 2.2-1 CVR 通話部分抄件摘要 1

來源	通話內容(2310 時至 2339 時)
CAM-1	注意空速 ok 準備結合
CAM-2	現在是 coupled 的嘛對不對
CAM-1	我還沒有 喔 對我這邊是 coupled 的
CAM-2	啊 flight director 結合
CAM-1	ok flight director f-m-s 結合
CAM-2	喔可以了 f-m-s 結合
CAM-1	唉唷我們怎麼往北咧 我航向是么洞洞 啊么洞洞 ok 沒錯
CAM-3	座艙燈啊
CAM-1	ok 我們這邊可以試開一下 在自動位置
CAM-2	座艙燈喔
CAM-1	okay f-m-s 解除 航向么八洞
CAM-1	我現在 f-m-s 沒有解除
CAM-2	好可以 remote standby
CAM-1	okay remote standby 好
CAM-2	okay 好
CAM-1	唉呦（駕駛艙出現警示，表示 remote standby 未致動）
CAM-2	沒關係
CAM-2	好 我們導航輸入 導航資料輸入一下
CAM-1	不是 reverse 就可以了嗎

2.2.3 操作程序

空勤總隊目前使用該型機原廠出版之飛航操作技術手冊為飛航操作之依據。該手冊 8.4 節為正常操作程序，包括起飛前檢查、發動機啟動前檢查、駕駛艙檢查、滑行前檢查、滑行檢查、滯空檢查、起飛及起飛後檢查等，於儀器飛航時應確認開啟空速管加溫電門。空勤總隊航務手冊第 51 條第 2 項亦規定飛航組員應依據操作手冊及飛航手冊中之各項規定執行飛航。另航務管理手冊第 17 條亦規定飛航中，操控飛行員負責航機之操控及與障礙物保持安全距離，監控飛行員應讀出檢查手冊檢查項次並確認、負責讀出各儀表指數，協助機外障礙物清除，並於每次起飛（落地）前，完成起飛（落地）前檢查。每 15 至 30 分鐘執行油量計算一次。

依據飛航組員於 2309 至 2349 時之 CVR 對話摘要資料（如表 1.11-1 及 2.2-2）與 FDR 紀錄資料，該次飛航，曾分別於 2337 時、2348 時及 2349 時出現 FD 系統失效之警示（如圖 2.2-1 及圖 2.2-2）。該次事故，飛航組員間有依規定執行相關障礙物清除之檢查、系統及飛航狀態之檢查、按時執行油量檢查並遵守無線電呼叫之規定。但未於系統失效時報出警示訊息，亦未確認於決定執行儀器飛航程序時檢查空速管加溫電門。另該機於蘭嶼起過程中，PF 應負責航機之操控，PM 應檢查並讀出各階段當時之速度，高度及升降率之變化，但該階段有關空速及高度卻由 PF 報出，PM 並未確實檢查及報出爬升過程中空速高度及下降率之數值，雖於航機向下俯衝時，PM 曾呼叫空速、下降率，但並未明確讀出相關數值，屬無效之呼叫。

綜上述，該次飛航，飛航組員未完全依照相關規定執行應有之檢查程序及呼叫，致使航機於低高度及低速狀態下，PF 為改正此低速狀況而推桿加速，但未發現高度過低而仍操作航機持續下降。

表 2.2-2 CVR 通話部分抄件摘要 2

來源	通話內容(2309 時至 2338 時)
CAM-1	ok 左 啊右邊 clear

來源	通話內容(2309 時至 2338 時)
CAM-3	右邊 clear
CAM-2	右邊 clear
CAM-2	ok 水平安定面上升 ok 好
CAM-1	ok 全程儀器喔
CAM-2	Okay
CAM-2	油量現在還有一千九百磅喔
CAM-1	Ok
CAM-1	欸你們這些晚上 那個蘭嶼的 e-m-s 也都這樣的 幾乎全黑的 對啊就飛儀器
CAM-1	okay 各儀表正常
CAM-2	okay 空速八十 高度四百八
CAM-1	okay 空速 okay 慢慢減
CAM-2	*高度 高度 高度 高度 對好 很好 很好 對 高度一百三
CAM-1	好 保持 好 okay 保持 roger
CAM-2	欸
CAM-2	沒有關係
CAM-1	四十 可以
CAM-2	欸 很好
CAM-2	嘿 高度很好 高度很好
CAM-2	好 沒有關係 來 對 很好
CAM-2	保持 okay 很好
CAM-2	沒有問題
CAM-3	okay 地面 clear
CAM-3	好 主輪 touch down
	………

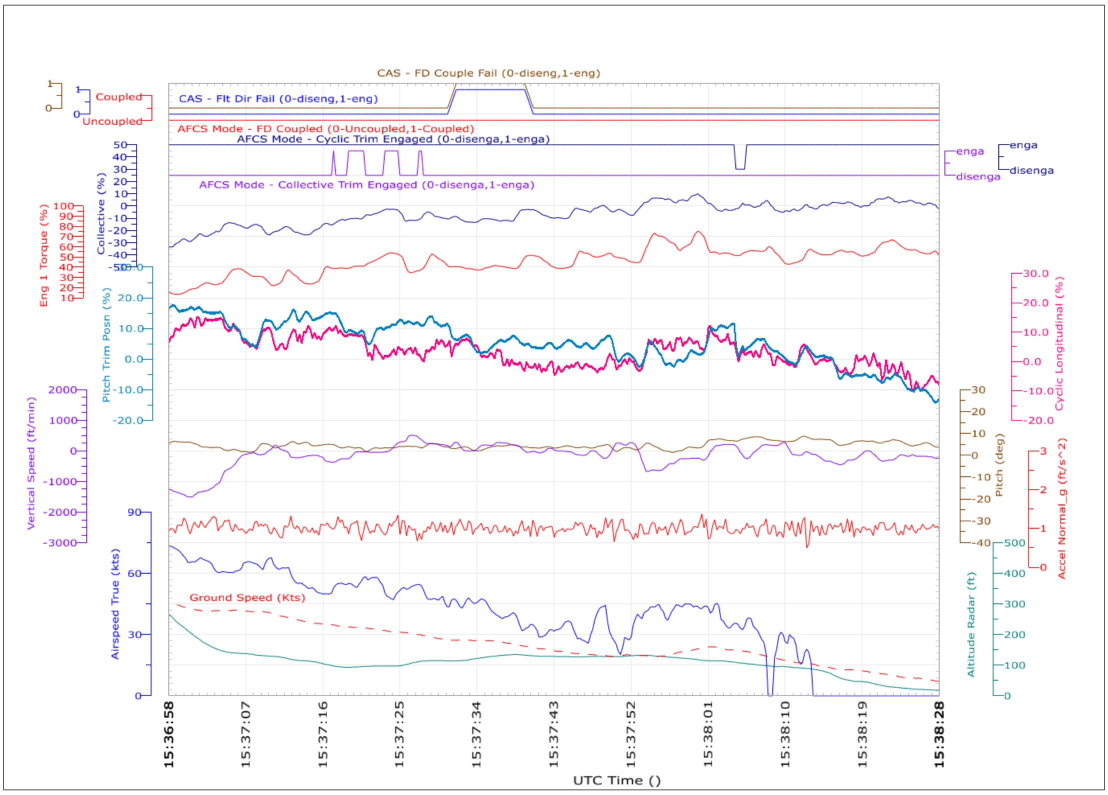

圖 2.2-2 事故機於蘭嶼落地前之操作

2.2.4 起飛操作

參考 1.17.1.4 節，有關正常起飛之操作方式，應先行增加馬力，建立滯空狀態，推桿加速並避開障礙物，繼續加速至所需爬升空速。到達爬升速度或最小單發動機之速度後，可視需要調整迴旋桿及集體桿並保持所需的爬升空速、爬升率或既定之爬升狀態。

依據 FDR 資料，比較該機自豐年起飛之速度、高度及爬升率均逐漸升高至一定範圍後保持穩定狀態（如圖 2.2-3），但自蘭嶼起飛之過程（如圖 2.2-1），可看出其高度雖持續上升，但甚緩慢，甚至其高度及速度曾一度停滯（2349:13 至 2349:26 時），且爬升率及空速未保持穩定狀態。

依據 1.16 節正常起飛模擬測試結果：顯示順風 40 浬時以下之起飛操作，無論使用自動或手控操作，航機加速及爬升均無操作問題，

僅大順風時，需適當調整馬力以維持穩定之爬升狀態。

綜上述，飛航組員於蘭嶼起飛時未把握正常起飛要領，建立正常起飛及爬升姿態，並爬升至安全之巡航高度。

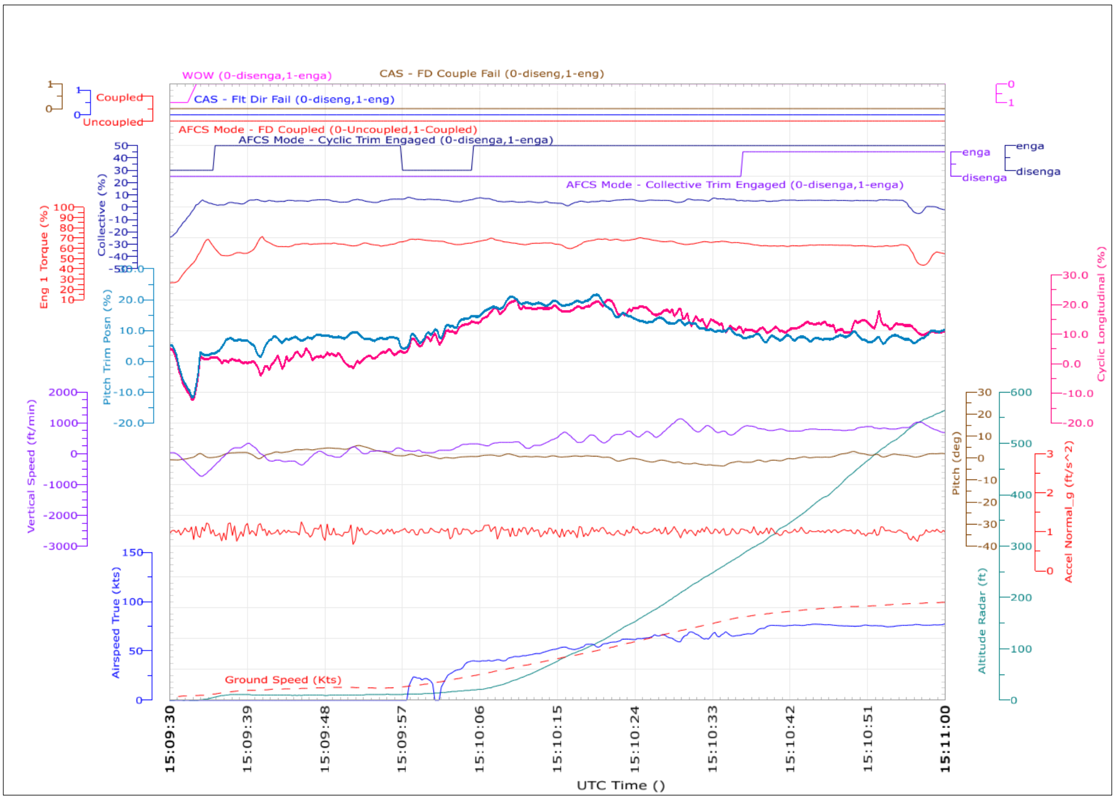

圖 2.2-3 事故機豐年機場起飛時之操作

2.2.5 溝通與決策

民航局及美國 FAA 頒定之組員資源管理訓練通告（參考 1.17.5 節）提及：飛航組員所遭遇的問題，除操作技術方面之問題外，通常和不良的團體決策、無效的溝通等問題有關。針對重要及關鍵之操作程序，增強有效溝通的最佳技巧是仔細的解說行動，並強調程序，與飛航任務關係愈密切的事項，愈需要清楚的溝通。所以飛行前之任務提示或於飛航中決策前，應適切地透過徵詢、建議及堅持，以找出最佳之行動方案。

經檢視 CVR 錄音資料，PF 於該次飛航曾三次提及使用儀器飛航，

但未針對相關儀器程序進行討論及複習，PM 亦未提出質疑；於蘭嶼落地前航機出現 FD 失效警示訊息，PF 及 PM 均未呼叫及反應，落地後等待期間飛航組員也未針對上述相關經過溝通及討論。於地面等待期間飛航組員曾討論起飛方式，提及避開亂流及使用重飛模式起飛等（如表 2.2-3），但未進一步討論遭遇亂流之處置及複習重飛模式之程序，PF 亦未明確告知 PM 決定是否使用重飛模式起飛，而 PM 亦未繼續堅持追問及討論起飛使用之模式。

本次飛航，飛航組員未詳細檢視儀器飛航程序、未針對發生之亂流及 FD 警示訊息進行溝通、未充分溝通事故前起飛之程序及方法，由 PF 一人決定起飛操作方式，顯示飛航組員對任務執行之溝通及決策能力待加強。

表 2.2-3 CVR 通話部分抄件摘要 3

來源	通話內容(2342 時至 2344 時)
CAM-1	等下一樣我們起來以後兩拐洞
CAM-2	是
CAM-1	兩拐洞 三浬以後我們再 f-m-s 結合
CAM-2	是
CAM-2	好 我們先提高 左轉
CAM-1	嘿
CAM-2	左轉 夠
CAM-1	左轉
CAM-2	立刻出去 夠 快一點 沒有關係 快一點出去
CAM-1	對 兩拐洞
CAM-2	然後趕快離開這亂流區
CAM-1	嘿
CAM-2	夠 趕快離開亂流區
CAM-2	* 待會兒你要 go around 也可以啊
CAM-1	喔
CAM-1	先起來以後再按 go around
CAM-2	嘿 轉過來然後 go around

來源	通話內容(2342 時至 2344 時)
CAM-1	對 這樣子 go around
CAM-2	對
CAM-2	不過要注意到 torque
CAM-1	對啊
CAM-2	嘿 注意到扭力
CAM-1	我們現在慢慢提好了 先不要
CAM-2	齁 如果說你覺得不放心的話

2.2.6 航機於可操控下接近地障

CFIT 係指航機於可正常操控狀態下，飛航組員因狀況警覺不足而操作航機與障礙物發生碰撞之事故。此狀況通常發生於能見度不佳及夜間之飛航環境，易使飛航組員產生空間迷向，進入死亡螺旋而使航機失去控制。與此類飛航相關之 CFIT 風險包括：計畫及提示不充分，航機失去控制、飛航組員之狀況警覺不足、反應時間不足、對速度及高度之控制不良、未依預劃飛航及未即時回航等。

檢視本次飛航狀況，飛航組員對起飛及離場方式未充分討論，另參考圖 2.2-1 資料，航機離地約 30 秒至 50 秒間，速度及高度分別為約維持於 100 浬/時及 200 呎之平飛狀態，之後 PF 將機頭帶起同時減低馬力，高度雖開始爬升，但速度卻快速下掉，約 65 秒後 PF 雖發現速度快速減低至 40 浬/時，開始推機頭加馬力改正，而使下降率增加及加速，並請 PM 注意監控高度，但航機加速至 70 浬/時以上後，PF 並未將航機恢復至正常爬升狀態，而繼續下降及加速，PM 亦未適時發現異常狀況而提醒 PF 適時改正。

綜上述，航機起飛後應維持恆定爬升及加速狀態至特定之高度巡航並加速至巡航速度。該次事故，飛航組員不正確的決策及於爬升中因喪失狀況警覺，未能維持安全之爬升姿態及速度、且未即時正確判讀飛航中高度及速度而執行異常之飛航操作，致使航機於可操控狀況下墜海。

2.3 環境因素

與本次事故有關之環境因素，包括天氣因素、暗適應及空間定向失能（空間迷向）等分析如下：

2.3.1 天氣因素

依據該型機操作手冊第 5.2 節內容（如 1.17.1.5 節），其側風及順風限制為 45 浬/時。側飛/後飛入之風速不得超過 45 浬/時。另依據模擬機測試結果（參考 1.16.1 節），該機於 40 浬/時以下之順/側風飛航，無操控困難狀況。

事故當時蘭嶼機場有雨，依據最接近事故發生時之天氣報告：蘭嶼機場風向不定，風速 11 浬/時；陣風最大約 32 浬/時。另依據中央氣象局蘭嶼氣象站之天氣報告（參考 1.7.2 節），2349 時之風向為 020 度，風速約為 42 浬/時；民航局臺北航空氣象中心於事故前後未發布任何顯著危害天氣資訊及低空危害天氣資訊（如 1.7 節）。另依據蘭嶼機場監控攝影機影像，顯示事故當時下雨且有不穩定之大陣風。

依據 1.16.6 事故地區風場數值模擬，估算該機飛行區域，風向為北北東風，風速最大約 36 浬/時，風切強度為中度風切。以上之模擬結果顯示，事故地點位於山區之背風面，受強烈東北風及地形影響，蘭嶼機場西側將會產生較大之順風及中度風切。

依據事故機 FDR 資料（參考圖 2.2-1），該機自蘭嶼起飛後至墜海前，航機並無操控異常狀況。該具 FDR 記錄兩項參數（真空速及地速），可做為計算該機遭遇風之狀況。依據 FDR 紀錄，航機離地後 23 秒（至 2348:59 時）內係處於逆風狀態，離地後 3 秒至 9 秒（2348:39 至 2348:45）間之逆風約為 35 浬/時，之後逆風逐漸減低，約於 2348:59 時，航機開始進入順風狀態並逐漸增強。約自 2349:44 時起之順風開始超過 30 浬/時，最大順風到達約 40 浬/時，此資料與上段敘述天氣

報告有關風速之大小，數值相近。另依據圖 2.2-1 空速與地速之趨勢變化，事故機自約 2348:59 時起至約 2349:57 墜海，期間並未發現有風切現象。

有關亂流部分，經判讀圖 2.2-1 之垂直加速度資料，事故機自蘭嶼起飛後其平均 g 值約有±0.2~0.5 之變化，最大值 2.1g 發生於 2349:13 時，飛航組員於 CVR 對話中，亦提及感受有亂流，顯示該機飛航中曾遭遇不同程度之亂流。依據 FDR 相關操作及航機反應（如圖 2.2-1），包括集體桿及迴旋桿之操作、發動機馬力之輸出等，期間航機姿態、升降率及速度/高度之變化，顯示相關操作並未受風及亂流之影響。

上述分析顯示，事故機自蘭嶼起飛後約 23 秒即遭遇順風，並逐漸增強，瞬間最大曾達 40 浬/時，並有中度亂流現象，但仍在航機安全操作限制範圍內，且相關操控數據亦未顯示航機有異常現象。

2.3.2 暗適應

事故機於蘭嶼機場起飛時，飛航組員係面對機場機坪強烈之照明燈光，離地後即轉入西面暗黑之天空，依據 1.18.3 節之參考資料，飛航組員可能進入暗適應情況。

經本會於現場實際執行暗適應測試（如 1.16.3 節）；靜態測試時受測人員由強光轉向黑暗海面後，可辨識距測試人員位置 67 公尺圍欄之時間約為 6 秒，而平均可辨識天地線時間則為 46 秒。動態測試時，於滯空中操作航機由強光轉向黑暗之海面後轉可辨識外界之適應時間為 30~50 秒。離場後目視可辨識外界影像之時間約為 45 秒。如將機內儀表燈光調亮，對外目視適應時間較長，約增加 10 秒。另執行動態測試期間，律定正駕駛員全程執行儀器飛行，期間分別以手動及自動起飛模式，均可正常操控航機。

依據本次暗適應測試結果，受測人員由強光轉入黑暗之海面，目視外界最長之適應時間約為 50 秒，但如避免目視外界狀況，專注駕

駛艙各儀表執行儀器飛航，則無暗適應現象。

有關暗適應，係因眼球對光之適應能力，亦可能因個人體質而異，本次事故亦無法完全排除飛航組員當時是否有暗適應之狀況，但如避免目視駕駛艙外界，專心執行儀器飛航，應可避免暗適應之問題。

2.3.3 空間定向失能

依據國軍航空醫務教範，有關空間定向失能之形式，涉及半規管感覺系統、耳石器感覺系統及視覺系統之錯覺及迷向，於三度空間飛行環境中，出現錯誤感受或判斷的原因甚為複雜。飛航組員在飛行中如受飛行天候、地形地貌、飛行動作、座艙設計、生理和心理因素的影響，常易發生定向失能的情況。

本次事故，航機遭遇輕至中度之亂流，飛航組員因亂流震動之關係，可能影響內耳前庭系統而產生體旋轉、體重力、眼旋轉、眼重力及科式錯覺等；夜間飛航因光及地面燈火影響，可能影響視覺系統而產生視覺錯覺。有關避免空間定向錯覺，主要靠飛行組員保持穩定的情緒，依照儀器指示操作，保持平直飛行，以去除錯覺的影響。另視錯覺之防制，飛航組員應對錯覺問題深入瞭解與警覺，避免進入錯覺之飛行操作。故就以上原則，飛行員之儀器飛行經驗及能力，在對抗空間錯覺上，實具有相當正面的作用。另錯覺模擬機訓練及飛行前之相關提示，均能使飛航組員在面對空間錯覺時，能做正確之處置。

依據本次事故所獲事實資料，當時之飛航環境存在亂流、燈光改變、天候不佳、目視與儀器飛行交替頻繁等導致飛航組員空間迷向之條件。參考 2.2 節及檢視比對 FDR 資料(如圖 2.2-1)，飛航組員於爬升中減低馬力、增加仰角、推頭加速未適時增加馬力及注意高度過低之異常操作，顯示飛航組員於航機墜毀前可能有空間迷向之現象。

2.4 組織管理

本事故與組織管理相關之議題含程序及手冊及人員訓練等 2 項分述於後：

2.4.1 程序及手冊

2.4.1.1 標準作業程序

標準作業程序（SOP）是公認之飛航安全基礎，一套清楚完整之標準作業程序也為組員資源管理訓練之訓練依據及重要理念。國際間事故調查顯示，歷次可操控狀態下撞擊地面之事故，有 50%以上係飛航組員未確實遵守標準作業程序或其程序之內容及程序不恰當，由此可見 SOP 之重要性。

空勤總隊航務管理手冊訂有直昇機空中救護-轉診與緊急救護任務作業程序任務作業程序（參考 1.17.1.3 節），但其並未定義自動化系統的使用原則、飛航管理系統（FMS）、自動化系統與飛行模式顯示的監控及 FD 模組操作輸入之標準呼叫術語及監控，亦未定義檢查表使用及執行程序之交互確認原則與程序（由誰要求開始檢查表；誰來念；誰來執行等）。

有效 SOP 之關鍵項目包括：程序符合實際狀況、可以實際操作、飛航組員瞭解程序之原因、分工清楚並須執行有效之訓練。經由本次事故經過發現，空勤總隊現有之任務作業程序應再行評估以符合實際操作效益。

2.4.1.2 手冊完整性

空勤總隊航務管理手冊第五十條規定：目的地機場及其備用機場於預計到達時間，其天氣未達最低飛航限度者，駕駛員應中止向該目的地機場飛航。事故機當日自豐年機場起飛時，蘭嶼機場之能見度為

3,500 公尺；雲高約為 1,200 呎。有關空勤總隊對各項任務執行訂定之天氣標準（參考表 1.7-1），並未訂定夜間執行傷患運送任務之天氣標準。

空勤總隊航務管理手冊第五十一條規定：飛航組員應依據操作手冊及飛航手冊中之各項規定、標準及限制操作航空器不得逾越之。另規定具飛航教師資格以上人員應參考飛機原廠所訂之航機操作手冊，在不違背相關法規原則下，制訂該機型操作手冊及檢查手冊。現行空勤總隊 UH-60M 型機使用之相關操作手冊為原廠提供之操作手冊及檢查表，事故當時該型機並無空勤總隊自行編撰之操作手冊。

空勤總隊航務管理手冊第六十七條規定，越水飛航之一級或二級性能直昇機以一般巡航速度飛越距陸岸達 10 分鐘以上者，應裝置永久或可快速完成設置之浮具，以確保水上迫降作業之安全。事故機為符合上述條件、應安裝水上浮具裝置之直昇機，空勤總隊目前並未依照該航務手冊之規定裝置水上浮具[19]。

2.4.1.3 座艙分工規定

空勤總隊航務管理手冊第十七條規定：PF 應負責操控並維持飛機之姿態、航路、高度、空速與安全及機外障礙物清除等，執行監控飛行員讀出項次並覆誦。PM 應負責航管通話、抄錄許可等資訊、讀出檢查手冊檢查項次並確認，完成操控飛行員（PF）要求事項；負責讀出各儀表指數，協助機外障礙物清除，並於每次起飛（落地）前，完成起飛（落地）前檢查。每 15 至 30 分鐘執行油量計算一次。

本次飛航，依據 CVR 之組員對話資料，PM 曾確實執行有關油量檢查之規定，飛航組員間亦曾依規定執行障礙清除之呼叫。有關其他相關自動化模組之操作、顯示及確認，如自動設定之轉換、警示訊

[19] 事故機係軍用直昇機，依據美陸軍適航標準執行越水任務並未規範需安裝緊急浮筒。

號出現之呼叫及確認等，飛航組員則未完整執行，容易遺漏相關操作之程序。

2.4.1.4 飛行時間

空勤總隊飛行人員飛行時間記錄表所登錄之飛行時間，分為日間目視時間、日間儀器時間、夜間目視時間及夜間儀器時間等 4 種。

經檢視事故飛航組員之飛行時間紀錄，PF 本機種之夜間目視時間約 2 小時，並無夜間儀器之飛行時間，其過去 5 年間之夜間飛行總時間僅約 18 小時。PM 6 年中之夜間飛行總時間約為 200 小時，該機種之夜間目視時間約 14 小時，夜間儀器之飛行時間則為 1 小時。

空勤總隊之任務概分為救災、救難、救護、偵巡及運輸等 5 大類，任務之複雜度及難度甚高，且須 24 小時待命，故飛行員之訓練及穩定度必須完整切實。其中因任務需要，必須執行及面對不同天候及環境下之飛航，故飛行員之儀器及夜航之訓練、操作能力及經驗益形重要。

空勤總隊目前係以結合實務，於年度訓練計畫採季管制方式，依飛行資格，律定各機型飛行員，當季須達成之最低夜間及儀器飛行時數，但相關手冊未明確訂定夜航及儀器飛行時間相關之規定及最低要求。

2.4.2 人員訓練

2.4.2.1 訓練規定

空勤總隊訓練手冊對機種換裝訂有機種轉換訓練相關規定，包含原具其他機種副駕駛資格者，完成換裝後，應繼續擔任副駕駛、正駕駛升訓規定該機種飛行時間須達 100 小時以上、飛航教師另有 100 小時之夜航及儀器飛行時間及 50 小時海上飛行時間之規定等（詳如

1.17.2 節)：該型機原廠之換裝訓練計畫亦訂有飛行員換裝訓練、飛航教師及維修試飛員之升訓資格要求(參考 1.17.3.1 節)。

航空器之系統及裝備複雜且精密，為使飛行員能正確、精準之操作航機，各階段飛行訓練之程序及內容必須前後呼應、循序漸進，務使飛行員能累積必要之操作經驗，達到安全操作航機之目的。

接受該型機轉換訓練之 PF，原為 UH-1H 型機之副駕駛，於 105 年 11 月赴美接受 UH-60M 型機換裝訓練，且於完成換裝後，直接接受該型機飛航教師及檢定機師訓練。此一訓練內容及程序係由空勤總隊管理階層依總隊訓練手冊第六章國外訓練之規定核准執行。PF 如能於完成換裝訓練後，依規定累積該型機之飛行經驗及系統操作，必能深入掌握該型機之操作特性，以利任務之遂行。

空勤總隊未能完整規劃相關飛航組員之訓練，影響飛航組員之資格能力及飛航安全。

2.4.2.2 訓練計畫

本次事故調查所獲 UH-60M 型機之飛行訓練資料，計有原廠訓練、我國陸軍之訓練、美陸軍建議之訓練及空勤總隊採用之訓練計畫(詳如 1.17.3 節)。上述各訓練計畫之內容雖各有不同，但均採循序漸進模式，依訓員不同之資格能力及背景分採不同之訓練時數，以滿足操作該型機之飛航資格需求，如原廠之換裝訓練計畫即因具該型機系列飛行資格及不具該型機系列飛行資格者，訂有不同之訓練時程及內容。另針對飛航教師及維修試飛員之進階訓練，更訂有飛行時數及機長飛航時間之要求，以確保訓員能順利完訓，並能保障日後其擔任相關飛航任務時之適職性。

UH-60M 型機配備先進數值電腦飛行控制及導航系統，經檢視 1.17.3 節該型機換裝各種訓練計畫，可看出各計畫無論何階段，對地面學科及系統整合訓練之要求均極重視，例如：我國陸軍之換裝學科

訓練時數即高達 755 小時，即使高階之維修試飛員訓練，其地面學科亦為 371 小時。我國空勤總隊之飛行員均係軍方轉任，具備一定之飛航經驗，經美陸軍安援辦公室建議我空勤總隊換裝地面學科時數約為 196 小時，顯示地面學科訓練應為該機型換裝之重點。

依據空勤總隊對該型機之訓練計畫（如 1.17.3.4 節），其飛行訓練實施經過(如 1.17.4 節)，分 2 年 7 梯次（第 1 年 3 梯次，第 2 年 4 梯次）。各梯次地面學科訓練時間為 96 小時，第一年（3 梯次）之模擬機訓練時數為 82 小時，而第 2 年之時數減低為 20 小時，大幅降低至原時數之四分之一。該機因配備先進之飛航控制及導航系統，受訓學員必須充分掌握及熟悉相關系統之特性、顯示及操作，始能於實際飛航時獲得較佳之訓練效益。空勤總隊該型機換裝訓練計劃之地面學科時數已較其他訓練計畫訂定之時數為少，但其於第一年之訓練課程內，模擬機之訓練時數甚多，尚可有效彌補地面學科之不足，模擬機訓練因可於地面設定各種狀況，且其為擬真狀況，能使學員對該型機先進系統操作及熟悉程度之訓練效果更佳，但如地面學科時數少，又無足夠模擬機之系統模擬訓練，可能大幅降低訓練之成效及素質。

事故機飛航組員即為該總隊第二年第 1 梯次赴美接受換裝訓練之學員，所受換裝訓練之內容較第一年少，故第二年換裝之學員，對系統熟悉程度，應不及第一年換裝之學員。又依據 2.2 節之分析，證實事故機飛航組員對該型機相關系統之熟悉程度不足，應與其接受換裝訓練時之訓練內容不足有關。

綜上述，空勤總隊未妥善安排該型機訓練資源，於換裝先進機種未規劃充分之地面學科，且模擬機之訓練時數不足，不易達成預期訓練效益。

2.4.2.3 其他訓練（CRM/CFIT/夜航）

空勤總隊執行任務之飛航環境，包括高低起伏之山區，蜿蜒之河

流山谷及無參考目標之水面，並有突出地面之障礙物及穿越山區河流之纜線，加以台灣地區之天氣多變，且須於夜間執行任務，所以相關組員合作、操控下接近地面及對逐漸惡化天候應變之概念及訓練異常重要。

組員資源管理訓練重點為溝通過程與決策行為、領導與人際關係、工作負荷管理與狀況警覺及遵循 SOP 等。避免操控狀況下撞擊地面及避開逐漸惡化之目視環境，主要係以組員合作為基礎，制定及遵守相關臨界飛航作業程序，於飛航中必可充分發揮相關地障察覺能力，並可避免飛航中產生空間迷向或航機失控。

組員資源管理訓練之目的，主要在強化組員間之協調合作而改善及提升組員績效，並進而預防飛航事故。其係基於「高度的技術嫻熟性與高效率作業的重要性」，以建立良好的組員合作概念，並透過反覆練習、回饋，以及持續的增強，使其融入所有航務訓練與作業當中。

經檢視空勤總隊飛行人員訓練手冊，其各階段之訓練，均訂有 CRM 之訓練項目，但並無一套具體完整之訓練教材，無法達成組員合作訓練之目的。

2.5 機場狀況

蘭嶼機場為一日間目視機場，並無跑道邊燈之設施。該機場因任務須於夜間執行飛航，相關飛航組員反應，進場過程中因無跑道燈，無法建立立體感，很難判斷落地點之位置，如於進場遭遇亂流，更增加操控困難，另蘭嶼跑道兩頭均有山，夜間進場時壓力很大，如有跑道邊燈指引，可大幅減輕操作壓力，並能安全對準跑道及落地。

經本會相關人員利用望安機場執行夜間跑道邊燈測試結果，於 10 公里能見度，機場燈光亮度最低狀況下，約距機場 8.9 浬外，即可清晰辨識機場之特徵，而於機場燈光關閉之狀況，距機場 1.9 浬始能大略辨識機場特徵；於開啟機場跑道燈光狀況下，可明顯辨識機場之物

理特性，機場之景深及障礙物之位置均可判斷，測場及進場操作均無問題；於關閉機場跑道燈光(機場航廈及機坪燈光保持開啟)狀況下，不易辨識機場之物理特性，且航廈及機坪燈光會影響進場操作之判斷，於進入跑道上空後才可辨識跑道之邊線。另於關閉機場跑道燈光（機場航廈及機坪燈光保持開啟）狀況下，使用夜視鏡進場，相關操作與白天相同。

經綜合執行夜間任務飛航組員及本會對夜間機場跑道燈光之測試結果，顯示機場夜間燈光對飛航中跑道之識別、障礙物隔離、進場及落地均大有助益。

2.6 飛航紀錄器

事故機之飛航資料係記錄於 MPFR 內，有關飛航資料之解讀係使用原廠地面設備及軟體，可順利將完整資料下載及解讀。相關資料於解讀過程中發現該 MPFR 紀錄之飛航資料分為 2 套，與其他飛航資料紀錄器配置及記錄之方式不同。此兩套系統分別記錄相同之參數共計 447 項，此 447 項參數包含我國民航局及 ICAO 規範之標準內容，已符合國際民航之規定。

解讀後之資料經檢視後，發現此 2 套系統大部分參數之紀錄正確，部分參數之紀錄有差異。有關紀錄之差異分析如下。

2.6.1 自動飛控系統相關參數

依據該系統設計原理，FD 於結合狀態下，自動駕駛相關功能才能作動（參考 1.6.3.1 節），另本會調查人員於執行模擬機測試時（參考 1.16.2 節）發現，「FD COUPLE FAIL」及「FLT DIR FAIL」之警示資訊係於 FD 模式結合狀態下，因某種自動控制功能失效才會出現，於 FD 模式未結合狀態下，不會出現「FD COUPLE FAIL」及「FLT DIR FAIL」之警示訊息，且一旦訊號出現於顯示器上，即使某種控制

功能之失效條件恢復至正常狀態，如不執行重置或領知(Acknowledge)動作，此一訊息不會自行消失。另根據 CVR 通話紀錄，飛航組員曾討論並曾確認FD於飛航中係接合狀態且飛航組員曾使用 FMS 導航，顯示當時之 FD 應在結合狀態。

經檢視事故機 FDR 記錄有關飛航導引之參數(如圖 2.7-1)，FDR 1 及 FDR 2 均紀錄有事故機自蘭嶼起飛後曾發生 2 次「FD COUPLE FAIL」及「FLT DIR FAIL」之警示訊息；於蘭嶼落地前 FDR 1 及 FDR 2 亦曾記錄 1 次「FD COUPLE FAIL」及「FLT DIR FAIL」之警示訊息。但有關 FD 接合之紀錄卻為：FD 全程均為 UNCOUPLE 狀態，如此紀錄為真，則不應出現「FD COUPLE FAIL」及「FLT DIR FAIL」之警示訊息，故 FDR 此一紀錄與系統之設計原理及實際狀況不符，顯示 FDR 此一「FD COUPLE FAIL」參數之紀錄有誤。

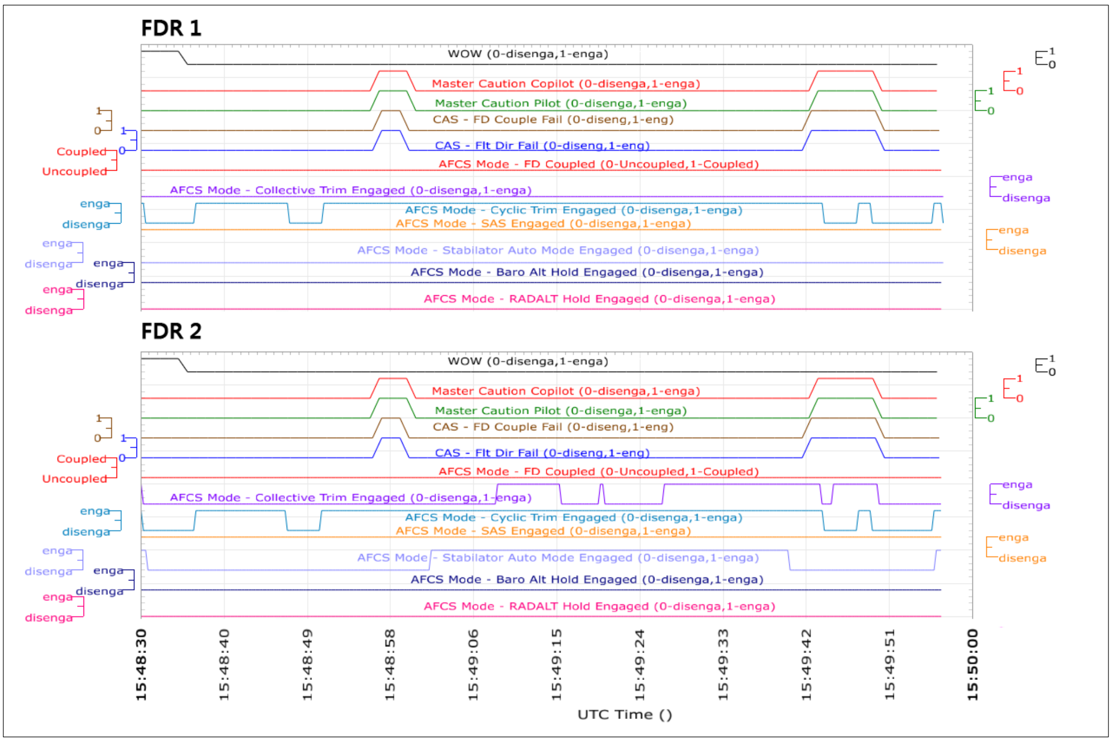

圖 2.7-1 有關飛航導引之參數

2.6.2 航機操控相關參數

本次事故 FDR 紀錄有關縱向操控之參數，該機自蘭嶼起飛至墜海期間；FDR 1 之「Cyclic Longitudinal」參數，全程紀錄為 100%，而 FDR 2「Cyclic Longitudinal」參數之紀錄則與「Pitch Trim」紀錄之參數趨勢同步，應為正確之紀錄；FDR 1 之「Collective Trim」參數，全程紀錄為 0，FDR 2「Collective Trim」參數之紀錄約於 49:26 至 49:44 時之間與「Collective」參數之資料同步，其他時間則紀錄為 0。同時，比較 FDR 1 及 FDR 2 紀錄之「Pitch」、「Pitch rate」及「Pitch trim posn」，其紀錄之資料則均相同且其數值會隨時間改變（如圖 2.7-2、圖 2.7-3）。

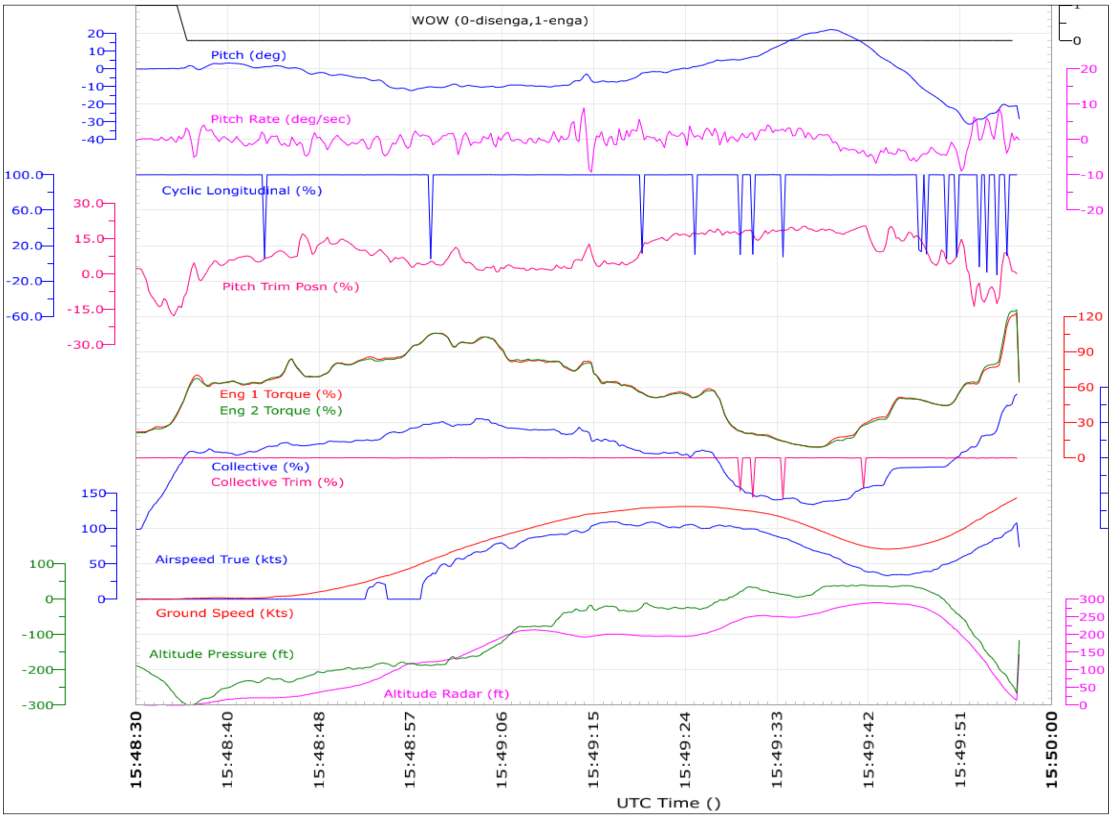

圖 2.7-2 FDR 1 縱向操控參數

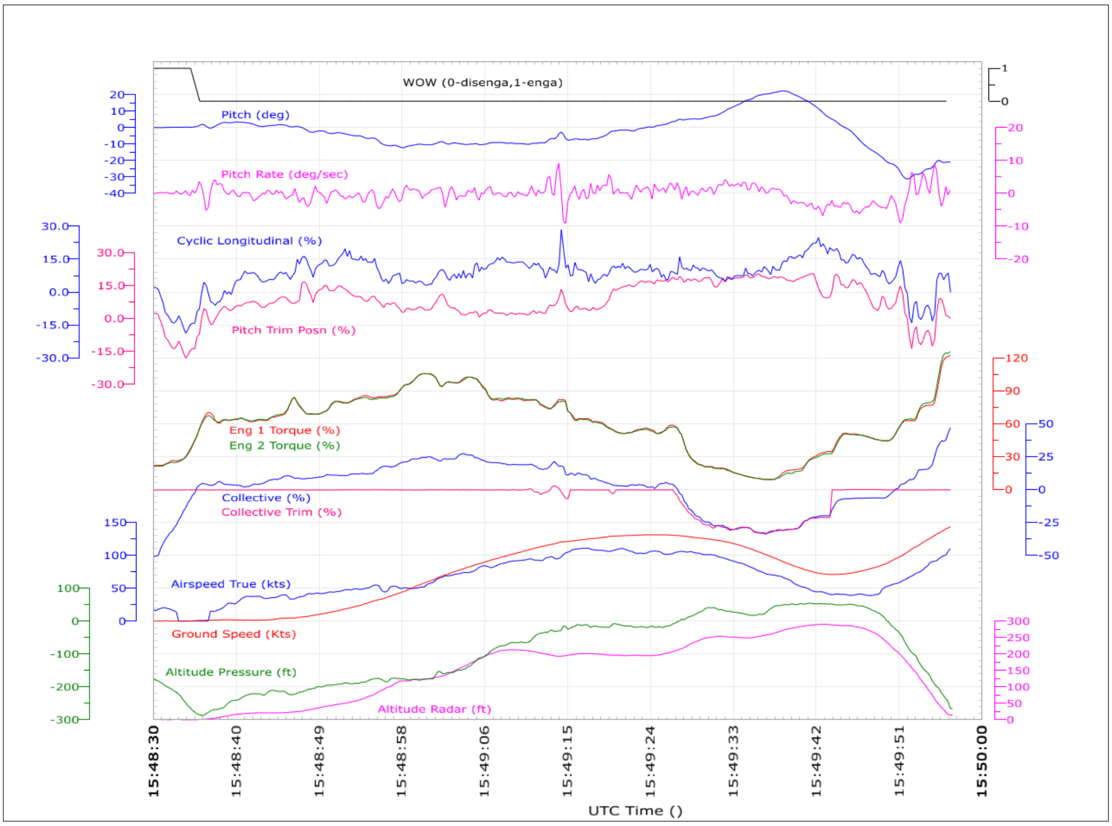

圖 2.7-3 FDR 2 縱向操控參數

有關橫航向操控之參數，FDR 1 之「Yaw trim posn」參數，全程紀錄為 0%，而 FDR 2「Yaw trim posn」參數之紀錄，約於 49:04 至 49:40 時之間有由 0 至 20 之變化，其他時間之紀錄則為 0。經比對檢視 FDR 1 及 FDR 2 之「Yaw rate」、「Roll 」、「Roll rate」及「Pedal」，其紀錄之資料則完全一致，其數值亦會隨時間改變。(如圖 2.7-4、圖 2.7-5)

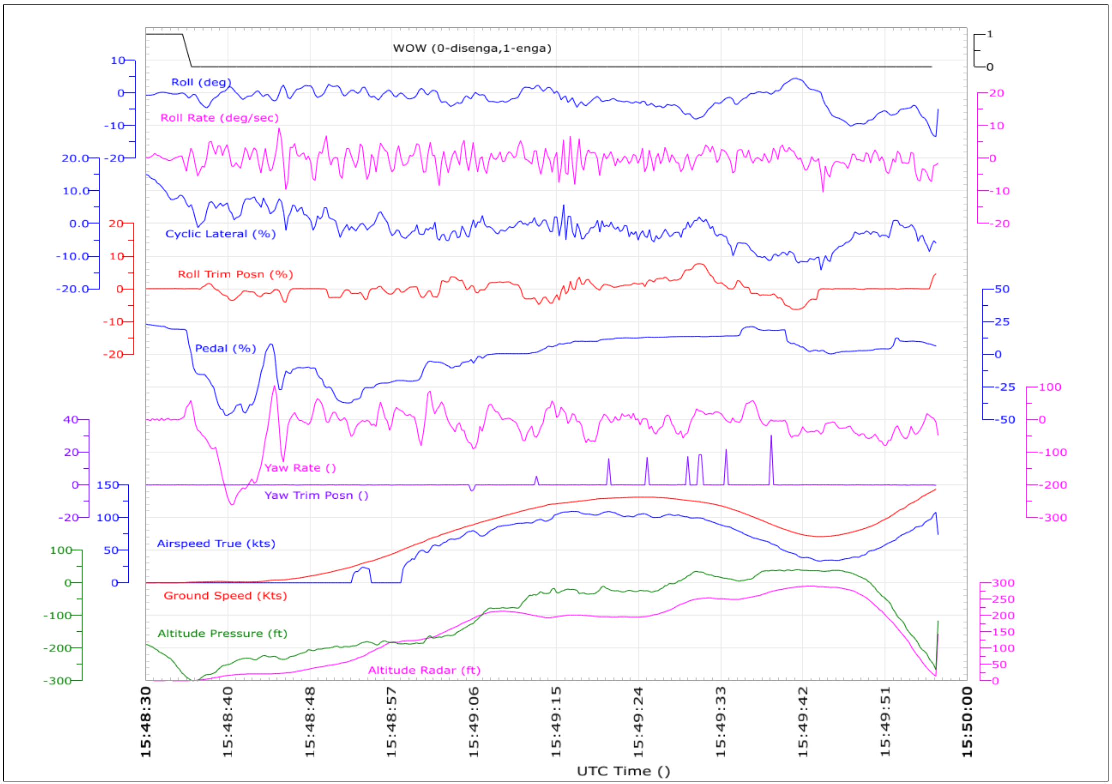

圖 2.7-4 FDR 1 橫航向操控參數

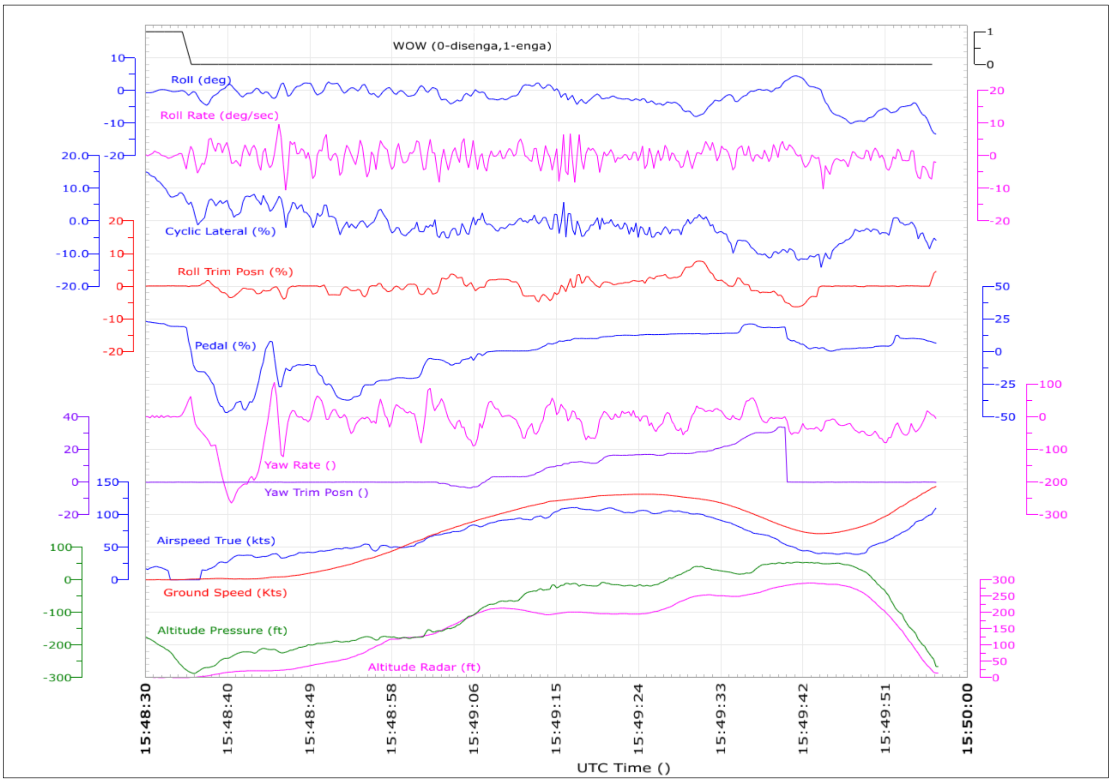

圖 2.7-5 FDR 2 橫航向操控參數

依上述資料之比對及同類型參數之趨勢分析，飛航資料中 FDR 1 之「Cyclic Longitudinal」參數、FDR 1 及 FDR 2「Collective Trim」參數、FDR 1 及 FDR 2「Yaw trim posn」等 3 項參數之紀錄有誤，並非航機之操控系統異常。

第 3 章　結論

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

與可能肇因有關之調查發現

此類調查發現係屬已經顯示或幾乎可以確定為與本次事故發生有關之重要因素，包括不安全作為、不安全狀況，或與造成本次事故發生息息相關之安全缺失等。

與風險有關之調查發現

此類調查發現係涉及影響運輸安全之潛在風險因素，包括可能間接導致本次事故發生之不安全作為、不安全條件，以及關乎組織與系統性風險之安全缺失，該等因素本身非事故之肇因，但提升了事故發生機率。此外，此類調查發現亦包括與本次事故發生雖無直接關聯，但基於確保未來運輸安全之故，所應指出之安全缺失。

其他調查發現

此類調查發現係屬具有促進運輸安全、解決爭議或澄清待決疑慮之作用者。其中部分調查發現係屬大眾所關切，且常見於國際民航組織（ICAO）事故調查報告之標準格式中，以作為資料分享、安全警示、教育及改善運輸安全目的之用。

3.1 與可能肇因有關之調查發現

1. 飛航組員對事故當時飛航環境之威脅管理、狀況警覺及溝通決策能力不夠充分，且對航機系統瞭解程度不足。於夜間、風向不定狀況下，未使用適當起飛模式起飛，於起飛過程中亦未能維持安全之

爬升姿態及速度、且於遭遇亂流時未能即時判讀高度及速度之變化而採行正確之修正操作，並可能伴隨有空間迷向之現象，最後於低高度狀況下，推機頭改正過低之空速時，因未注意當時高度且使用過當之馬力及俯角，致造成航機於可操控之狀態下墜海。（1.1, 1.11, 1.16, 2.2, 2.3）

3.2 與風險有關之調查發現

1. 事故機自蘭嶼起飛後約 23 秒即遭遇順風，並逐漸增強，瞬間最大曾達 40 浬/時，並兼具有風切與亂流現象，但仍在航機安全操作限制範圍內，且相關操控數據亦未顯示航機有異常現象。（1.7, 2.3.1）
2. 事故當時之飛航環境存在暗適應及空間迷向之條件。（2.3.2, 2.3.3）
3. 空勤總隊未編撰該型機完整之標準作業程序；事故飛航中飛航組員亦未完全依照現行相關規定執行應有之檢查程序及呼叫，容易遺漏相關操作之程序。（1.17, 2.2.3, 2.4.1.1, 2.4.1.3）
4. 空勤總隊未能完整規劃相關飛航組員之訓練，影響飛航組員之資格能力及飛航安全。（1.1, 1.17.2, 2.4.2.1）
5. 空勤總隊未妥善安排 UH-60M 型機之訓練資源，於換裝先進機種未規劃充分之地面學科，且模擬機之訓練時數不足，影響飛航組員相關系統之熟悉程度，不易達成預期訓練效益。（2.2, 2.4.2.2）
6. 空勤總隊相關手冊並無與夜航及儀器飛行時間相關之規定及最低要求。（1.5, 2.4.1.4）
7. 空勤總隊無具體完整之組員資源管理訓練教材，無法達成組員合作訓練之目的。（1.17, 2.4.2.3）
8. 空勤總隊事故當時之任務作業程序及手冊未訂定夜間執行傷患運送任務之天氣標準，影響飛航安全。（2.4.1.2）

3.3 其他發現

1. 空勤總隊未依照該航務手冊之規定裝置水上浮具[20]。(1.17.1, 2.4.1.2)
2. 夜間飛航時，目的地機場夜間跑道邊燈對飛航中跑道之識別、障礙物隔離、進場及落地均大有助益。(1.16.4, 2.5)
3. 事故機「FD COUPLE」、FDR 1 之「Cyclic Longitudinal」、FDR 1 及 FDR 2「Collective Trim」參數、FDR 1 及 FDR 2「Yaw trim posn」等參數之紀錄有誤。(1.11,.2 2.6)
4. 飛行員於夜間飛行期間配戴夜視鏡，有助於對外界地形、地物之參考。(1.16.4)
5. 飛航組員相關飛航證照，符合現行空勤總隊相關之規定，無證據顯示飛航組員於該次飛航中曾受任何酒精藥物之影響。(1.5, 2.1)
6. 本次事故與航機之載重平衡及航機系統無關。(1.6, 2.1)
7. 依據中央氣象局蘭嶼氣象站 2 月 5 日 2300 時至 2 月 6 日 0000 時之風向風速觀測紀錄，此時段最大陣風為風向 040 度，風速 68 浬/時。(1.7.2)

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[20] 事故機係軍用直昇機，依據美陸軍適航標準執行越水任務並未規範需安裝緊急浮筒。

第 4 章　改善建議

4.1 改善建議

致內政部空中勤務總隊

1. 加強飛航組員威脅管理、狀況警覺、溝通決策能力、航機系統瞭解程度之訓練，並訂立儀器飛航及夜航訓練需求及標準。（TTSB-ASR-19-09-001）

2. 檢視 UH-60M 型機飛航組員訓練計畫之完整性及訓練資源，以落實相關飛航組員之訓練成效。（TTSB-ASR-19-09-002）

3. 檢視航務管理手冊、任務作業程序內容之一致性及完整性，以利相關飛航任務執行之安全。（TTSB-ASR-19-09-003）

4. 考量訂定夜間執行傷患運送任務之天氣標準及 UH-60M 型機標準作業程序之必要性，以利相關任務之執行。（TTSB-ASR-19-09-004）

5. 規劃具體完整之組員資源管理訓練教材，以利飛航任務之執行。（TTSB-ASR-19-09-005）

6. 檢視整合式載具健康管理系統(IVHMS)，有關「FD COUPLE」、FDR 1 之「Cyclic Longitudinal」、FDR 1 及 FDR 2「Collective Trim」參數、FDR 1 及 FDR 2「Yaw trim posn」等參數之正確性，以利相關飛航資料之判讀。（TTSB-ASR-19-09-006）

致交通部民用航空局

1. 重新考量蘭嶼機場夜間緊急醫療起降需求，強化跑道燈光辨識及引導功能。如未能改善跑道建設需求，則應強化夜間直昇機停機坪之規劃及作業程序。（TTSB-ASR-19-09-007）

4.2 已完成或進行中之改善措施

1. 民航局正辦理中之「蘭嶼機場跑道整建工程」案，已納入增設該機場跑道助航燈光設備（跑道頭/末端燈、跑道邊燈及燈光設備機房等)。

附錄 1　事故前 1 個月日常維護保養記錄對照表

事故前一個月NA-706任務派遣統計表																				
勤務項目＼日期	03	04	05	06	07	08	09	10	14	18	19	20	22	23	24	25	26	03	04	05
救護轉診											1							1		1
海洋/岸空偵巡護（架次）	1														1					
演習/演練（架次）			1																	
訓練飛行（架次）	1					1	1	1		2	1					2				
維護飛行（架次）																		1		
試車（架次）				1	1		1				1	1					1		1	1
共勤訓練（架次）	1	2				1		1									1			
總飛時	05:20	04:05	02:05	00:20	00:30	03:50	02:00	03:05		02:15	03:20	00:30			02:40	03:50	03:30	02:55	00:30	01:30
統計（架次）	3	2	1	1	1	2	2	2		2	3	1			1	2	2	2	1	2
IVHMU飛航紀錄（架次）	3	3	3	1	1	4	2	2		2	3	1			1	2	2	2	1	
BEF（架次）	1	1	1			1	1	1		1	1									
BFF			●	●	●	●	● ●(紅)	● ●(紅)		●	● ●(紅)	●		● ●(紅)	● ●(紅)	●(紅)	●			
PFC	●	●	●			●														
PMD	●	●	●				●	●	●	●	●		●							

- ● 當日紀錄
- ●(紅) 重複紀錄

附錄 2　事故前 1 個月 IVHMS 維修監控記錄

ICON	Status Time	Severity	Status
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	2/4/2018 1:26:54 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Exceeded/Alert.	2/3/2018 6:10:35 AM	Exceeded	Engine 1 TGT - Shutdown Maximum
Exceeded/Alert.	2/3/2018 4:38:01 AM	Exceeded	Chip Intermediate Gear Box
Exceeded/Alert.	2/3/2018 4:38:01 AM	Exceeded	Chip Left-Hand Accesory Module
Exceeded/Alert.	2/3/2018 4:38:01 AM	Exceeded	Chip Left-Hand Input Module
Exceeded/Alert.	2/3/2018 4:38:01 AM	Exceeded	Chip Right-Hand Accesory Module
Exceeded/Alert.	2/3/2018 4:38:01 AM	Exceeded	Chip Right-Hand Input Module
Exceeded/Alert.	2/3/2018 4:38:01 AM	Exceeded	Chip Tail Gear Box
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	2/3/2018 4:42:07 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	2/3/2018 1:25:44 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Exceeded/Alert.	2/3/2018 1:47:02 AM	Caution	Main Gear Box Oil Pressure - Steady State Flight 2
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/9/2018 10:03:17 AM	Caution	Main Gear Box Oil Pressure - Steady State Flight 2
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED

Exceeded/Alert.	1/9/2018 7:09:13 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/8/2018 9:26:26 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Exceeded/Alert.	1/8/2018 2:48:41 AM	Exceeded	Engine 1 TGT - Shutdown Maximum
Exceeded/Alert.	1/8/2018 2:50:03 AM	Exceeded	Engine 2 TGT - Shutdown Maximum
Exceeded/Alert.	1/8/2018 10:55:05 AM	Exceeded	Engine 2 TGT - Shutdown Maximum
120 hour	1/8/2018 10:15:26 AM	Caution	Engine 1 High Speed Shaft Balance, SO1, 0.43 IPS
Mech/Dia.	1/8/2018 10:15:26 AM	Caution	Engine 1 High Speed Shaft Balance, SO1, 0.43 IPS
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/8/2018 1:45:19 AM	Caution	Main Gear Box Oil Pressure - Steady State Flight 2
120 hour	1/7/2018 3:58:30 AM	Caution	Engine 1 High Speed Shaft Balance, SO1, 0.47 IPS
Mech/Dia.	1/7/2018 3:58:30 AM	Caution	Engine 1 High Speed Shaft Balance, SO1, 0.47 IPS
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
120 hour	1/5/2018 3:58:30 AM	Caution	Engine 1 High Speed Shaft Balance, SO1, 0.47 IPS
Mech/Dia.	1/5/2018 3:58:30 AM	Caution	Engine 1 High Speed Shaft Balance, SO1, 0.47 IPS
Exceeded/Alert.	1/6/2018 6:21:51 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Mech/Dia.	1/5/2018 3:58:30 AM	Exceeded	Engine 1 High Speed Shaft Balance, SO1, 0.47 IPS
Exceeded/Alert.	1/5/2018 4:32:09 AM	Exceeded	Engine 1 TGT - Shutdown Maximum
120 hour	1/5/2018 3:58:30 AM	Caution	Engine 1 High Speed Shaft Balance, SO1, 0.47 IPS
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/5/2018 3:32:38 AM	Caution	IVHMU Internal Battery Low Voltage Wanring

Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/5/2018 12:57:32 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Exceeded/Alert.	1/4/2018 8:26:45 AM	Exceeded	Engine 2 TGT - Shutdown Maximum
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/4/2018 6:28:12 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Exceeded/Alert.	1/4/2018 7:11:58 AM	Caution	Main Gear Box Oil Pressure - Steady State Flight 2
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/26/2018 7:43:03 AM	Caution	Main Gear Box Oil Pressure - Steady State Flight 2
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/26/2018 2:30:58 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Exceeded/Alert.	1/25/2018 8:02:13 AM	Exceeded	Engine 1 TGT - Shutdown Maximum
Exceeded/Alert.	1/25/2018 8:03:29 AM	Exceeded	Engine 2 TGT - Shutdown Maximum
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/25/2018 7:00:33 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Exceeded/Alert.	1/25/2018 7:13:37 AM	Caution	Main Gear Box Oil Pressure - Steady State Flight 2
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/24/2018 3:23:43 AM	Exceeded	Engine 1 TGT - Shutdown Maximum
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/24/2018 12:58:42 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Mech/Dia.	1/19/2018 12:19:59 PM	Exceeded	Swashplate Bearing Health, Envelope RMS, 0.41 G

Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/20/2018 1:02:36 PM	Caution	IVHMU Internal Battery Low Voltage Wanring
Fault Bit	N/A	Caution	LINE STATUS NA NOGO - ETHERNET EXT2 LINE STATUS
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/19/2018 7:28:28 PM	Caution	IVHMU Internal Battery Low Voltage Wanring
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/19/2018 2:04:58 PM	Exceeded	Engine 2 Anti-Ice Fail During HIT
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/19/2018 1:52:55 PM	Caution	IVHMU Internal Battery Low Voltage Wanring
Exceeded/Alert.	1/19/2018 2:20:34 PM	Caution	Main Gear Box Oil Pressure - Steady State Flight 2
Mech/Dia.	1/18/2018 7:43:20 PM	Exceeded	Swashplate Bearing Health, Envelope RMS, 0.34 G
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/18/2018 6:47:17 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Exceeded/Alert.	1/18/2018 7:03:15 AM	Caution	Main Gear Box Oil Pressure - Steady State Flight 2
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/18/2018 2:24:19 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Exceeded/Alert.	1/18/2018 2:46:35 AM	Caution	Main Gear Box Oil Pressure - Steady State Flight 2
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Fault Bit	N/A	Caution	CBIT DETAILS AVC I/F FAULT - AVC INTERFACE DOWN OR DISABLED
Exceeded/Alert.	1/10/2018 1:34:35 AM	Caution	IVHMU Internal Battery Low Voltage Wanring
Exceeded/Alert.	1/10/2018 2:35:39 AM	Caution	Main Gear Box Oil Pressure - Steady State Flight 2

附錄 3　Type IV 型飛航資料紀錄器之必要紀錄參數

序號	參數	測量範圍	取樣率(秒)	精確度	解析度	備註
1	時間	24 小時	4	±0.125% 每小時	1 秒	
2	壓力高度	-1k～Max＋5k 呎	1	±30m 至 ±200m (±100 呎至±700 呎)	5 呎	
3	指示空速		1	±3%	1kt	
4	航向	360 度	1	±2°	0.5°	
5	Nz	- 3g ~+6g	0.125	±0.09g	0.004g	
6	俯仰角	±75°or100%	0.5	±2°	0.5°	
7	滾轉角	±180°	0.5	±2°	0.5°	
8	無線電傳送紀錄	開 -- 關	1			
9	每具發動機推力	全範圍	1	±2%	全範圍之 0.1%	
10	主旋翼： 主旋翼速度 主旋翼煞車	 50 -- 130% 離散值	 0.51	 ±2% —	 全範圍之 0.3% —	
11	駕駛員輸入及/或控制面位置 – 主操縱面位置 (Collective pitch、longitudinal cyclic pitch、lateral cyclic	全範圍	0.5（建議 0.25)	±2%,除非有獨特要求之較高精確度	操作範圍之 0.5%	對傳統控制系統之直昇機得不記錄，對非機械控制系統之

	pitch、Tail rotor pedal)					直昇機必須記錄。
12	液壓	離散值	1	—	—	
13	外界空氣溫度	感應器範圍	2	±2°C	0.3°C	
14	自動駕駛/自動油門/AFCS 模式與結合狀態		1	—	—	離散值應顯示何系統已結合
15	穩定增強系統結合	離散值	1	—	—	
16	主齒輪箱油壓	安裝值	1	安裝值	6.895kN/m^2 (1 psi)	
17	主齒輪箱油溫	安裝值	2	安裝值	1^0C	
18	側偏速率	±400^0/每秒	0.25	±1.5%最大範圍，不含±5%之基準誤差	±2%/每秒	
19	吊掛載重力	0 – 200%之檢定載重	0.5	最大範圍之±3%	最大檢定載重之5%	
20	縱向加速度	±1g	0.25	±0.015g，不含±0.05g之基準誤差	0.004g	
21	橫向加速度	±1g	0.25	±0.015g，不含±0.05g之基準誤差	±0.004g	
22	無線電高度	- 6m 至 750m(-20 呎至 2500 呎)	1	當低於 150m (500 呎)，±0.6m (±2 呎)或±3%；當高於 150 m(500 呎)，±5%，選較大值	當低於 150m (500 呎)，0.3m (1 呎)；當高於 150	

					(500 呎)，0.3m (1 呎)＋0.5%之全範圍	
23	垂直波束偏差	信號範圍	1	±3%	全範圍之0.3%	
24	水平波束偏差	信號範圍	1	±3%	全範圍之0.3%	
25	通過信標台信號	離散值	1	—	—	對所有信標器而言，一離散值即可接受
26	警告	離散值	1	—	—	對變速箱低油壓及SAS失效而言，應記錄主警告信號之離散值。當不能從其它參數

						或座艙通話紀錄器確定警告情況時，應記錄其它「紅色」警告信號。
27	每一導航接收機頻率選擇	足以確定所選擇之頻率	4	安裝值	—	若可獲得數位式信號
28	DME 1 與 2 距離	0 – 200 浬	4	安裝值	1 浬	若可獲得數位式信號，則從 INS 或其他導航系統記錄經緯度乃較佳之替

						代品。
29	導航資料(經緯度、地面速度、偏移角、風速、風向)	安裝值	2	安裝值	安裝值	
30	起落架或起落架選擇器位置	離散值	4	—	—	

附錄 4　事故地區之天氣數值模擬報告

利用 WRF 數值模式模擬分析個案：

2018 年 2 月 5 日黑鷹直昇機蘭嶼事故

一、模式設定與資料

本研究利用氣象數值模式 Weather Research and Forecasting model(簡稱 WRF) 3.9.1.1 版本，模擬 2018 年 2 月 5 日本地時間約 23:49～23:52 左右，台灣蘭嶼島西南側附近（圖 1；事故地點坐標約 121.535˚E、22.026˚N）發生之黑鷹直昇機墜毀事件，主要分析其空域之重要氣象因素是否可能出現不利直昇機正常飛行之環境條件。

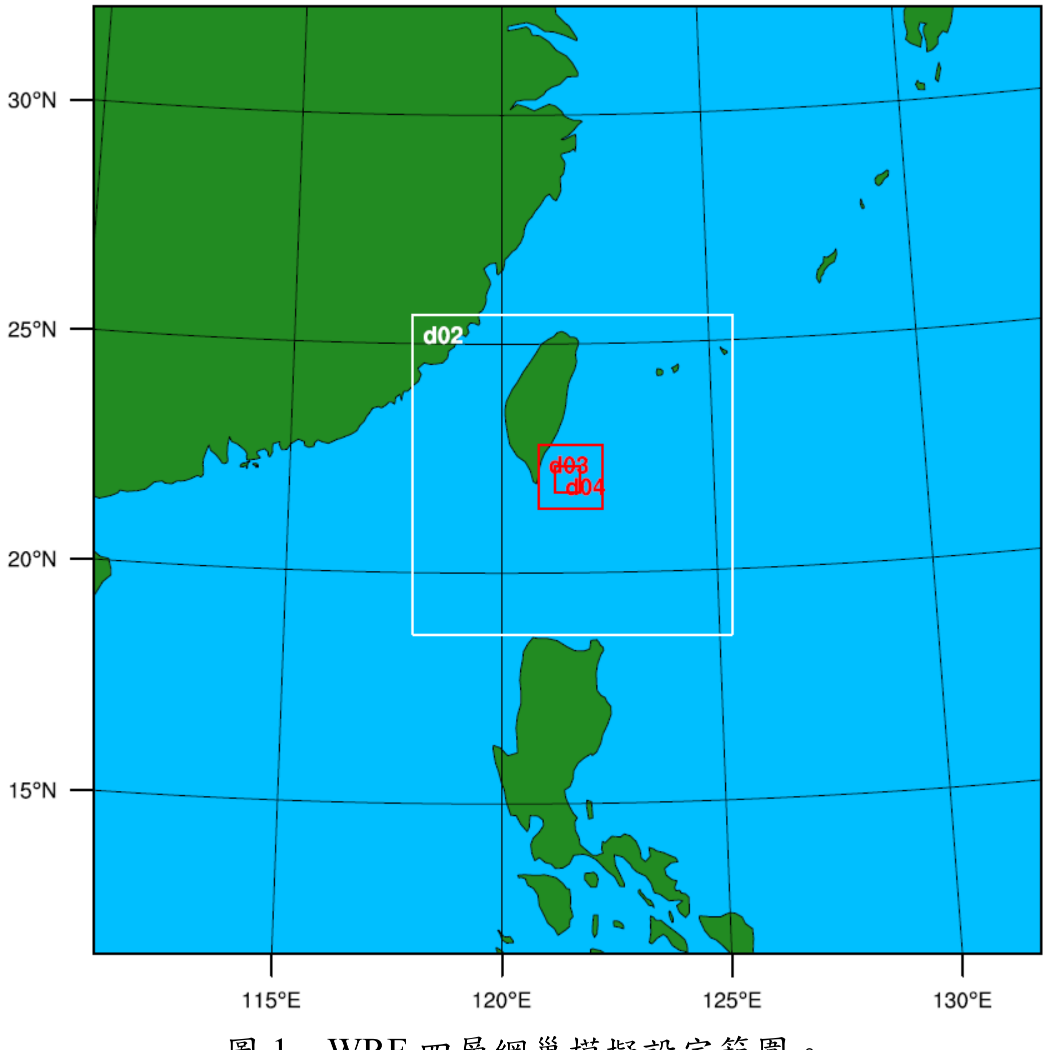

圖 1　WRF 四層網巢模擬設定範圍。

以美國 National Centers for Environmental Prediction 之 Global Data Assimilation System Final 資料為 WRF 所需之初始與邊界條件，該資料水平解析度 0.25°E × 0.25°N、每 6 小時一筆、垂直方向自地面至 1 hPa 共 32 層。

WRF 模式 4 層網巢設定水平解析度自第 1～第 4 層網巢分別為 25 公里、5 公里、1 公里及 200 公尺。垂直層（追隨地勢 σ 坐標）自地面至模式頂 50 hPa 共 55 層；海拔高度 1000 公尺以下約有 11 層。模擬時間為 2018 年 2 月 5 日 06:00～18:00 UTC。WRF 其他設定包括：僅第 1 層網巢選用 Kain-Fritsch 積雲參數法，其他網巢未使用積雲參數化且選用 Morrison 雲微物理法；長波輻射選用 Goddard longwave 法；短波輻射選用 Goddard shortwave 法；近地層（surface-layer）選用 Revised MM5 Monin-Obukhov 法；地面（land-surface）選用 UnifiedNoad land-surface 模式；選用 two-way 網巢間回饋；第 1～3 層網巢地形資料來源之水平解析度為 30 弧秒（約 1 公里），第 4 層網巢則為 0.6 弧秒（約 30 公尺）。WRF 最接近事故地點網格之海拔高度約為 0.41 公尺。

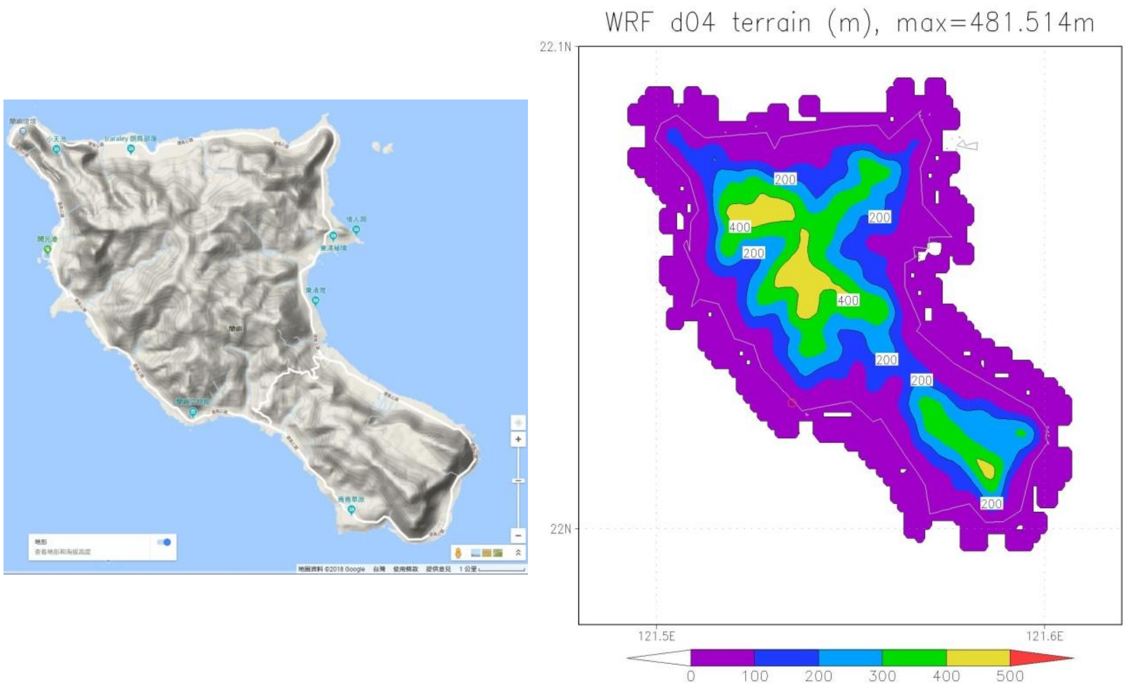

圖 2　Google earth 之蘭嶼地形（左）與 WRF 第 4 網巢所使用之 30 公尺地形（右）。右圖空心圓為失事地點。地形單位皆為公尺。

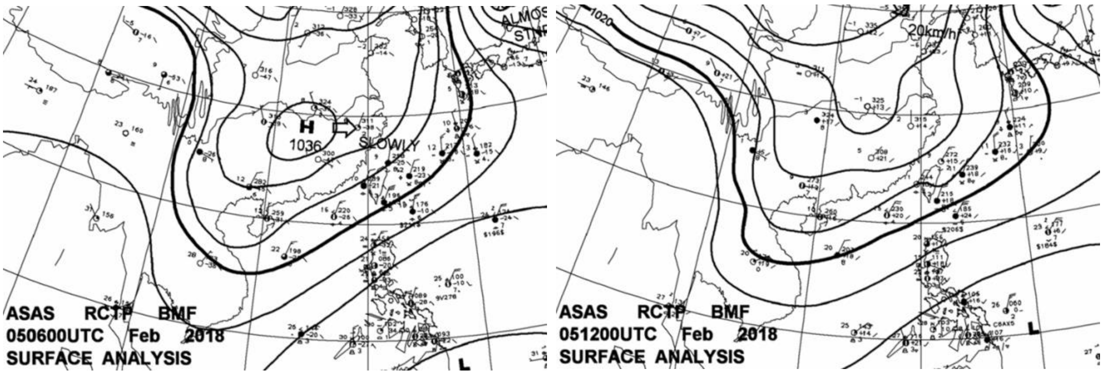

圖 3　中央氣象局分析之 2017 年 2 月 5 日 0600 UTC（左）與 1200 UTC（右）地面天氣圖

本研究之 WRF 模擬結果是利用國家高速網路與計算中心 Taiwania 1 平行化超級電腦 384 個計算節點執行數值計算。

二、分析結果

中央氣象局分析之 2 月 5 日 06:00 與 12:00 UTC 地面天氣圖顯示（圖 3），位於中國長江之冷高壓雖逐漸減弱且東移，但在台灣東側有出現冷空氣堆積之局部氣壓增加現象；蘭嶼地面觀測站受冷高壓影響，東北風風速常達 24 m s^{-1} 左右（圖 4）。

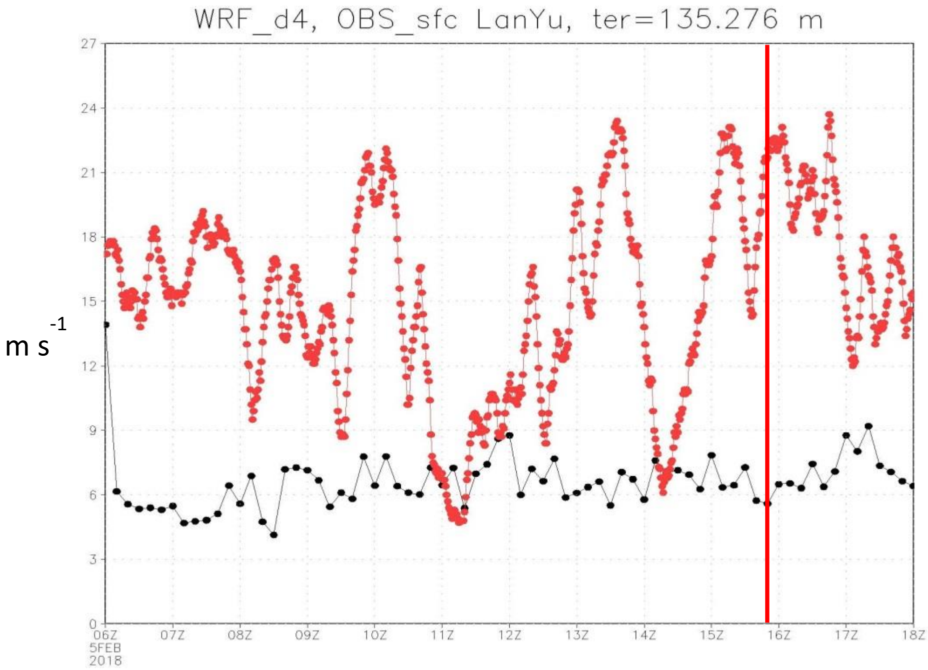

圖 4　蘭嶼測站（紅線）與 WRF 地面風速（黑線），單位皆為 m s-1。紅色垂直線標示失事時間。

以垂直中差分法計算垂直風切：

$$\sqrt{\left(\frac{\partial u}{\partial z}\right)^2 + \left(\frac{\partial v}{\partial z}\right)^2}$$

WRF 模擬之垂直風切（圖 5）於失事地點附近海拔高度約 100 公尺以下之低邊界層，在 14:00～18:00 UTC 期間常出現較強之垂直風切，其強度約達 0.08 s^{-1} 以上，為國際民用航空組織（International Civil Aviation Organization）所訂定之中等強度（moderate）風切（0.08～0.13 s^{-1}）。

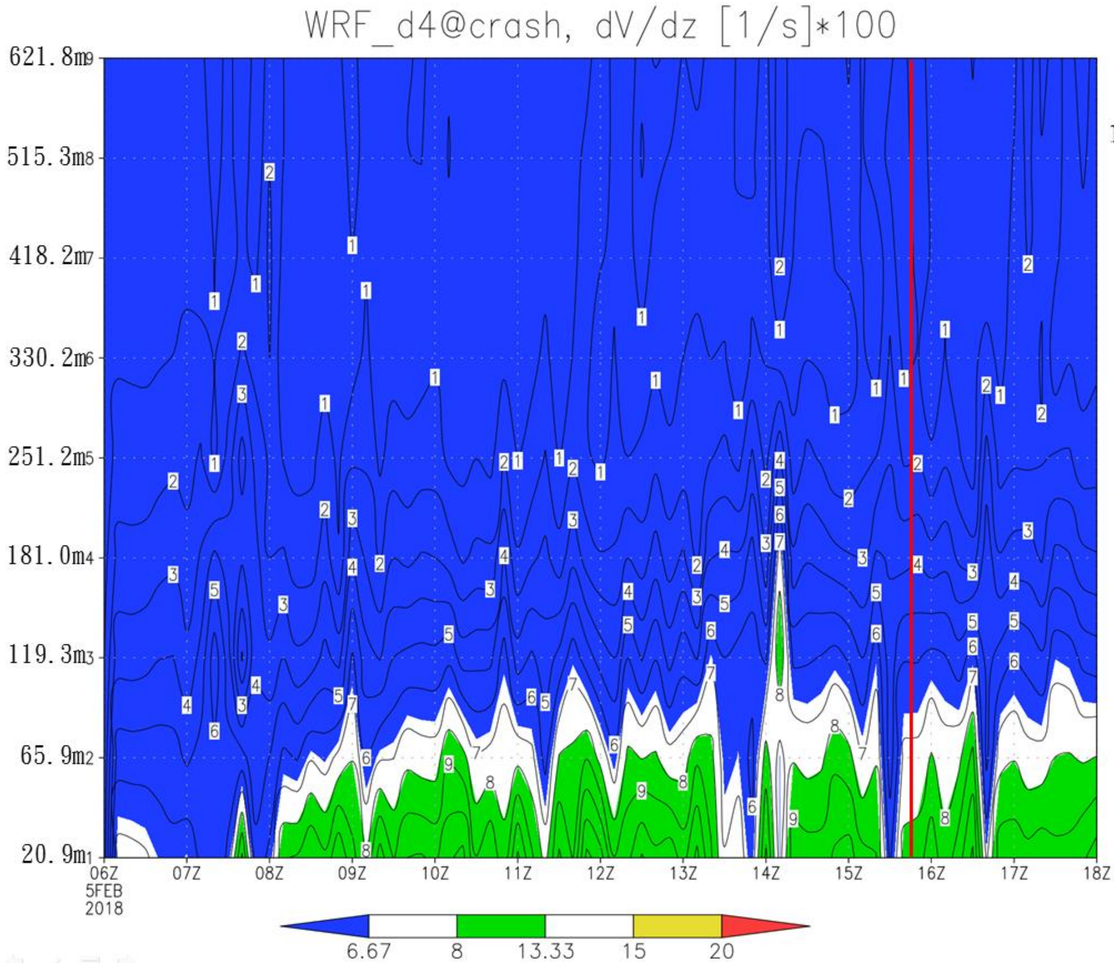

圖 5　WRF 模擬失事地點之垂直風切時間序列圖（單位：0.01 s^{-1}）。紅色垂直線標示失事時間。Y 軸為海拔高度（單位：公尺）。

若將水平風切之影響亦加入計算：

$$\sqrt{\left(\frac{\partial u}{\partial \mathrm{y}}\right)^2+\left(\frac{\partial v}{\partial x}\right)^2+\left(\frac{\partial u}{\partial z}\right)^2+\left(\frac{\partial v}{\partial z}\right)^2}$$

結果顯示自晚間 08:00 UTC 之後，海拔高度約 120 公尺以下之低邊界層三維風切幾皆維持於中等強度（圖 6）。

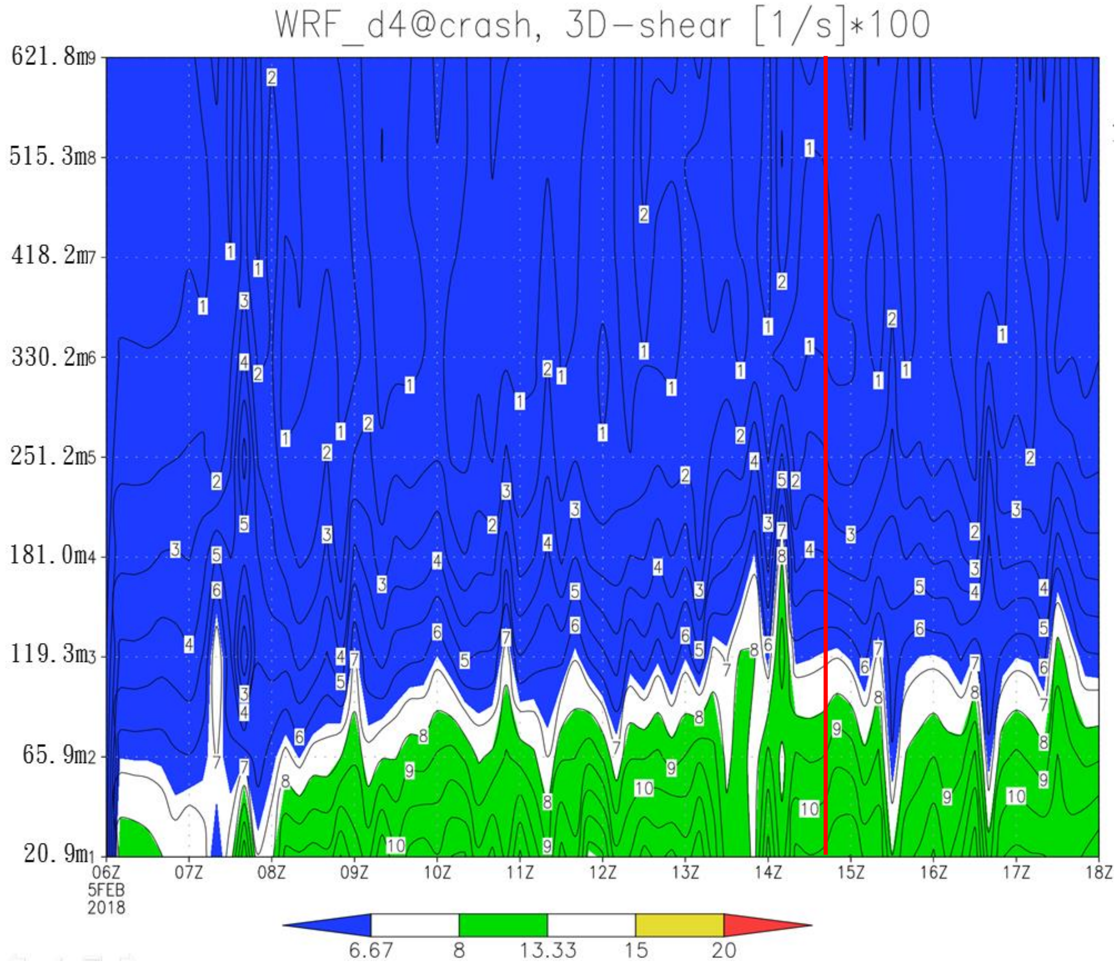

圖 6　同圖 5，但為水平風切加垂直風切。

WRF 模擬 15:50 UTC，海拔高度 100 公尺之水平風場顯示失事地點為北北東風，風速可達 18 m s^{-1}（圖 7）。

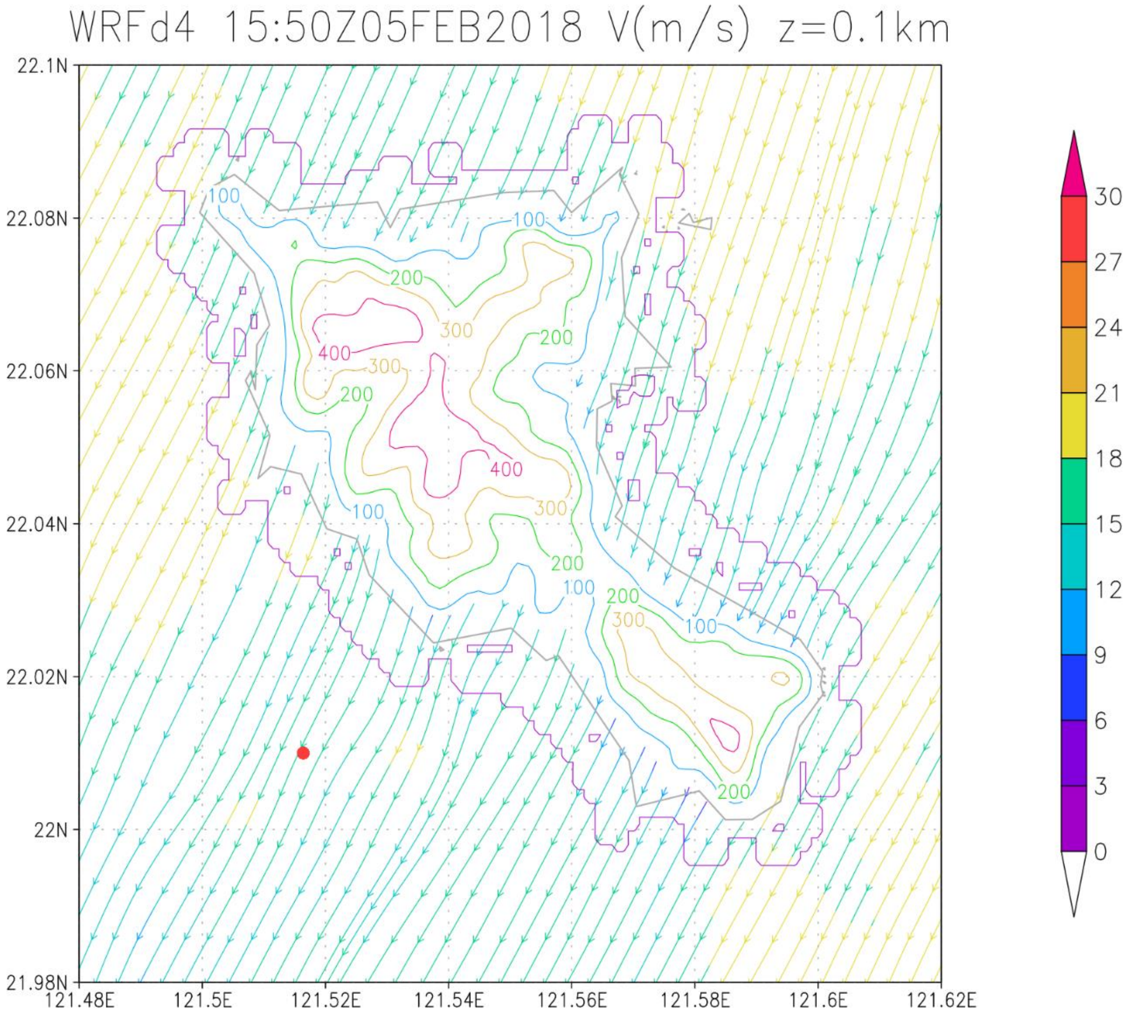

圖 7　WRF 模擬失事地點之水平風場（單位：m s^{-1}）。紅點標示失事位置。

附錄 5　任務作業程序內容

空中勤務總隊	航務管理手冊	版期：7 日期：99.12.23 頁次：15-6-27

勤務項目(八)：空中救護-轉診與緊急救護

飛機種類：直升機

程序：以點(•) 帶頭的文字表示				
職稱 階段	PF (操控飛行員)	PM (監控飛行員)	CE (機工長)	SAR(O) (搜救員與共乘)
任務受領	•召集人員分配工作與取得相關資料(任務地點座標、標高，通信頻率、呼號，聯絡人有線及手機電話號碼)。 對任務風險因子評估，預採相關作為，並納入任務提示。 對任務機組員及乘員實施任務提示。	•協助查詢天氣資料，飛航通報及航路資料。 依照機長指示，協助完成各項準備工作。	•依照任務提示，完成飛機各項準備工作。	依任務需求及載重擇其必要之裝備。
飛行前檢查	•參閱及填寫飛機狀況紀錄表。 •按檢查表執行。 •完成飛行前機外檢查。	•確認所有程序已完成。 •使用檢查手冊協助機長完成機外檢查。 •讀、確認並回應飛行前檢查表。讀出 REFLIGHT CHECK…	協助正副駕駛完成機外檢查。 檢查後艙並視需要調整裝備配置。	
座艙內部檢查	•座椅、腳蹬、肩帶、安全帶、耳機之調整檢查。 •確認並回答座艙內部檢查。 •完成座艙內部檢查。 •確認油量符合派遣及飛行計畫要求。	•確認所有程序已完成。 •座椅、腳蹬、肩帶、安全帶、耳機之調整檢查。 •讀出檢查手冊項目協助機長完成座艙內部檢查。 •完成副駕駛座艙內部檢查，讀、確認並回應。 讀出"PREFLIGHT CHECK COMPLETE."	•確認並報告所攜帶裝備。	固定安置救援裝備 •就座及繫安全帶。
引擎啟動程序	•使用檢查手冊完成引擎啟動及飛機各功能測試檢查。 •確認無線電及導航儀表電台、GPS位置調整設定。	•確認所有程序已完成。 •讀出檢查手冊項目協助機長完成引擎啟動及飛機各功能測試檢查。 •無線電及導航儀表電台、GPS 位置調整設定。 •抄收 ATIS 資料。	•就欲啟動引擎前側方定位持滅火器注視引擎啟動情況(手勢顯示)。	

滑出前檢查	•告知F/O起飛企圖 飛航路線、高度、目標位置..。 •告知機組員準備滑出起飛。 設定QNH、雷達高度表及航行儀表。	•與塔台及管制單位通聯飛航路線、高度、目標位置..請求起飛。 確認機上油量是否符合派遣及飛航計劃需求。 •確認所有程序已完成。	•回報後艙狀況…	
起飛前檢查	依各機型完成起飛前檢查程序。	•確認所有程序已完成。		
起飛及爬升	依許可爬升至指定高度。	•監控爬昇高度及飛行航跡。 預計到達目標時間 (到達高度與空速) •回報起飛時間。	執行後側方障礙視察。	協助空中障礙視察。
任務執行 飛航中	目標區前完成分工與提示。 目標起降區性質 航路天氣概況 飛航高度、時間 如出海時: •浮筒 ARM 位置	•與本總隊或勤務指揮中心通聯確認任務相關資訊.目標位置.. •到達距目標區約 2 海浬告知機長。 浮筒 ARM	依照提示分工，完成緊急醫療準備工作。 後艙安全管理及重心配置。 協助空中障礙視察。	檢視個人裝備及救援裝備器材，並確認通訊無礙。
目標區	確認組員全程保持目視。 (依狀況以無線電請求其他支援) 實施空中偵察確定下列資料。 1.風向、風速。 2.場地幅員。 3.障礙狀況。 4.起降方向。 5.重飛點、緊急落地場或迫降場。 6.起降任務地區之高度。 7.視需要執行馬力檢查。 8.採取最佳位置及方式實施起降。	目標指引(鐘點指示) 目標定位。 •與本總隊或勤務指揮中心通聯回報目標位置.狀況及紀錄。 監控高度及緊急醫療預估作業載重、障礙物資料。	目標指引(鐘點指示) 依機長指示目標完成緊急醫療準備工作(含安全檢查) • 落地後開啟後艙門並實施引導之安全措施。 •核對管制搭載人數。 •回報後艙狀況。	目標指引(鐘點指示) •完成緊急醫療準備 工作。 •協助地面醫護人員及病（傷）患及家屬登機及管制周邊安全。

返航飛行中	爬升至指定高度。 （依需要請求地面支援項目）。	GPS設定返航座標及航行儀表設定。 • 與本總隊或勤務指揮中心回報救援狀況及紀錄。 • 監控爬昇高度及飛行航跡及油量計算。 預計到達時間。 (到達高度與空速)	• 後艙載重配置管理及醫療裝備固定。 • 協助醫護人員及病（傷）患及家屬安全措施。	• 回報救援後艙狀況。 • 協助醫護人員及病（傷）患及家屬實施必要之照護及安全措施。
落地前檢查	依各機型完成落地前檢查程序。	• 確認所有程序已完成。協助機長完成落地前檢查程序。	執行後側方障礙視察。	協助空中障礙視察。
落地後	• 滑行至定位。	• 協助機長完成其他程序 • 回報落地時間。	• 通知機長開機門協助醫療裝備搬運。 • 協助醫護人員及病（傷）患及家屬實施下機引導之安全措施。	• 與地面救護支援人員共同協助醫護人員及病（傷）患及家屬實施下機引導之安全。 協助飛機地面周邊安全警戒。
關車	• 使用檢查手冊完成引擎關車程序之檢查。 • 完成飛機狀況紀錄表填寫。 完成飛行後檢查。	• 確認所有程序已完成。 • 讀出檢查手冊項目協助機長完成引擎關車程序之檢查。 • 無線電及各導航儀表電關。 • 協助機長完成飛行後檢查。	• 完成任務後飛機保養（修護）。 完成加油及保養工作。 (依各機型規定)	
任務歸詢	• 召集人員對任務機組員及乘員實施任務歸詢。 1. 任務執行情形 2. 飛航缺點改正 3. 表格資料填寫 4. 不正常情況報告 5. 其他建議事項	• 依照機長指示，協助完成各項資料填寫及回報。	• 報告任務執行及飛機狀況。	依任務歸詢報告任務執行狀況。
其他	1. 夜間僅執行機場對機場之病（傷）患後送。 2. 臨時著陸場開設及管制由申請單位負責。 3. 眾多病（傷）患後送時先後順序由申請單位負責管制，由單位值日人員負責協調後轉知任務機機長。			

附錄 6　標準操作程序範本重點

STANDARD OPERATING PROCEDURES 範本

標準操作手冊或手冊之一部分可使用為飛航組員的訓練導引之用，內容必須明確及詳盡，但不一定要冗長。沒有任何範例可能包含所有的項目，除非是經常的修訂。許多特殊性的操作及新技術並未列入範例中，諸如 ETOPS、SMGS、RNP 等等。

下列可作為組成詳盡操作手冊的範例項目：

- 機長（Captain）的權限
- 自動化系統的使用：
  公司自動化系統的使用原則
  不同層次自動化系統的使用原則
  自動駕駛（AP）/飛航指導儀（FD）模組操作輸入
  飛航管理系統（FMS）的輸入
  自動化系統與飛行模式顯示（FMA）的監控
  飛行前交互確認FMS輸入航線與ATC之許可一致
- 檢查表（Checklist）原則
  原則及程序
  (由誰要求開始檢查表；誰來念；誰來執行)
  格式及術語
  檢查表（Checklist）的種類
  查詢提出－執行－再確認
  執行－再確認
  360 度機外檢查
- 檢查表
  安全檢查－啟動電力power on
  開啟作業/接收資訊（Originating/receiving）

開車前

開車後

滑行前

起飛前

起飛後

爬升檢查

航行檢查

落地前

落地

落地後

停車及安全

緊急程序

非正常 (Non-normal) / 不正常 (abnormal procedures)

- 通信

由誰來操作無線電

指定正式語言 (Primary language)

ATC 方面

駕駛艙內

使兩位飛航組員都參予在內

公司通信程序

駕艙/客艙訊號

客艙/駕艙訊號

- 提示

CFIT 風險考量(見範例，本通告六 （五）)

特殊機場資格考量

場溫修正考量

起飛前

下降/進場/迷失進場

通常在下降開始之前完成進場提示

- 駕艙進入程序

地面/空中

觀察員座（Jump-Seat）

進入的暗號，鑰匙

- 駕艙紀律
  PF/PM職責劃分
  安靜駕艙
  保持機外警覺
  監控/交互檢查
- 飛機操控的交接
  額外的任務
  航行包
  耳機/擴音機
  耳掛式麥克風（Boom Mikes）/手持式麥克風（Handsets）
  航行圖表/進場圖表
  餐飲
- 飛機高度的警覺性
  高度表設定
  轉換空層
  Callouts 再確認
  最低安全高度 (MSA)
  溫度校正
  達到新高度1000呎內之監督
- 報到時間
  報到
  到達駕艙
  檢查表完成
- 地勤維修程序（Maintenance Procedures）
  紀綠本/先前的缺點
  未完成的缺點
  通知維修人員寫入的缺點
  最低裝備表 (Minimum Equipment List, MEL) 何處取得
  裝備差異表 (Configuration Deviation List, CDL)
  地面除冰的組員協調
- 飛航計劃/派遣程序/起飛落地計算

VFR/IFR

結冰狀況的考量

油量

天氣資料

天氣資料取得管道

離場程序的爬昇梯度分析

- 旅客登機/貨物裝載

  隨身行李

  緊急出口邊的座位

  危險物品

  人犯/隨行警衛

  機上軍械

  計算/裝載

- 後推/飛機動力後推
- 滑行

  全引擎

  部分引擎

  冰或雪上滑行

  入侵跑道的防止

- 組員資源管理 (CRM)

  組員提示簡報

客艙組員

飛航組員

- 載重平衡/貨物裝載

  裝貨及貨物裝載捆綁檢查負責人

  載重平衡表製作人；檢查人日期有效性

移交組員備份載重平衡表

- 前後艙組員協調

  登機

  滑行前檢查完成

  客艙緊急事件

  起飛/落地前

- 起飛（Take-Off）
  - PF/PM職責
  - 由誰執行
  - 簡報提示, IFR/VFR
  - 減推力起飛程序
  - 尾風，跑道不平
  - 非使用全跑道起飛/飛機落地後跑道前等待（Intersections/Land and Hold Short Procedures (LAHSO)）
  - 噪音管制離場
  - 特殊離場程序
  - 飛航指導儀（Flight Directors）
    - 是否使用
  - Callouts
  - 收完外型
  - 發動機失效
  - 適當時狀況接手操控
    - 放棄起飛
    - V_1 後
      - 採取程序/Callouts
  - 襟翼（Flap）設定
    - 正常
    - 非正常及其理由
    - 側風
  - 近距離轉彎
- 爬升（Climb）
  - 速度
  - 外型
  - 再確認符合離場爬升梯度要求
  - 再確認符合適當的低場溫度校正
- 巡航高度的選擇
  - 速度/重量
- 位置報告/天氣回報飛航組員天氣報告（PIREPs）

航管－包括積冰、雷雨、亂流等飛航組員天氣報告（PIREPs）

公司

- 緊急下降
- 待命程序

轉降備降站的程序

- 正常下降

開始下降點的計劃與口述

風險評估及說明 (見範例，本通告 六（七）)

減速板： 是/否

襟翼/起落架的使用

結冰考量

大氣對流情況考量

- 接近地面警告系統 (GPWS or TAWs)

脫離警告之操作程序

- 空中防撞系統TCAS
- 風切

事先避免

認知

改正 / 脫離操作

- 進場原則

進場時之監控

優先使用精確系進場

適當配合ATC，並且及早規劃以避免慌亂進場

穩定進場標準

助航設施的使用

飛航管理系統 (FMS)/自動駕駛

使用及終止使用時機

進場檢查點（Approach Gates）

穩定進場限制

雷達高度表的使用

重飛：每次進場皆計劃重飛，直到目視可行或在低能見度但情況合宜且穩定時，再決定落地

- 進場種類

  各種進場，包括發動機失效進場

- 對每個進場方式

  高度限制輪廓

  依據以下條件決定飛機外型

  目視進場

  低能見度

  跑道有積雪（水）結冰

  襟翼/起落架的伸放

依飛機製造商頒布程序（或合適公司程序），飛航組員兩方皆確認自動減速板及自動煞車已經預備作用

  程序及Callouts

- 重飛 / 迷失進場

  不符合穩定進場要求時

  程序及Callouts (見範例, 附件 四)

  收外型時機

- 落地

  程序及 callouts

  近距離轉彎

  側風

  放棄落地

  落地滑出程序及Callouts（見範例，附件十八）

  “No Spoilers” callout

  反向推力 “overboost” callout

  由副駕駛落地後之操作及轉換操控程序及 callouts

(範例)

正常重飛－程序及 CALLOUTS

Callouts：以 "**粗體字**" 表示 -- **程序**：以點(•) 帶頭的文字表示		
重飛	**PF**	**PM**
	"GO AROUND" • 按下重飛鈕 **"GO-AROUND POWER"** • 確認油門柄移到重飛位置 • 仰轉到 15°，跟隨 flight director 指示 **"FLAPS 20"**	• 確認重飛模示 • 選取 flaps 20 • 確認油門柄移至保持 2,000 FPM 上升率 **"POWER SET"**
正向爬升率	• 確認正爬升率 **"GEAR UP"** • 執行航圖的迷失進場程序或航管許可	**"POSITIVE RATE"** • 起落架柄收起 • 告知航管 • 監督迷失進場程序
400' AFE 以上	**"LNAV"** or **"HEADING SELECT"**	• 選取LNAV or HDG SEL • 確認LNAV or HDG SEL

		警示
爬升超過1,000' AFE	"**REF 80**" "**FLAPS_____**"（依 flap 速度收起 flaps）	• 將速度標移到 VREF 30 + 80 • 依要求設定適當的 flap
於收起 flap 速度	"**FLAPS UP, AFTER TAKEOFF CHECKLIST**"	• 收起 flaps • 完成檢查表

附錄 7　我國陸軍赴美訓練時數及課程內容

（一） AQC 課程時數

UH-60M Aviator Qualification, 2C-SIB3/153M (UH-60M), Training Sequence

(Select to Return to Table of Contents)

TD	Start Time	End Time	Location/Bldg	Lesson ID	Lesson Title	LSN Time	LSN BLK Time	Instructional Element	Remarks
1	7:00	10:30	5700/SSC	H60M2900	Adminstrative (Inprocessing)	3.5	3.5	C Co 1-13TH AVN	
1	11:00	12:30	40164/Lowe AAF	H60M2900	Administrative UH-60M Flight Commander's/Aviation Life Support Equipment (ALSE) Briefing	2.5	1.5	F Co, 1-212TH AVN	
1	13:30	16:30	5207/Ford Hall	H60M2000	Systems Academics (UH-60M Introduction/Airframe Configuration)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
2	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Academics (UH-60M Crew Station Configuration/Seats)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
2	13:00	16:00	5207/Ford Hall	H60M2000	Systems Academics-UH-60M T701D GE Engine / IHIRSS	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
3	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-UH-60M T701D GE Engine / IHIRSS	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
3	13:00	16:00	5207/Ford Hall	H60M2000	Systems Academics-UH-60M Performance Planning	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
4	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-UH-60M Performance Planning (Integrated Performance and Aircraft Configuration)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
4	13:00	16:00	5207/Ford Hall	H60M2000	Systems Academics-UH-60M Flight/Mission Display Systems (F/MDS) Multifunction Displays (MFDs)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
5	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-UH-60M Flight/Mission Display Systems (F/MDS) Multifunction Displays (MFDs)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
5			5102/Goodhand	H60M2600	Flight Training-Contact/Instruments (TBOS)	290.5	6.5	F Co, 1-212TH AVN	
6	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Flight/Mission Display System (F/MDS) Multifunction Displays (MFDs) (Tactical Display)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
6			5102/Goodhand	H60M2600	Flight Training-Contact/Instruments (TBOS)	290.5	6.5	F Co, 1-212TH AVN	
7	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Flight Management System (FMS)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
7	13:00	15:00	5207/Ford Hall	H60M2000	Systems Academics-Systems Academics-Flight Management System (FMS)	99.5	2.0	UH-60 ACAD, 1-212TH AVN	
7	15:00	16:00	5207/Ford Hall	H60M2000	Systems Academics-Data Transfer System Overview (DTS)	99.5	1.0	UH-60 ACAD, 1-212TH AVN	
8	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Flight Director/Display Control Panel (FD/DCP)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
8	13:00	15:00	5207/Ford Hall	H60M2000	Systems Academics-Flight Director/Display Control Panel (FD/DCP)	99.5	2.0	UH-60 ACAD, 1-212TH AVN	

UH-60M Aviator Qualification, 2C-SIB3/153M (UH-60M), Training Sequence

(Select to Return to Table of Contents)

9	7:30	9:30	5102/Goodhand	H60M2001	Aircraft Systems Examination Part I	2.0	2.0	UH-60 ACAD, 1-212TH AVN	Critique
9			5102/Goodhand	H60M2600	Flight Training-Contact/Instruments (TBOS)	290.5	6.5	F Co, 1-212TH AVN	
10	7:30	8:30	5207/Ford Hall	H60M2000	Systems Academics-Reversionary Switch Panel Overview	99.5	1.0	UH-60 ACAD, 1-212TH AVN	
10			5102/Goodhand	H60M2600	Flight Training-Contact/Instruments (TBOS)	290.5	6.5	F Co, 1-212TH AVN	
11	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Flight Controls / Hydraulics	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
11			5102/Goodhand	H60M2600	Flight Training-Contact/Instruments (TBOS)	290.5	6.5	F Co, 1-212TH AVN	
12	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Flight Controls / Hydraulics	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
12			5102/Goodhand	H60M2600	Flight Training-Contact/Instruments (TBOS)	290.5	6.5	F Co, 1-212TH AVN	
13	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Flight Controls / Hydraulics	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
13	11:30	18:30	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments (Preflight)	290.5	7.0	F Co, 1-212TH AVN	
14	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Automatic Flight Control System/Stabilator	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
14	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments	290.5	6.5	F Co, 1-212TH AVN	
15	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Automatic Flight Control System/Stabilator	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
15	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments	290.5	6.5	F Co, 1-212TH AVN	
16	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Drivetrain / Rotor System	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
16	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments	290.5	6.5	F Co, 1-212TH AVN	
17	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Electrical	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
17	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments	290.5	6.5	F Co, 1-212TH AVN	
18	7:30	9:30	5207/Ford Hall	H60M2000	Systems Academics-Electronic Standby Instrument System (ESIS)	99.5	2.0	UH-60 ACAD, 1-212TH AVN	
18			5102/Goodhand	H60M2600	Flight Training-Contact/Instruments (TBOS)	290.5	6.5	F Co, 1-212TH AVN	
19	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Auxilary Equipment	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
19			5102/Goodhand	H60M2600	Flight Training-Contact/Instruments (TBOS)	290.5	6.5	F Co, 1-212TH AVN	

UH-60M Aviator Qualification, 2C-SIB3/153M (UH-60M), Training Sequence

(Select to Return to Table of Contents)

20	7:30	9:30	5207/Ford Hall	H60M2000	Systems Academics-Fuel System	99.5	2.0	UH-60 ACAD, 1-212TH AVN	
20	9:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Crashworthy External Fuel System (CEFS)	99.5	1.0	UH-60 ACAD, 1-212TH AVN	
20			5102/Goodhand	H60M2600	Flight Training-Contact/Instruments (TBOS)	290.5	6.5	F Co, 1-212TH AVN	
21	7:30	9:30	5207/Ford Hall	H60M2002	Aircraft Systems Examination Part II	2.0	2.0	F Co, 1-212TH AVN	
21	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments	290.5	6.5	F Co, 1-212TH AVN	
22	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Aviation Mission Planning System (AMPS) Aircraft/Weapons/Electronics (A/W/E)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
22	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments	290.5	6.5	F Co, 1-212TH AVN	
23	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Aviation Mission Planning System (AMPS) Aircraft/Weapons/Electronics (A/W/E)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
23	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments	290.5	6.5	F Co, 1-212TH AVN	
24	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Aviation Mission Planning System (AMPS) Aircraft/Weapons/Electronics (A/W/E)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
24	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments	290.5	6.5	F Co, 1-212TH AVN	
25	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Aviation Mission Planning System (AMPS) Aircraft/Weapons/Electronics (A/W/E)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
25	11:30	18:30	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments (Instructor Led Discussion)	290.5	7.0	F Co, 1-212TH AVN	
26	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Aviation Mission Planning System (AMPS) Aircraft/Weapons/Electronics (A/W/E)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
26	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments	290.5	6.5	F Co, 1-212TH AVN	
27	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Flight/Mission Display System (F/MDS) Multifunction Displays (MFDs) (JVMF/BFT)	99.5	3.0	UH-60 ACAD, 1-212TH AVN	
27	11:30	15:30	40164/Lowe AAF	H60M2604	Limitations & Emergency Procedures Examination	3.5	4.0	F Co, 1-212TH AVN	
27	15:00	18:00	40164/Lowe AAF	H60M2605	Operators Manual Examination	3.0	3.0	F Co, 1-212TH AVN	
28	7:30	8:30	5207/Ford Hall	H60M2000	Systems Academics-Active Vibration Control System (AVCS)	99.5	1.0	UH-60 ACAD, 1-212TH AVN	
28	8:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Integrated Vehicle Health Management System (IVHMS)	99.5	2.0	UH-60 ACAD, 1-212TH AVN	
28	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments	290.5	6.5	F Co, 1-212TH AVN	
29	7:30	9:00	5207/Ford Hall	H60M2000	Systems Academics-Common Missile Warning System (CMWS) Overview	99.5	1.5	UH-60 ACAD, 1-212TH AVN	

UH-60M Aviator Qualification, 2C-SIB3/153M (UH-60M), Training Sequence

(Select to Return to Table of Contents)

29	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Contact/Instruments	290.5	6.5	F Co, 1-212TH AVN	
30	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Malfunction Analysis	99.5	3.0	F Co, 1-212TH AVN	
30	11:30	18:30	40164/Lowe AAF	H60M2601	Contact/Instruments Flight Evaluation	7.0	7.0	F Co, 1-212TH AVN	
31	7:30	10:30	5207/Ford Hall	H60M2000	Systems Academics-Malfunction Analysis	99.5	3.0	F Co, 1-212TH AVN	
31	11:30	18:30	40164/Lowe AAF	H60M2600	Flight Training-Tactics (Student Led Classes)	290.5	7.0	F Co, 1-212TH AVN	
32	7:30	10:30	5207/Ford Hall	H60M2000	System Academics-UH-60M Malfunction Analysis	99.5	3.0	F Co, 1-212TH AVN	
32			5102/Goodhand	H60M2600	Flight Training-Tactics (TBOS)	290.5	6.5	F Co, 1-212TH AVN	
33	7:30	10:30	5207/Ford Hall	H60M2004	Malfunction Analysis PE	3.0	3.0	F Co, 1-212TH AVN	
33	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Tactics	290.5	6.5	F Co, 1-212TH AVN	
34	7:30	9:30	5207/Ford Hall	H60M2003	Aircraft Systems Examination Part III	2.0	2.0	F Co, 1-212TH AVN	
34	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Tactics	290.5	6.5	F Co, 1-212TH AVN	
35	11:30	18:30	40164/Lowe AAF	H60M2600	Flight Training-Tactics (Instructor Led Discussion)	290.5	7.0	F Co, 1-212TH AVN	
36	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Tactics	290.5	6.5	F Co, 1-212TH AVN	
37	11:30	18:00	40164/Lowe AAF	H60M2600	Flight Training-Tactics	290.5	6.5	F Co, 1-212TH AVN	
38	11:30	18:30	40164/Lowe AAF	H60M2602	Tactics Flight Evaluation	7.0	7.0	F Co, 1-212TH AVN	
39	11:30	18:30	40164/Lowe AAF	H60M2600	Flight Training-Night (Student Led Classes)	290.5	7.0	F Co, 1-212TH AVN	
40	13:00	16:00	616/NVD (Rm 1)	NVDB1000	Night Vision Academics *	9.0	3.0	NVD ACAD, 110TH AB	
40			5102/Goodhand	H60M2600	Flight Training-Night (TBOS)	290.5	6.5	F Co, 1-212TH AVN	
41	13:00	16:00	616/NVD (Rm 1)	NVDB1000	Night Vision Academics *	9.0	3.0	NVD ACAD, 110TH AB	
41	17:30	0:00	40145/Lowe AAF	H60M2600	Flight Training-Night	290.5	6.5	F Co, 1-212TH AVN	
42	13:00	16:00	616/NVD (Rm 1)	NVDB1000	Night Vision Academics *	9.0	3.0	NVD ACAD, 110TH AB	
42	17:30	0:00	40145/Lowe AAF	H60M2600	Flight Training-Night	290.5	6.5	F Co, 1-212TH AVN	
43	7:30	9:30	616/NVD (Rm 1)	NVDB1000	Night Vision Academics *	2.0	2.0	NVD ACAD, 110TH AB	
43			5102/Goodhand	H60M2600	Flight Training-NVG (TBOS)	290.5	6.5	F Co, 1-212TH AVN	
44	13:00	14:00	616/NVD (Rm 1)	NVDB1001	Night Vision Academics Examination	1.0	1.0	NVD ACAD, 110TH AB	
44	17:30	0:00	40145/Lowe AAF	H60M2600	Flight Training-NVG	290.5	6.5	F Co, 1-212TH AVN	
45	13:00	15:00	616/NVD (Rm 1)	NVDB6002	AN/AVS-7 Heads-Up Display (HUD) Operations * (I-HUD)	2.0	2.0	NVD ACAD, 110TH AB	

UH-60M Aviator Qualification, 2C-SIB3/153M (UH-60M), Training Sequence

(Select to Return to Table of Contents)

45	17:30	0:00	40145/Lowe AAF	H60M2600	Flight Training-NVG	290.5	6.5	F Co, 1-212TH AVN	
46	13:00	15:00	616/NVD (Rm 1)	NVDB6003	AN/AVS-7 Heads-Up Display (HUD) Examination * (I-HUD)	2.0	2.0	NVD ACAD, 110TH AB	
46	17:30	0:00	40145/Lowe AAF	H60M2600	Flight Training-NVG	290.5	6.5	F Co, 1-212TH AVN	
47	17:30	0:30	40145/Lowe AAF	H60M2600	Flight Training-NVG (Instructor Led Discussion)	290.5	7.0	F Co, 1-212TH AVN	
48	17:30	0:00	40145/Lowe AAF	H60M2600	Flight Training-NVG	290.5	6.5	F Co, 1-212TH AVN	
49	17:30	0:00	40145/Lowe AAF	H60M2600	Flight Training-NVG	290.5	6.5	F Co, 1-212TH AVN	
50	17:30	0:00	40145/Lowe AAF	H60M2600	Flight Training-NVG	290.5	6.5	F Co, 1-212TH AVN	
51	17:30	0:30	40145/Lowe AAF	H60M2603	NVG Flight Evaluation	7.0	7.0	F Co, 1-212TH AVN	
52	16:30	17:30	40145/Lowe AAF	H60M2900	Adminstrative (Course Critique)	2.5	1.0	F Co, 1-212TH AVN	
52	17:30	0:30	40145/Lowe AAF	H60M2600	Flight Training-NVG	290.5	7.0	F Co, 1-212TH AVN	
53	17:30	0:30	40145/Lowe AAF	H60M2600	Flight Training-NVG	290.5	7.0	F Co, 1-212TH AVN	
54	17:30	0:30	40145/Lowe AAF	H60M2600	Flight Training-NVG	290.5	7.0	F Co, 1-212TH AVN	
55	7:30	11:30	5700/SSC	H60M2900	Administrative (Outprocessing)	4.0	4.0	C Co 1-13TH AVN	

*If a student is previously night vision goggle qualified, lessons 011-NVDB6000, Night Operations Review, 2.0 hours, and 011-NVDB6001, Night Operations Examination, 1.0 hour, will be substituted for lessons 011-NVDB1000 and 011-NVDBlOOl. If a student is previously night vision goggle qualified, lessons 011-NVDB6000, Night Operations Review, 2.0 hours, and 011-NVDB6001, Night Operations Examination, 1.0 hour, will be substituted for lessons 011-NVDB1000 and 011-NVDBlOOl.

Operate AMPS and UH-60M AWE. The student handout can be provided to foreign military students; however, the AMPS Mission Planning Pocket Guide and the AMPS software CAN NOT be provided to foreign military students due to distribution restrictions.

Identify the characteristics of the UH-60M CMWS and the BFT portion of ELO F - Identify the characteristics of the Flight/Mission Display System (F/MDS) Multifunction Displays (MFDs). The materials contained in this training event/course have been reviewed by the training/educational developers in coordination with the USAACE, Foreign Disclosure Officer, Fort Rucker, AL FD authority. Some component(s) of this training event/course is(are) NOT releasable to students from foreign countries. See each TSP subcomponent/product for applicable FD restriction statement. These portions of the student handout and the examination must be purged for foreign students attending this course.

（二） IPC 課程時數

UH-60M IP, 2C-F196/SQIC (UH-60M) Master Flow

(Select to Return to Table of Contents)

TD	Start Time	End Time	Building/Location	Lesson ID	Lesson Title	LSN Time	LSN BLK Time	Instructional Element	Remarks
1	7:00	11:00	6225/1-13th AVN	H60M3900	In-process	9.0	4.0	C CO 1-13TH	
1	12:00	13:00	40144/Lowe AAF	H60M3901	Non-Fly ICH (Flight Commander Brief)	1.0	1.0	F CO, 1-212TH AVN	
1	13:00	15:00	40144/Lowe AAF	H60M3604	Limitations and Emergency Procedures Exam (5&9)	2.0	2.0	F CO, 1-212TH AVN	
2	7:30	10:30	30165-B/Cairns AAF	GRAD3000	Graduate Academics (Instructing Fund For IP's)	33.0	3.0	110TH AB, GRAD BR	
3	7:30	10:30	30165-B/Cairns AAF	GRAD3000	Graduate Academics (Instructing Fund For IP's)	33.0	3.0	110TH AB, GRAD BR	
3	13:00	16:00	30166-B/Cairns AAF	GRAD3000	Graduate Academics (Aircrew Training Program)	33.0	3.0	110TH AB, GRAD BR	
4	7:30	8:30	30166-B/Cairns AAF	GRAD3002	Instruct Fund Exam For Ip's	1.0	1.0	110TH AB, GRAD BR	
4	8:30	11:30	30166-A/Cairns AAF	GRAD3000	Graduate Academics (Regulations For Army Aircraft - Airspace)	33.0	3.0	110TH AB, GRAD BR	
4	13:00	14:00	30166-B/Cairns AAF	GRAD3000	Graduate Academics (Aircrew Training Program)	33.0	1.0	110TH AB, GRAD BR	
4	14:00	16:00	30166-B/Cairns AAF	GRAD3004	Aircrew Training Program Practical Exercise	2.0	2.0	110TH AB, GRAD BR	
5	6:30	9:30	30166-A/Cairns AAF	GRAD3000	Graduate Academics (Regulations For Army Aircraft - Airspace/AR 95-1)	33.0	3.0	110TH AB, GRAD BR	
5	13:00	16:00	30166-B/Cairns AAF	GRAD3000	Graduate Academics (ACT-E Instructor Qualification)	33.0	3.0	110TH AB, GRAD BR	
6	7:30	10:30	30166-A/Cairns AAF	GRAD3000	Graduate Academics (Flight Information Publications Seminar)	33.0	3.0	110TH AB, GRAD BR	
6	13:00	14:00	30166-B/Cairns AAF	GRAD3000	Graduate Academics (ACT-E Instructor Qualification)	33.0	1.0	110TH AB, GRAD BR	
6	14:00	16:00	30166-B/Cairns AAF	GRAD3005	Aircrew Coordination Training - Enhanced Examination	2.0	2.0	110TH AB, GRAD BR	
7	6:30	7:30	30166-A/Cairns AAF	GRAD3000	Graduate Academics (Flight Information Publications Seminar)	33.0	1.0	110TH AB, GRAD BR	
7	7:30	9:30	30166-A/Cairns AAF	GRAD3003	Regs & DOD Flip Exam	2.0	2.0	110TH AB, GRAD BR	
7	9:30	11:30	30165-A/Cairns AAF	GRAD3000	Graduate Academics (Applied Aerodynamics)	33.0	2.0	110TH AB, GRAD BR	
8	6:30	10:30	30165-A/Cairns AAF	GRAD3000	Graduate Academics (Applied Aerodynamics)	33.0	4.0	110TH AB, GRAD BR	
8	11:30	13:30	40144/Lowe AAF	H60M3605	Flight Training (IFR Review/IPAC/SWB2)	243.5	2.0	1-212TH, F CO.	
9	6:30	9:30	30165-A/Cairns AAF	GRAD3000	Graduate Academics (Applied Aerodynamics)	33.0	3.0	110TH AB, GRAD BR	
9			5102/Goodhand	H60M3605	Flight Training (TBOS) (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
10	6:30	8:30	30165-A/Cairns AAF	GRAD3001	Applied Aerodynamics Exam	2.0	2.0	110TH AB, GRAD BR	
10			5102/Goodhand	H60M3605	Flight Training (TBOS) (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	

UH-60M IP, 2C-F196/SQIC (UH-60M) Master Flow

(Select to Return to Table of Contents)

TD	Start Time	End Time	Building/Location	Lesson ID	Lesson Title	LSN Time	LSN BLK Time	Instructional Element	Remarks
11	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (T-701D Engine/IHIRRS)	53.0	3.0	CUB, 110TH AB	
11			5102/Goodhand	H60M3605	Flight Training (TBOS) (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
12	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (T-701D Engine/IHIRRS)	53.0	3.0	CUB, 110TH AB	
12	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
13	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Power Train System, Main Rotor & Tail Rotor Groups)	53.0	3.0	CUB, 110TH AB	
13	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
14	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Flight Controls & Hydraulics System)	53.0	3.0	CUB, 110TH AB	
14	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
15	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Flight Controls & Hydraulics System)	53.0	3.0	CUB, 110TH AB	
15			5102/Goodhand	H60M3605	Flight Training (TBOS) (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
16	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Automatic Flight Control System - AFCS)	53.0	3.0	CUB, 110TH AB	
16			5102/Goodhand	H60M3605	Flight Training (TBOS) (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
17	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Automatic Flight Control System - AFCS/Stabilator)	53.0	3.0	CUB, 110TH AB	
17	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
18	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Electrical Power Supply & Distribution Systems)	53.0	3.0	CUB, 110TH AB	
18	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
19	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Fuel System)	53.0	3.0	CUB, 110TH AB	
19	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
20	7:30	9:30	5207/Ford Hall (A-24)	H60M3001	Aircraft Aircraft System Exam I	2.0	2.0	CUB, 110TH AB	
20	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
21	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Flight Management System - FMS)	53.0	3.0	CUB, 110TH AB	
21	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
22	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Flight Display System Multifunction Display - FDS MFD)	53.0	3.0	CUB, 110TH AB	
22			5102/Goodhand	H60M3605	Flight Training (TBOS) (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	

UH-60M IP, 2C-F196/SQIC (UH-60M) Master Flow

(Select to Return to Table of Contents)

TD	Start Time	End Time	Building/Location	Lesson ID	Lesson Title	LSN Time	LSN BLK Time	Instructional Element	Remarks
23	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Flight Display System Multifunction Display - FDS MFD)	53.0	3.0	CUB, 110TH AB	
23	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
24	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Flight Display System Multifunction Display - FDS MFD)	53.0	3.0	CUB, 110TH AB	
24	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
25	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Flight Director Display Control Panel - FDDCP)	53.0	3.0	CUB, 110TH AB	
25	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
26	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (Flight Director Display Control Panel - FDDCP)	53.0	3.0	CUB, 110TH AB	
26	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
27	7:30	9:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (IVHMS/AVCS)	53.0	2.0	CUB, 110TH AB	
27	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
28	7:30	9:30	5207/Ford Hall (A-24)	H60M3002	Aircraft Aircraft System Exam II	2.0	2.0	CUB, 110TH AB	
28	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
29	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (AWE)	53.0	3.0	CUB, 110TH AB	
29	11:30	18:00	40144/Lowe AAF	H60M3605	Flight Training (Cont/Inst)	243.5	6.5	F CO, 1-212TH AVN	
30	7:30	10:30	5207/Ford Hall (A-24)	H60M3000	Aircraft Systems Academics (AMPS)	53.0	3.0	CUB, 110TH AB	
30	11:30	19:00	40144/Lowe AAF	H60M3602	Contact/Instrument Flight Evaluation	7.5	7.5	F CO, 1-212TH AVN	
31			5102/Goodhand	H60M3605	Flight Training (TBOS) (Tac)	243.5	7.5	F CO, 1-212TH AVN	
32	7:30	8:30	9204/Learning Center	U3004501	Night Vision Review (Comp-Based)	1.0	1.0	Self Paced	
32	11:30	19:00	40144/Lowe AAF	H60M3605	Flight Training (Tac)	243.5	7.5	F CO, 1-212TH AVN	
33	7:30	9:00	616/NVDB	NVDB6000	Night Operations Review	1.5	1.5	NVDB, 110TH AB	
33	9:00	10:30	616/NVDB	NVDB6004	AN/AVS-7 Operations IHUD	1.5	1.5	NVDB, 110TH AB	
33	11:30	19:00	40144/Lowe AAF	H60M3605	Flight Training (Tac)	243.5	7.5	F CO, 1-212TH AVN	
34	7:30	8:30	616/NVDB	NVDB6001	Night Operations Review Examination	1.0	1.0	NVDB, 110TH AB	
34	8:30	9:30	616/NVDB	NVDB6005	AN/AVS-7 Operations IHUD Exam	1.0	1.0	NVDB, 110TH AB	
34	11:30	19:00	40144/Lowe AAF	H60M3605	Flight Training (Tac)	243.5	7.5	F CO, 1-212TH AVN	

UH-60M IP, 2C-F196/SQIC (UH-60M) Master Flow

(Select to Return to Table of Contents)

TD	Start Time	End Time	Building/Location	Lesson ID	Lesson Title	LSN Time	LSN BLK Time	Instructional Element	Remarks
35	7:30	8:30	9204/Learning Center	U3004495	Spatial Disorientation Rev (Comp-Based)	1.0	1.0	Self Paced	
35	8:30	9:30	9204/Learning Center	U3004496	Stress & Fatigue Rev (Comp-Based)	1.0	1.0	Self Paced	
35	9:30	10:30	9204/Learning Center	U3004517	Noise In Army Avn Rev (Comp-Based)	1.0	1.0	Self Paced	
35			5102/Goodhand	H60M3605	Flight Training (TBOS) (N)	243.5	7.5	F CO, 1-212TH AVN	
36	17:30	1:00	40144/Lowe AAF	H60M3605	Flight Training (N)	243.5	7.5	F CO, 1-212TH AVN	
37	17:30	1:00	40144/Lowe AAF	H60M3605	Flight Training (NVG)	243.5	7.5	F CO, 1-212TH AVN	
38	17:30	1:00	40144/Lowe AAF	H60M3605	Flight Training (NVG)	243.5	7.5	F CO, 1-212TH AVN	
39	17:30	1:00	40144/Lowe AAF	H60M3605	Flight Training (NVG)	243.5	7.5	F CO, 1-212TH AVN	
40	17:30	1:00	40144/Lowe AAF	H60M3605	Flight Training (NVG)	243.5	7.5	F CO, 1-212TH AVN	
41	17:30	1:00	40144/Lowe AAF	H60M3605	Flight Training (NVG)	243.5	7.5	F CO, 1-212TH AVN	
42	17:30	1:00	40144/Lowe AAF	H60M3605	Flight Training (NVG)	243.5	7.5	F CO, 1-212TH AVN	
43	17:30	1:00	40144/Lowe AAF	H60M3605	Flight Training (NVG)	243.5	7.5	F CO, 1-212TH AVN	
44	15:30	16:30	40144/Lowe AAF	H60M3900	Course Critique	9.0	1.0	F CO, 1-212TH AVN	
44	17:30	1:00	40144/Lowe AAF	H60M3603	NVG Flight Evaluation	7.5	7.5	F CO, 1-212TH AVN	
45	8:30	12:30	6225/1-13th AVN	H60M3900	Out-processing	9.0	4.0	C CO 1-13TH	
45	17:30	1:00	40144/Lowe AAF	H60M3605	Flight Training (NVG) No-Fly Wx Makeup	243.5	7.5	F CO, 1-212TH AVN	

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UH-60M MAINTENANCE TEST PILOT, 4D-SQIG (UH-60M), TRAINING SEQUENCE

(Select to Return to Table of Contents)

TD	Start Time	End Time	Location/Bldg	Lesson ID	Lesson Title	TTL LSN Time	LSN BLK Time	Instructional Element	Remarks
1	7:00	12:00	5700/SSC	H60M0006	Inprocessing	7.5	5.0	C Co, 1-13TH	
1	13:00	14:00	40146/Lowe AAF	H60M0004	Flight Commander/ALSE Brief	217.5	1.0	F Co, 1-212TH AVN	
1	14:00	18:00	40146/Lowe	H60M0005	UH-60M MTP Course Overview (MTP-T)	155.0	4.0	F Co, 1-	
1	16:00	17:00	40146/Lowe AAF	H60M0005	Limitations & Emergency Procedures Exam (5&9)	155.0	1.0	F Co, 1-212TH AVN	
2	7:00	11:00	40146/Lowe AAF	H60M0005	TMs, IETMs, MTF Manual	155.0	4.0	F Co, 1-212TH AVN	
2	12:30	16:30	40146/Lowe AAF	H60M0005	MTF REGS, UH60 PMD/PMS SYSTEM, ATM	155.0	4.0	F Co, 1-212TH AVN	
2	16:30	17:30	40146/Lowe AAF	H60M0005	Regulations PE	155.0	1.0	F Co, 1-212TH AVN	
3	9:30	14:30	40146/Lowe AAF	H60M0005	Electrical Power Supply & Distribution Systems	155.0	5.0	F Co, 1-212TH AVN	
3			5102/Goodhand	H60M0004	UH-60M MTP Flight Training (TBOS)	217.5	5.0	F Co, 1-212TH AVN	
4	9:30	13:30	40146/Lowe AAF	H60M0005	Electrical Power Supply & Distribution Systems	155.0	4.0	F Co, 1-212TH AVN	
4	13:30	14:30	40146/Lowe AAF	H60M0005	Electrical Power Supply & Distribution Systems PE	155.0	1.0	F Co, 1-212TH AVN	
4			5102/Goodhand	H60M0004	UH-60M MTP Flight Training (TBOS)	217.5	5.0	F Co, 1-212TH AVN	
5	9:00	12:00	40146/Lowe AAF	H60M0005	Serial Data Bus	155.0	3.0	F Co, 1-212TH AVN	
5	12:00	13:00	40146/Lowe AAF	H60M0005	Serial Data Bus PE	155.0	1.0	F Co, 1-212TH AVN	
5			5102/Goodhand	H60M0004	UH-60M MTP Flight Training (TBOS)	217.5	5.0	F Co, 1-212TH AVN	
6	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training (Ground Run)	217.5	5.5	F Co, 1-212TH AVN	
6	12:30	16:30	40146/Lowe AAF	H60M0005	FDS/MFD/FDDCP	155.0	4.0	F Co, 1-212TH AVN	
7	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training (Ground Run)	217.5	5.5	F Co, 1-212TH AVN	
7	12:30	16:30	40146/Lowe AAF	H60M0005	Master Warning/EICAS/DCU	155.0	4.0	F Co, 1-212TH AVN	
8	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training (Ground Run)	217.5	5.5	F Co, 1-212TH AVN	
8	12:30	16:30	40146/Lowe AAF	H60M0005	Flight Management System (FMS)/Embedded Global Positioning/Inertial Navigation System	155.0	4.0	F Co, 1-212TH AVN	
8	16:30	17:30	40146/Lowe AAF	H60M0005	Flight Management System (FMS) Lab	155.0	1.0	F Co, 1-212TH AVN	
9	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training (Ground Run)	217.5	5.5	F Co, 1-212TH AVN	
9	12:30	16:30	40146/Lowe AAF	H60M0005	Hydraulic System	155.0	4.0	F Co, 1-212TH AVN	
9	16:30	17:30	40146/Lowe AAF	H60M0005	Hydraulic System PE	155.0	1.0	F Co, 1-212TH AVN	

UH-60M MAINTENANCE TEST PILOT, 4D-SQIG (UH-60M), TRAINING SEQUENCE

(Select to Return to Table of Contents)

TD	Start Time	End Time	Location/Bldg	Lesson ID	Lesson Title	TTL LSN Time	LSN BLK Time	Instructional Element	Remarks
10	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training (Ground Run)	217.5	5.5	F Co, 1-212TH AVN	
10	12:30	16:30	40146/Lowe AAF	H60M0005	Flight Controls	155.0	4.0	F Co, 1-212TH AVN	
10	16:30	17:30	40146/Lowe AAF	H60M0005	Flight Controls PE	155.0	1.0	F Co, 1-212TH AVN	
11	7:30	9:00	40146/Lowe AAF	H60M0005	UH-60M Aircraft Systems Exam I (MTP)	155.0	1.5	F Co, 1-212TH AVN	
11	9:00	11:30	40146/Lowe AAF	H60M0005	Vibration Analysis	155.0	2.5	F Co, 1-212TH AVN	
11	12:30	16:30	40146/Lowe AAF	H60M0005	Vibration Analysis	155.0	4.0	F Co, 1-212TH AVN	
11	16:30	17:30	40146/Lowe AAF	H60M0005	IVHMS Vib Analysis and IVHMS Vib Analysis PE	155.0	1.0	F Co, 1-212TH AVN	
12	7:30	11:30	40146/Lowe AAF	H60M0005	IVHMS Condition Based Maintenance (CBM)	155.0	4.0	F Co, 1-212TH AVN	
12	12:30	16:30	40146/Lowe AAF	H60M0005	IVHMS Condition Based Maintenance (CBM)	155.0	4.0	F Co, 1-212TH AVN	
13	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training (Hover Demo)	217.5	5.5	F Co, 1-212TH AVN	
13	12:30	16:30	40146/Lowe AAF	H60M0005	Automatic Flight Control System (AFCS)	155.0	4.0	F Co, 1-212TH AVN	
14	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	5.5	F Co, 1-212TH AVN	
14	12:30	16:30	40146/Lowe AAF	H60M0005	Automatic Flight Control System (AFCS)	155.0	4.0	F Co, 1-212TH AVN	
14	16:30	17:30	40146/Lowe AAF	H60M0005	Automatic Flight Control System (AFCS) PE	155.0	1.0	F Co, 1-212TH AVN	
15	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	5.5	F Co, 1-212TH AVN	
15	12:30	16:30	40146/Lowe AAF	H60M0005	Main Rotor & Tail Rotor Groups	155.0	4.0	F Co, 1-212TH AVN	
15	16:30	17:30	40146/Lowe AAF	H60M0005	Main Rotor & Tail Rotor Groups PE	155.0	1.0	F Co, 1-212TH AVN	
16	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	5.5	F Co, 1-212TH AVN	
16	12:30	16:30	40146/Lowe AAF	H60M0005	Power Plant System	155.0	4.0	F Co, 1-212TH AVN	
17	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	5.5	F Co, 1-212TH AVN	
17	12:30	16:30	40146/Lowe AAF	H60M0005	Power Plant System	155.0	4.0	F Co, 1-212TH AVN	
17	16:30	17:30	40146/Lowe AAF	H60M0005	Power Plant System PE	155.0	1.0	F Co, 1-212TH AVN	
18	7:30	8:30	40146/Lowe AAF	H60M0005	Ground Support Equipment (GSE)	155.0	1.0	F Co, 1-212TH AVN	
18	9:30	11:30	40146/Lowe AAF	H60M0005	Aircraft Shipping, AGSE & PGSE - Mission Equipment	155.0	2.0	F Co, 1-212TH AVN	
18	12:30	16:30	40146/Lowe AAF	H60M0005	Engine Start Systems	155.0	4.0	F Co, 1-212TH AVN	
19	7:30	10:30	40146/Lowe AAF	H60M0005	Engine HIT, Max Power Check, Auto Check	155.0	3.0	F Co, 1-212TH AVN	
19	10:30	11:30	40146/Lowe AAF	H60M0005	HIT TEAC PE	155.0	1.0	F Co, 1-212TH AVN	

UH-60M MAINTENANCE TEST PILOT, 4D-SQIG (UH-60M), TRAINING SEQUENCE

(Select to Return to Table of Contents)

TD	Start Time	End Time	Location/Bldg	Lesson ID	Lesson Title	TTL LSN Time	LSN BLK Time	Instructional Element	Remarks
19	12:30	16:30	40146/Lowe AAF	H60M0005	Powertrain System	155.0	4.0	F Co, 1-212TH AVN	
19	16:30	17:30	40146/Lowe AAF	H60M0005	Powertrain System PE	155.0	1.0	F Co, 1-212TH AVN	
20	7:30	9:00	40146/Lowe AAF	H60M0005	UH-60M Aircraft Systems Exam II (MTP)	155.0	1.5	F Co, 1-212TH AVN	
20	9:00	11:30	40146/Lowe AAF	H60M0005	Auxiliary Power Unit (APU)	155.0	2.5	F Co, 1-212TH AVN	
20	12:30	14:30	40146/Lowe AAF	H60M0005	Auxiliary Power Unit (APU)	155.0	2.0	F Co, 1-212TH AVN	
20	14:30	15:30	40146/Lowe AAF	H60M0005	Auxiliary Power Unit (APU) PE	155.0	1.0	F Co, 1-212TH AVN	
20	15:30	17:30	40146/Lowe AAF	H60M0005	Electronic Standby Instrument System (ESIS)	155.0	2.0	F Co, 1-212TH AVN	
21	7:30	8:30	40146/Lowe AAF	H60M0005	Compass Swing PE	155.0	1.0	F Co, 1-212TH AVN	
21	08:30	13:00	40146/Lowe AAF	H60M0005	Airframe AVCS	155.0	4.5	F Co, 1-212TH AVN	
21			5102/Goodhand	H60M0004	UH-60M MTP Flight Training (TBOS)	217.5	5.0	F Co, 1-212TH AVN	
22	7:30	12:00	40146/Lowe AAF	H60M0005	Navigation & Communication Radios	155.0	4.5	F Co, 1-212TH AVN	
22	12:00	13:00	40146/Lowe AAF	H60M0005	Navigation & Communication Radios PE	155.0	1.0	F Co, 1-212TH AVN	
22			5102/Goodhand	H60M0004	UH-60M MTP Flight Training (TBOS)	217.5	5.0	F Co, 1-212TH AVN	
23	7:30	10:00	40146/Lowe AAF	H60M0005	Fuel System (CEFS)	155.0	2.5	F Co, 1-212TH AVN	
23	10:00	12:30	40146/Lowe AAF	H60M0005	Landing Gear	155.0	2.5	F Co, 1-212TH AVN	
23			5102/Goodhand	H60M0004	UH-60M MTP Flight Training (TBOS)	217.5	5.0	F Co, 1-212TH AVN	
24	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	5.5	F Co, 1-212TH AVN	
24	12:30	13:30	40146/Lowe AAF	H60M0005	Fuel System/Landing Gear PE	155.0	1.0	F Co, 1-212TH AVN	
24	16:00	17:00	40146/Lowe AAF	H60M0005	Fire/Utility System PE	155.0	1.0	F Co, 1-212TH AVN	
24	1330	2:30	40146/Lowe AAF	H60M0005	Utility System	155.0	2.5	F Co, 1-212TH AVN	
25	6:00	11:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	5.5	F Co, 1-212TH AVN	
25	12:30	15:00	40146/Lowe AAF	H60M0005	UH-60M Aircraft Systems Exam III (MTP)	155.0	2.5	F Co, 1-212TH AVN	
26	6:00	16:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	10.5	F Co, 1-212TH AVN	
27	6:00	16:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	10.5	F Co, 1-212TH AVN	
28	6:00	16:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	10.5	F Co, 1-212TH AVN	
29	6:00	16:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	10.5	F Co, 1-212TH AVN	
30	7:30	11:30	40146/Lowe AAF	H60M0005	IVHMS Condition Based Maintenance (CBM)	155.0	4.0	F Co, 1-212TH AVN	

UH-60M MAINTENANCE TEST PILOT, 4D-SQIG (UH-60M), TRAINING SEQUENCE

(Select to Return to Table of Contents)

TD	Start Time	End Time	Location/Bldg	Lesson ID	Lesson Title	TTL LSN Time	LSN BLK Time	Instructional Element	Remarks
30	12:30	16:30	40146/Lowe AAF	H60M0005	IVHMS Condition Based Maintenance (CBM)	155.0	4.0	F Co, 1-212TH AVN	
31	7:30	12:30	40146/Lowe AAF	H60M0004	IVHMS Condition Based Maintenance (CBM) PE	217.5	5.0	F Co, 1-212TH AVN	
31	12:30	16:30	40146/Lowe AAF	H60M0005	IVHMS Condition Based Maintenance (CBM)	155.0	4.0	F Co, 1-212TH AVN	
32	6:00	16:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	10.5	F Co, 1-212TH AVN	
33	6:00	16:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	10.5	F Co, 1-212TH AVN	
34	6:00	16:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	10.5	F Co, 1-212TH AVN	
35	6:00	16:30	40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training	217.5	10.5	F Co, 1-212TH AVN	
36	6:00	16:30	40146/Lowe AAF	H60M4600	UH-60M MTP Flight Evaluation	10.5	10.5	F Co, 1-212TH AVN	
37			40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training (No-Fly WX Make-Up)	217.5	10.5	F Co, 1-212TH AVN	
38			40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training (No-Fly WX Make-Up)	217.5	10.5	F Co, 1-212TH AVN	
39			40146/Lowe AAF	H60M0004	UH-60M MTP Flight Training (No-Fly WX Make-Up)	217.5	10.5	F Co, 1-212TH AVN	
39	14:30	15:30	40146/Lowe AAF	H60M0006	Course Critique	7.5	1.0	F Co, 1-212TH AVN	
40	15:30	17:00	5700/SSC	H60M0006	Outprocessing	7.5	1.5	C Co, 1-13TH AVN	

附錄 8　安援辦公室建議課程內容（民國 102 年）

NASC UH-60M Pilot Aircraft Qualification Course (AQC)						
The UH-60M AQC is conducted in five stages: STAGE I – Contact – students learn the basic aircraft skills, emergency operating procedures, and basic combat skills under day conditions. STAGE II – Instruments – students learn the skills required to operate under instrument meteorological conditions (IMC) and comply with local instrument flight rules (IFR) procedures. STAGE III – Terrain Flight – students learn terrain flight skills. STAGE IV – Night – student learn to perform contact stage tasks under night conditions.						
	Flight Hours					
Training Subject	S*	D	N	NVS	Total	Days/Weeks
STAGE I - Contact	4.5	10.2	-	-	14.7	13/2.6
STAGE II - Instruments	3	5.4	-	-	8.4	7/1.4
STAGE III – Terrain Flt	1.5	3.9	-	-	5.4	4/0.8
STAGE IV - Night	1.5	-	4	-	5.5	4/0.8
Total	10.5	19.5	4	-	34	28/5.6
*Training may be accomplished in a UH-60M aircraft if simulator is not available.						

Stage	Number	Tasks	OFT (hr)	ACFT (hr)	Total
STAGE I Contact	1000	Participate in a crew mission briefing	4.5	10.2	14.7
	1010	Prepare a performance planning card			
	1011	Determine aircraft performance using tabular data			
	1012	Verify aircraft weight and balance			
	1013	Operate mission planning system			
	1014	Operate aviation life support equipment			
	1020	Prepare aircraft for mission			
	1022	Perform preflight inspection			
	1024	Perform before-starting-engine through before-leaving helicopter checks			
	1025	Operate integrated vehicle health monitoring system			
	1026	Maintain airspace surveillance			
	1028	Perform hover power check			
	1032	Perform radio communication procedures			
	1034	Perform ground taxi			
	1038	Perform hovering flight			

NASC UH-60M AQC (continued)					
Stage	Number	Tasks	OFT	ACFT	Total
STAGE I Contact (con't)	1040.01	Perform a constant angle VMC takeoff			
	1040.03	Perform a level acceleration VMC takeoff			
	1040.04	Perform a rolling VMC takeoff			
	1052	Perform VMC flight maneuvers			
	1058	Perform VMC approach			
	1064	Perform a roll-on landing			
	1068	Perform go-around			
	1070	Respond To Emergencies			
	1070.02	Respond To Engine Failure At A Hover			
	1070.03	Respond To Engine Failure At Curse Flight			
	1070.04	Respond to a AFCS Malfunction			
	1070.05	Respond To Decreasing RPM R Or Nr			
	1070.06	Respond To Stabilizer Malfunction			
	1142	Perform digital communications			
	1162	Perform emergency egress			
	1082	Perform Autorotation			
	1190	Perform hand and arm signals			
	1194	Perform refueling operations			
	1253	Operate flight management system/central display unit			
	1254	Operate multifunction display			
	1260	Operate digital map			
	1262	Participate in a crew-level after action review			
	3100	Perform Np over speed protection			
	3101	Perform TGT limiting			
	3006	Oral knowledge			
STAGE II IMC/ IFR	1006	Plan an instrument flight rules flight	3	5.4	8.4
	1046	Perform electronically aided navigation			
	1142	Perform digital communication			
	1148	Perform fuel management procedures			
	1166	Perform instrument maneuvers			

NASC UH-60M AQC (continued)					
Stage	Number	Tasks	OFT	ACFT	Total
STAGE II IMC/ IFR (con't)	1167	Perform flight maneuvers using standby instrument system			
	1169	Perform flight director operations			
	1170	Perform instrument takeoff			
	1174	Perform holding procedures			
	1176	Perform non-precision approach (coupled)			
	1178	Perform precision approach (coupled)			
	1178.01	Perform precision approach (non-coupled)			
	1180	Perform emergency GPS recovery procedure			
	1182	Perform Unusual Attitude Recovery			
	1184	Respond to inadvertent instrument meteorological conditions (IMC)			
STAGE III Terrain Flt	1016	Perform internal load operations	1.5	3.9	5.4
	1040.02	Perform a vertical VMC takeoff			
	1044	Navigate by pilotage and dead reckoning			
	1054	Select landing zone/pickup zone/holding area			
	1062	Perform slope operations			
	1114	Perform a rolling takeoff			
	1155	Negotiate wire obstacles			
	2024	Perform terrain flight navigation			
	2026	Perform terrain flight			
	2036	Perform terrain flight deceleration			
STAGE IV Night	----	Perform STAGE I Tasks at Night	1.5	4.0	5.5
	1182	Perform Unusual Attitude Recovery			
	1184	Respond to inadvertent instrument meteorological conditions (IMC)			
AQC TOTAL HOURS			10.5	23.5	34

NASC UH-60M Crew Member Course (CMC)						
The UH-60M CMC trains Aircraft Repairers to perform in-flight crew member duties and is conducted in two stages: STAGE I – Day – students learn the crew member basic aircraft skills and emergency operating procedures under day conditions. STAGE II – Night – students learn to perform STAGE I tasks under night conditions.						
	Flight Hours					
Training Subject	S	D	N	NVG	Total	Days/Weeks
STAGE I - Day	-	6	-	-	6	4/0.8
STAGE V – Night	-	-	2	-	2	2/0.4
Total	-	6	2	-	8	6/1.2
*Training may be accomplished in a UH-60M aircraft if simulator is not available.						

Stage	Number	Tasks	OFT (hr)	ACFT (hr)	Total
STAGE I Day	1000	Participate in a crew mission briefing	-	6	6
	1014	Operate aviation life support equipment			
	1016	Perform internal load operations			
	1020	Prepare aircraft for mission			
	1022	Perform preflight inspection			
	1024	Perform before-starting-engine through before-leaving helicopter checks			
	1026	Maintain airspace surveillance			
	1032	Perform radio communications procedures			
	1038	Perform hovering flight			
	1040	Perform a VMC takeoff			
	1148	Perform fuel management procedures			
	1052	Perform VMC flight maneuvers			
	1058	Perform VMC approach			
	1062	Perform slope operations			
	1070	Respond To Emergencies			
	1162	Perform emergency egress			
	1190	Perform hand and arm signals			
	1194	Perform refueling operations			
	1262	Participate in a crew-level after action review			
	3006	Oral knowledge			

NASC UH-60M CMC (continued)					
Stage	Number	Tasks	OFT	ACFT	Total
STAGE II Night	----	Perform STAGE I Tasks under Night conditions	-	2	2
CMC TOTAL HOURS			-	8	8

NASC UH-60M Special Mission Training (SMT)						
The UH-60M SMT trains Pilots and Crew Members to perform special mission tasks and is conducted in four stages: STAGE I – Low Altitude Search and Rescue STAGE II – Aerial Firefighting STAGE III – Overwater Search and Rescue STAGE IV – High Altitude Flight The purpose of the training is to train fully mission qualified, integrated UH-60M crews.						
	Flight Hours					
Training Subject	S	D	N	NVG	Total	Days/Weeks
STAGE I – Low Alt	-	8	-	-	8	5/1.0
STAGE II – Firefighting	-	4	-	-	4	3/0.6
STAGE III - Overwater	-	4	4	-	8	4/0.8
STAGE IV – High Alt.	2	8		-	10	5/1.0
Total	2	24	4	-	30	17/3.4
*Training may be accomplished in a UH-60M aircraft if simulator is not available.						

Stage	Number	Tasks	OFT (hr)	ACFT (hr)	Total
STAGE I Low Altitude SAR	1000	Participate in a crew mission briefing	-	8	8
	1013	Operate mission planning system			
	1016	Perform internal load operations			
	1020	Prepare aircraft for mission			
	1024	Perform before-starting-engine through before-leaving helicopter checks			
	1026	Maintain airspace surveillance			
	1040	Perform a VMC takeoff			
	1148	Perform fuel management procedures			
	1052	Perform VMC flight maneuvers			
	1054	Select LZ/PZ/HA			
	1155	Negotiate wire obstacles			
	1058	Perform VMC approach			
	1062	Perform slope operations			
	1070	Respond To Emergencies			
	1184	Respond to inadvertent instrument IMC			
	1190	Perform hand and arm signals			
	1262	Participate in a crew-level after action review			
	2010	Perform multiaircraft operations			

NASC UH-60M SMT (continued)					
Stage	Number	Tasks	OFT	ACFT	Total
STAGE I Low Altitude SAR (con't)	2012	Perform tactical flight mission planning			
	2014	Perform ECM/ECCM procedures			
	2024	Perform terrain flight navigation			
	2026	Perform terrain flight			
	2036	Perform terrain flight deceleration			
	2048	Perform sling load operations			
	2054	Perform fast-rope insertion and extraction system operations			
	2060	Perform rescue hoist operations			
	3006	Oral knowledge			
ST. II Firefight.	2052	Perform water bucket operations	-	4	4
	----	Conduct aerial firefighting procedures			
STAGE III Overwater	1014	Operate aviation life support equipment	-	8	8
	1162	Perform emergency egress			
	2010	Perform multiaircraft operations			
	2060	Perform rescue hoist operations			
	----	Perform search and rescue procedures			
STAGE IV High Alt	----	Perform high altitude operations	2	8	10
	----	Conduct power management techniques			
	2060	Perform rescue hoist operations			
	3006	Oral knowledge			
SMT TOTAL HOURS			2	28	30

NASC 6 UH-60M Special Equipment Training (SET)						
The UH-60M SMT trains Pilots and Crew Members to perform special NASC 6 equipment tasks in a single overwater stage: STAGE I – Special Equipment Tasks (Overwater)						
	Flight Hours					
Training Subject	S	D	N	NVG	Total	Days/Weeks
STAGE I – Spec. Equip.	-	3	5	-	8	10/2.0
*Training may be accomplished in a UH-60M aircraft if simulator is not available.						

Stage	Number	Tasks	OFT (hr)	ACFT (hr)	Total
STAGE I Special Equip. Tasks	----	Operate the D1000A SATCOM radio	-	8	8
	----	Operate the ARS-6(V)12 Personnel Locator System			
	----	Operate the 701A Weather Radar			
	----	Operate the Star Safire III Forward Looking Infrared (FLIR) system			
	----	Operate the Primus Night Sun searchlight			
	----	Perform Mark-on-Top SAR approach			
SET TOTAL HOURS			-	8	8

NASC UH-60M Instructor Pilot Course (IPC)						
The UH-60M IPC is conducted in three stages: STAGE I – Contact – students learn to instruct and evaluate the basic aircraft skills and emergency operating procedures under day and instrument meteorological conditions (IMC) conditions. STAGE II – Mission Skills - students learn to instruct and evaluate the mission skills. STAGE III – Night – students learn to instruct and evaluate contact stage tasks under night conditions.						
	Flight Hours					
Training Subject	S	D	N	NVS	Total	Days/Weeks
STAGE I – Contact/Inst	9	20	-	-	29.0	29/5.8
STAGE II – Mission	1.5	5.9	-	-	7.4	5/1.0
STAGE III - Night	1.5	-	2.5	-	4.0	2/0.4
Total	12.0	25.9	2.5	-	40.4	36/7.2
*Training may be accomplished in a UH-60M aircraft if simulator is not available.						

Stage	Number	Tasks	OFT (hr)	ACFT (hr)	Total
STAGE I Contact & Inst.	1000	Participate in a crew mission briefing	9	20	29
	1001	Administer a flight evaluation			
	1003	Conduct flight instruction			
	1004	Plan a visual flight rules flight			
	1006	Plan an instrument flight rules flight			
	1010	Prepare a performance planning card			
	1012	Verify aircraft weight and balance			
	1014	Operate aviation life support equipment			
	1016	Perform internal load operations			
	1020	Prepare aircraft for mission			
	1022	Perform preflight inspection			
	1024	Perform before-starting-engine through before-leaving helicopter checks			
	1025	Operate integrated vehicle health monitoring system			
	1026	Maintain airspace surveillance			
	1028	Perform hover power check			
	1032	Perform radio communication procedures			
	1034	Perform ground taxi			

NASC UH-60M IPC (continued)					
Stage	Number	Tasks	OFT	ACFT	Total
STAGE I Contact & Inst. (con't)	1038	Perform hovering flight			
	1040.01	Perform a constant angle VMC takeoff			
	1040.03	Perform a level acceleration VMC takeoff			
	1040.04	Perform a rolling VMC takeoff			
	1046	Perform electronically aided navigation			
	1052	Perform VMC flight maneuvers			
	1058	Perform VMC approach			
	1064	Perform a roll-on landing			
	1068	Perform go-around			
	1070	Respond To Emergencies			
	1070.02	Respond To Engine Failure At A Hover			
	1070.03	Respond To Engine Failure At Curse Flight			
	1070.04	Respond to a AFCS Malfunction			
	1070.05	Respond To Decreasing RPM R Or Nr			
	1070.06	Respond To Stabilizer Malfunction			
	1142	Perform digital communications			
	1162	Perform emergency egress			
	1082	Perform Autorotation			
	1142	Perform digital communication			
	1148	Perform fuel management procedures			
	1166	Perform instrument maneuvers			
	1167	Perform flight maneuvers using standby instrument system			
	1169	Perform flight director operations			
	1170	Perform instrument takeoff			
	1174	Perform holding procedures			
	1176	Perform non-precision approach (coupled)			
	1178	Perform precision approach (coupled)			
	1178.01	Perform precision approach (non-coupled)			
	1180	Perform emergency GPS recovery procedure			
	1182	Perform Unusual Attitude Recovery			
	1184	Respond to inadvertent instrument meteorological conditions (IMC)			
	1188	Operate aircraft survivability equipment			
	1190	Perform hand and arm signals			

NASC UH-60M IPC (continued)					
Stage	Number	Tasks	OFT	ACFT	Total
STAGE I Contact & Inst. (con't)	1194	Perform refueling operations			
	1253	Operate flight management system/central display unit			
	1254	Operate multifunction display			
	1260	Operate digital map			
	1262	Participate in a crew-level after action review			
	3006	Oral knowledge			
	3100	Perform/demonstrate Np over speed protection			
	3101	Perform/demonstrate TGT limiting			
	3102	Demonstrate the stabilator functions			
	3103	Perform/initiate a stabilator malfunction			
	3104	Perform/initiate an engine fire emergency			
	3105	Perform/initiate a simulated engine failure at a hover			
	3106	Perform/initiate a simulated engine failure at cruise flight			
	3107	Perform/Initiate a Flight With Automatic Flight Control System (AFCS) Off Malfunction			
	3108	Perform/Initiate a Electronic Control Unit/Digital Electronic Control (ECU/DEC) Malfunction			
STAGE II Mission Skills	1013	Operate mission planning system	1.5	5.9	7.4
	1016	Perform internal load operations			
	1040.02	Perform a vertical VMC takeoff			
	1044	Navigate by pilotage and dead reckoning			
	1054	Select landing zone/pickup zone/holding area			
	1062	Perform slope operations			
	1114	Perform a rolling takeoff			
	1155	Negotiate wire obstacles			
	2024	Perform terrain flight navigation			
	2026	Perform terrain flight			
	2034	Perform masking and unmasking			
	2036	Perform terrain flight deceleration			

NASC UH-60M IPC (continued)					
Stage	Number	Tasks	OFT	ACFT	Total
STAGE II Mission Skills (con't)	2048	Perform sling load operations			
	2054	Perform fast-rope insertion and extraction system operations			
	2052	Perform water bucket operations			
	2060	Perform rescue hoist operations			
	----	Conduct aerial firefighting procedures			
	----	Conduct search and rescue procedures			
STAGE III Night	----	Perform STAGE I Tasks at Night	1.5	2.5	4.0
	1182	Perform Unusual Attitude Recovery			
	1184	Respond to inadvertent instrument meteorological conditions (IMC)			
IPC TOTAL HOURS			12	37	49

NASC UH-60M Maintenance Test Pilot Course (MTPC)					
The UH-60M MTPC is conducted in a single stage.					
	Flight Hours				
Training Subject	S*	D	Ground Run/OFT*	Total	Days/Weeks
Maintenance Tasks	9	28	19.5 (non-flight)	56.5 (35 flight)	35/7.0
*Training may be accomplished in a UH-60M aircraft if simulator is not available.					

Stage	Number	Tasks	GR/OFT (hr)	ACFT (hr)	Total
Maint. Tasks	1000	Participate in a Crew Mission Briefing	28.5	28.0	56.5
	1010	Prepare a Performance Planning Card (PPC)			
	1012	Verify Aircraft Weight and Balance			
	1022	Perform Preflight Inspection			
	1026	Maintain Airspace Surveillance			
	1028	Hover Power Check			
	1034	Perform Ground Taxi			
	1038	Perform Hovering Flight			
	1040	Perform Visual Meteorological Conditions (VMC) Takeoff			
	1048	Perform Fuel Management Procedures			
	1058	Perform Visual Meteorological Conditions (VMC) Approach			
	1070	Respond to Emergencies			
	3113	Dual Generator Failure (Demo)			
	3114	#2 Pitch Rate Gyro (Demo)			
	3115	APU T-handle (Demo)			
	4000	Perform prior to maintenance test flight checks			
	4000.01	Forms and Records			
	4000.02	Conduct a Maintenance Test Flight			
	4004	Perform Interior Checks			
	4081	Perform before-starting-engine checks			
	4081.01	Perform Starting Auxiliary Power Unit (APU) Checks			
	4081.02	Perform Caution Advisory/Master Warning Check			
	4081.03	Perform CDU/PDU Check			

NASC UH-60M MTPC (continued)					
Stage	Number	Tasks	OFT	ACFT	Total
Maint. Tasks (con't)	4081.04	Perform Photocell Sensitivity Check			
	4081.05	Perform Stabilator Audio Warning Priority Check			
	4081.06	Perform Heater/Ventilation System Check			
	4081.07	Perform Windshield Wiper System Operating Check			
	4081.08	Perform Cyclic Forward Stop Check			
	4081.09	Perform Primary Servo Check			
	4081.10	Perform Boost Servo Check			
	4081.11	Perform Collective Friction Check			
	4081.12	Perform Tail Rotor Servo Check			
	4081.13	Perform AFCS Computer Check (Demo)			
	4081.14	Perform AFCC Computer Check (Demo)			
	4081.16	Perform Flight Control Breakout Forces Checks			
	4081.17	Perform Trim Check			
	4081.18	Perform Cyclic Force Gradient Check			
	4081.19	Perform Cyclic Trim Check			
	4081.20	Perform Cyclic Force Check			
	4081.21	Perform Yaw Pedal Force Gradient Check			
	4081.22	Perform Yaw Pedal Trim Check			
	4081.23	Perform Damping Forces Check			
	4081.24	Perform Beep Trim Check			
	4081.25	Perform Beep Timing Check			
	4081.26	Perform Collective to Yaw Electronic Coupling Check			
	4081.27	Perform FPS Heading Hold Check			
	4081.28	Perform Stabilator Checks			
	4081.29	Perform Fuel Quantity Indicator Checks			
	4081.30	Perform Barometric Altimeter Check			
	4081.31	Perform Radar Altimeter Check			
	4081.32	Perform Fire Detection System Checks			
	4081.33	Perform Windshield Anti-ice and Backup Pump Interlock Checks.			
	4081.34	Perform Pitot Heat System Check			
	4081.35	Perform Fuel Boost Pump Checks			

NASC UH-60M MTPC (continued)					
Stage	Number	Tasks	OFT	ACFT	Total
Maint. Tasks (con't)	4088	Perform starting engine checks			
	4088.01	Perform Engine Starter/Air Start Valves/Automatic Fuel Prime Checks			
	4088.02	Perform Engine Abort System and Heater Dropout Check			
	4088.03	Perform Engine Start			
	4088.04	Perform Hydraulic Leak System Check			
	4090	Perform engine run-up and systems checks			
	4090.01	Perform Engine Overspeed System Test			
	4090.02	Perform ECU Lockout/Np Overspeed RPM Check			
	4090.03	Perform Torque Matching Check			
	4090.04	Perform Acceleration/Deceleration Check			
	4090.05	Perform Under-frequency Protection Test			
	4090.06	Perform AC System Primary Bus Tie Connector Test			
	4090.07	Perform AC System Essential Bus Tie Connector Test			
	4090.08	Perform DC System Bus Tie Connector Test			
	4090.09	Perform Systems Instruments Check			
	4090.10	Perform Brakes/Tail wheel Lock Check			
	4090.11	Perform Health Indicator Test (HIT)/Baseline Bleed Air and Anti-ice Checks			
	4113	Perform integrated vehicle health monitoring system operations (IVHMS)			
	4156	Perform hover checks			
	4156.02	Perform SAS Check			
	4156.03	Perform FPS Check			
	4193	Perform in flight checks			
	4193.01	Perform Takeoff and Climb Checks			
	4193.02	Perform In-flight Controllability Check			
	4193.03	Perform Cruise Stabilator Checks			
	4193.04	Perform FPS/SAS Checks			
	4193.05	Perform Beep Trim Check			
	4193.06	Perform Attitude/Airspeed Check			

NASC UH-60M MTPC (continued)					
Stage	Number	Tasks	OFT	ACFT	Total
Maint. Tasks (con't)	4193.07	Perform Communication and Navigation Equipment – Airborne Checks/Flight Instruments Checks			
	4200	Perform backup tail rotor servo check			
	4202	Perform generator under frequency protection disable/low rotor revolutions per minute checks			
	4204	Perform compasses, turn rate, and vertical gyros checks			
	4220	Perform maximum power check			
	4220.03	Perform Maximum Power Check (T-701D) (Demo Only)			
	4228	Perform vibration absorber check and tuning			
	4236	Perform autorotation revolutions per minute check			
	4252	Perform Vibration Analysis Check.			
	4254	Perform Vh check			
	4284	Perform engine shutdown checks			
	4288	Perform gust lock/rotor brake operations			
MTPC TOTAL HOURS			30	14	44

附錄 9　安援辦公室建議課程內容（民國 103 年）

2.1.1.1.2.1.1 Transition Pilot Training Course:

Course Module	Duration：20 Days
Ground School	58 hours
Crew Resource Management(CRM)	2 hours
Flight Procedural Trainer	7.5 hours
Briefing/Debriefing	20 hours
External Power/APU(Aircraft)	2.5 hours
Ground Run(Aircraft)	2.5 hours
Simulator(PIC and Copilot Flying)	15 hours
Aircraft(Flying)	5 hours
Aircraft Night Visual Flight (Flying)	4 hours
Total	**116.5 hours**

2.1.1.1.2.1.2 Instrument Procedural Pilots Course:

Course Module	Duration：5 Days
Ground School	14 hours
Crew Resource Management(CRM)	1 hours
Briefing/Debriefing	5 hours
Simulator(PIC and Copilot Flying)	7.5 hours
Total	**27.5 hours**

2.1.1.1.2.1.3 Emergency Procedural Pilot:

Course Module	Duration：5 Days
Ground School	14 hours
Crew Resource Management(CRM)	1 hours
Briefing/Debriefing	5 hours
Simulator(PIC and Copilot Flying)	7.5 hours
Total	**27.5 hours**

2.1.1.1.2.1.4 Advance Maneuvers Pilot:

Course Module	Duration：15 Days
Ground School	35 hours
Crew Resource Management(CRM)	1 hours
Flight Procedural Trainer	3 hours
Briefing/Debriefing	15 hours
External Power/APU(Aircraft)	5 hours
Ground Run(Aircraft)	5 hours

Simulator(PIC and Copilot Flying)	4.5 hours
Confined Area Landing(Flying)	2 hours
Low Level Flight(Flying)	2 hours
Navigation and Route Planning (Flying)	2 hours
Offshore SAR Procedural and skills (Flying)	4 hours
Total	**78.5 hours**

2.1.1.1.2.2 Instructor Pilot: about 2 weeks:

Course Module	**Duration：10 Days**
Ground School	28 hours
Crew Resource Management(CRM)	2 hours
Briefing/Debriefing	10 hours
External Power/APU(Aircraft)	2.5 hours
Ground Run(Aircraft)	2.5 hours
Simulator(PIC and Copilot Flying)	7.5 hours
Aircraft(Flying)	5 hours
Total	**57.5 hours**

2.1.1.1.2.3 Maintenance Test Pilot Training Course: about 3 weeks:

Course Module	**Duration：15 Days**
Ground School	43 hours
Crew Resource Management(CRM)	2 hours
Briefing/Debriefing	15 hours
External Power/APU(Aircraft)	8 hours
Ground Run(Aircraft)	5 hours
Simulator(PIC and Copilot Flying)	4.5 hours
Aircraft(Flying)	10 hours
Total	**87.5 hours**

附錄 10　第一年第 1 梯次訓練課程表

日　　　期	班　　　別	訓　練　機　構
2015 年 4 月 11 日~5 月 06 日	Initial Pilot	FlightSafety
2015 年 5 月 09 日~5 月 20 日	Pilot Transition Course	塞考斯基訓練中心
2015 年 5 月 23 日~5 月 27 日	Instrument Procedures	FlightSafety
2015 年 5 月 31 日~6 月 06 日	Emergency Procedures	FlightSafety
2015 年 6 月 07 日~6 月 14 日	Mission Equipment Course	塞考斯基訓練中心
2015 年 6 月 05 日~6 月 28 日	Instructor Pilot Course	FlightSafety
2015 年 6 月 29 日~7 月 13 日	Instructor Pilot Course	塞考斯基訓練中心
2015 年 7 月 14 日~7 月 27 日	Maintenance Pilot Course	FlightSafety
2015 年 7 月 28 日~8 月 10 日	Maintenance Pilot Course	塞考斯基訓練中心

AQC 訓練包含：Initial Pilot, Pilot Transition Course, Instrument Procedures, Emergency Procedures 及 Mission Equipment Course

1. FlightSafety Initial Pilot：2 週的地面學科及 2 週的模擬機。地面學科 66 小時任務提示/歸詢 15 小時、模擬機每人正駕駛時間 20 小時/副駕駛時間 20 小時。

Ground Training Curriculum

Aircraft General	Main Rotor and Hub	Kits and Accessories
Aircraft Lighting and Master Warning	Tail Rotor and Hub	Systems Review, Examination and Critique
Electrical	Hydraulics	Weight and Balance
Auxiliary Power Unit (APU)	Landing Gear and Brakes	Performance
Fuel	Flight Controls	Flight Planning
Powerplant	Automatic Flight Control System and Stabilator	Approved RFM/ROM
Ice and Rain Protection	Avionics	Adverse Weather
Fire Protection	Command Instrument System	CRM / ADM / Risk Management
Powertrain	Environmental	Systems Integration

Ground Training Hours: 66.00
Briefing/Debriefing Hours: 15.00

2. 塞考斯基訓練中心 Pilot Transition Course：實體機飛行課程 2 週，每人飛行 1(小時。

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Day 1 Lesson 1 Introduction Aircrew Coordination Brief 1.0 hrs Preflight 1.0 hrs Grd run Grd run Debrief 0.5 hrs	Day 2 Lesson 2 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.2 hrs Flight 2 – 1.2 hrs Debrief 0.5 hrs	Day 3 Lesson 3 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.2 hrs Flight 2 – 1.2 hrs Debrief 0.5 hrs	Day 4 Lesson 4 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.2 hrs Flight 2 – 1.2 hrs Debrief 0.5 hrs	Day 5 Lesson 5 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.2 hrs Flight 2 – 1.2 hrs Debrief 0.5 hrs	
	Day 6 Lesson 6 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.3 hrs Flight 2 – 1.3 hrs Debrief 0.5 hrs	Day 7 Lesson 7 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.3 hrs Flight 2 – 1.3 hrs Debrief 0.5 hrs	Day 8 Lesson 8 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.3 hrs Flight 2 – 1.3 hrs Debrief 0.5 hrs	Day 9 Lesson/Evaluation 9 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.3 hrs Flight 2 – 1.3 hrs Debrief 0.5 hrs	Day 10 Flex day for Weather or Maintenance Delays	

3. FlightSafety Instrument Procedures:模擬機儀器程序專精課程 1 週。地面學科 13.5 小時、任務提示/歸詢 7.5 小時,模擬機每人正駕駛時間 8 小時/副駕駛時間 8 小時。

4. FlightSafety Emergency Procedures: 模擬機緊急程序專精課程 1 週。地面學科 13.5 小時、任務提示/歸詢 7.5 小時，模擬機每人正駕駛時間 8 小時/副駕駛時間 10 小時/後座觀察員 8 小時

5. 塞考斯基訓練中心 Pilot Mission Equipment Course:實體機任務裝備課程 1 週，每人飛行 5 小時。

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Day 1 Lesson 1 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.2hrs Flight 2 – 1.2 hrs Debrief 0.5 hrs	Day 2 Lesson 2 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.3 hrs Flight 2 – 1.3 hrs Debrief 0.5 hrs	Day 3 Lesson 3 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.2 hrs Flight 2 – 1.2 hrs Debrief 0.5 hrs	Day 4 Lesson 4 Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.3 hrs Flight 2 – 1.3 hrs Debrief 0.5 hrs	Day 5 FLEX DAY	

(二)教官班訓練：2015 年 6 月 05 日~7 月 13 日

1. FlightSafety Instructor Pilot Course：2 週的地面學科及 2 週的模擬機。地面學科 42 小時，任務提示/歸詢 15 小時，模擬機每人正駕駛時間 10 小時/副駕駛時間 10 小時。

2. 塞考斯基訓練中心 Instructor Pilo Course：實體機飛行課程 2 週，每人飛行 10 小時。

Day 1 Lesson 1 Introduction Brief 1.0 hrs Preflight 0.5 hrs Flight 1 – 1.2 hrs Flight 2 – 1.2 hrs Debrief 0.5 hrs	Day 2 Lesson 2 Brief 0.5 hrs Preflight 0.5 hrs Flight 1 – 1.2 hrs Flight 2 – 1.2 hrs Debrief 0.5 hrs	Day 3 Lesson 3 Brief 0.5 hrs Preflight 0.5 hrs Flight 1 – 1.2 hrs Flight 2 – 1.2 hrs Debrief 0.5 hrs	Day 4 Lesson 4 Brief 0.5 hrs Preflight 0.5 hrs Flight 1 – 1.2 hrs Flight 2 – 1.2 hrs Debrief 0.5 hrs	Day 5 Lesson 5 Brief 0.5 hrs Preflight 0.5 hrs Flight 1 – 1.3 hrs Flight 2 – 1.3 hrs Debrief 0.5 hrs
Day 6 Lesson 6 Brief 0.5 hrs Preflight 0.5 hrs Flight 1 – 1.3 hrs Flight 2 – 1.3 hrs Debrief 0.5 hrs	Day 7 Lesson 7 Brief 0.5 hrs Preflight 0.5 hrs Flight 1 – 1.3 hrs Flight 2 – 1.3 hrs Debrief 0.5 hrs	Day 8 Lesson/Evaluation 8 Brief 0.5 hrs Preflight 0.5 hrs Flight 1 – 1.3 hrs Flight 2 – 1.3 hrs Debrief 0.5 hrs	Day 9 Flex day for Weather or Maintenance Delays	Day 10 Flex day for Weather or Maintenance Delays

(三)試飛官班：2015 年 7 月 14 日~8 月 10 日

1. FlightSafety Maintenance Pilot Course：2 週的地面學科及 2 週的模擬機。地面學科 42 小時，任務提示/歸詢 15 小時，模擬機每人正駕駛時間 10 小時/副駕駛時間 10 小時。
2. 塞考斯基訓練中心 Maintenance Pilot Course：實體機飛行課程 2 週，每人飛行 10 小時。

Lesson	Aircraft Config.	Subject	Flight Time	Ground Time	Briefing/ Academic Time
1	Optional	Preflight; all ground checks through HIT check (Plan one-half day for two students).	None	3.0 hrs.	2.0 hrs.
2	Optional	Full ATP Demo, short vibration checks (Basic FDDCP, Auto RPM, MAX PWR)	1.5 hrs.	2.0 hrs.	2.0 hrs.
3	Optional	2nd ATP Demo, short vibration checks (Full FDDCP, Auto RPM, MAX PWR)	1.5 hrs.	2.0 hrs.	2.0 hrs.
4	Optional	Full 1/P data acquisition flight (Basic FDDCP, Auto RPM, MAX PWR) IVHUMS HIT and IVHUMS ENG Checks	1.5 hrs.	2.0 hrs.	2.0 hrs.
5	Optional	Avionics check flight; all BIT checks, all FD modes, VOR accuracy, ILS from 45° intercept and Max PWR	1.5 hrs.	1.0 hrs.	2.0 hrs.
6	Optional	Full 1/P data acquisition flight (Basic FDDCP, Auto RPM, MAX PWR) IVHUMS HIT and IVHUMS ENG Checks	1.5 hrs.	2.0 hrs.	2.0 hrs.
7	Optional	Avionics check flight; all BIT checks, all FD modes, VOR accuracy, ILS from 45° intercept and Max PWR	1.5 hrs.	2.0 hrs.	2.0 hrs.
8	Optional	Review / Evaluation	1.0 hrs.	1.0 hrs.	1.0 hrs.
		Total Time	**10.0 hrs.**	**15.0 hrs.**	**15.0 hrs.**

以上為第 1 年第 3 批之訓練內容

附錄 11　第二年訓練課程表

AQC 課表

第 2 年第 1 批 AQC（事故機正副駕駛）

UH-60M Training Sequence

This Course Management Plan contains the recommended training sequence (student schedule). Individual units/organizations may adjust training location and/or the order in which lessons are administered to accommodate weather, maintenance, or other similar scheduling issues as long as the Course Map (Mandatory Training Sequence) is not violated. Academic hours, lesson content, academic/flight evaluations, tasks, flight hours, and simulator hours CAN NOT be altered.

TD	Start Time	End Time	Bldg/Location	Lesson ID	Lesson Title	LSN Time	LSN BLK Time	Instructional Element	Remarks
001	7:00	9:00	KLNA, Hanger 807		UH-60M Systems Academics (Introduction/Airframe)	2.0	2.0		
001	9:00	12:00	KLNA, Hanger 807		UH-60M Systems Academics (Crew Station Configuration/Seats)	3.0	3.0		
001	13:00	16:00	KLNA, Hanger 807		UH-60M Systems Academics (F/MDS - MFD I)	12.0	3.0		
002	7:00	10:00	KLNA, Hanger 807		UH-60M Systems Academics (F/MDS - MFD II)	12.0	3.0		
002	10:00	12:00	KLNA, Hanger 807		UH-60M Systems Academics (FMS I)	7.5	2.0		
002	13:00	16:00	KLNA, Hanger 807		UH-60M Systems Academics (FMS II)	7.5	3.0		
003	7:00	10:00	KLNA, Hanger 807		UH-60M Systems Academics (FD/DCP I)	6.0	3.0		
003	10:00	12:00	KLNA, Hanger 807		UH-60M Systems Academics (FD/DCP II)	6.0	3.0		
003	13:00	14:00	KLNA, Hanger 807		UH-60M Systems Academics (Data Transfer System - DTS)	1.0	1.0		
003	14:00	16:00	KLNA, Hanger 807		UH-60M Systems Academics (F/MDS - Tac Display))	12.0	3.0		
004	0:00	0:00	KLNA, Hanger 807		UH-60M Aircraft Systems Examination I	2.0	2.0		
004	7:00	10:00	KLNA, Hanger 807		UH-60M Systems Academics (Performance Planning)	12.0	3.0		
004	10:00	12:00	KLNA, Hanger 807		UH-60M Systems Academics (Limitations and Indications)	3.0	3.0		
004	13:00	16:00	KLNA, Hanger 807		UH-60M Systems Academics (Engines I)	3.0	3.0		
005	7:00	10:00	KLNA, Hanger 807		UH-60M Systems Academics (Engines I)	6.0	3.0		
005	10:00	12:00	KLNA, Hanger 807		UH-60M Systems Academics (Engines II)	6.0	3.0		
005	13:00	16:00	KLNA, Hanger 807		UH-60M Systems Academics (Flight Controls & Hydraulics I)	9.0	3.0		
006	7:00	10:00	KLNA, Hanger 807		UH-60M Systems Academics (Flight Controls & Hydraulics II)	9.0	3.0		

006	10:00	12:00	KLNA, Hanger 807		UH-60M Systems Academics (Flight Controls & Hydraulics III)	9.0	3.0		
006	13:00	16:00	KLNA, Hanger 807		UH-60M Aircraft Systems (AFCS I)	6.0	3.0		
007	7:00	10:00	KLNA, Hanger 807		UH-60M Systems Academics (AFCS II)	6.0	3.0		
007	10:00	12:00	KLNA, Hanger 807		UH-60M Systems Academics (Powertrain & Rotor)	3.0	3.0		
007	13:00	16:00	KLNA, Hanger 807		UH-60M Systems Academics (Electrical)	3.0	3.0		
008	SIM	SIM	Class will be conducted before or after sim period		UH-60M Systems Academics (ESIS)	2.0	2.0		
008	SIM	SIM	Class will be conducted before or after sim period		UH-60M Systems Academics (AVCS)	1.0	1.0		
009	SIM	SIM	Class will be conducted before or after sim period		UH-60M Systems Academics (Auxilliary)	3.0	3.0		
010	SIM	SIM	Class will be conducted before or after sim period		UH-60M Systems Academics (Fuel System)	2.0	2.0		
010	SIM	SIM	Class will be conducted before or after sim period		UH-60M Systems Academics (IVHUMS)	1.0	1.0		
011	SIM	SIM	Class will be conducted before or after sim period		UH-60M Systems Academics Examination II	2.0	2.0		
011	SIM	SIM	Class will be conducted before or after sim period		UH-60M Systems Academics (MALANAL I)	9.0	3.0		
012	SIM	SIM	Class will be conducted before or after sim period		UH-60M Systems Academics (MALANAL II)	9.0	3.0		
013	SIM	SIM	Class will be conducted before or after sim period		UH-60M Systems Academics (MALANAL III)	9.0	3.0		
014	SIM	SIM	Class will be conducted before or after sim period			12.0	3.0		
015	SIM	SIM	Class will be conducted before or after sim period			2.0	2.0		
016	TBD	TBD	KLNA, Hanger 807		Flight Line Inbrief		1.0		
016	TBD	TBD	KLNA, Hanger 807		UH 60M EP and Limits Exam		1.0		
016	TBD	TBD	KLNA, Hanger 807		UH 60M Preflight		3.0		
016	TBD	TBD	KLNA, Hanger 807		Flight Line Academics		2.0		
017	6:00	13:30	KLNA, Hanger 807		UH-60M Flight Line/ IQC		7.5		
018	6:00	13:30	KLNA, Hanger 807		UH-60M Flight Line/ IQC		7.5		
019	6:00	13:30	KLNA, Hanger 807		UH-60M Flight Line/ IQC		7.5		
020	6:00	13:30	KLNA, Hanger 807		UH-60M Flight Line/ IQC		7.5		
021	6:00	TBD	KLNA, Hanger 807		Flight Line Academics/WX Day		7.5		
022	6:00	13:30	KLNA, Hanger 807		UH-60M Flight Line/ IQC		7.5		

023	6:00	13:30	KLNA, Hanger 807		UH-60M Flight Line/ IQC		7.5		
024	6:00	13:30	KLNA, Hanger 807		Flight Line Academics/WX Day		7.5		
025	TBD	TBD	SIM		UH-60M AAVS Flight Training		6.5		
026	TBD	TBD	SIM		UH-60M AAVS Flight Training		6.5		
027	TBD	TBD	SIM		UH-60M AAVS Flight Training		6.5		
028	TBD	TBD	SIM		UH-60M AAVS Flight Training		6.5		
029	7:30	14:30	KLNA, Hanger 807		Flight Line Academics/WX Day		7.5		
030	5:00	12:30	KLNA, Hanger 807		UH-60M Flight Line/ AQC		7.5		
031	5:00	12:30	KLNA, Hanger 807		UH-60M Flight Line/ AQC		7.5		
032	5:00	12:30	KLNA, Hanger 807		UH-60M Flight Line/ AQC		7.5		
033	6:00	13:30	KLNA, Hanger 807		UH-60M Flight Line/ IQC/AQC End of Stage Checkride		7.5		
034	5:00	12:30	KLNA, Hanger 807		Flight Line Academics/WX Day		7.5		
035	8:00	15:30	KLNA, Hanger 807		Flight Line Academics/ Instruments		7.5		
036	TBD	TBD	SIM		UH-60M AAVS Flight Training		6.5		
037	TBD	TBD	SIM		UH-60M AAVS Flight Training		6.5		
.38	TBD	TBD	SIM		UH-60M AAVS Flight Training		6.5		
039	TBD	TBD	SIM		UH-60M AAVS Flight Training		6.5		
040	8:00	15:30	KLNA, Hanger 807		Flight Line Academics		7.5		
041	TBD	TBD	SIM		UH-60M AAVS Flight Training		6.5		
042	TBD	TBD	SIM		UH-60M AAVS Flight Training		6.5		
043	TBD	TBD	SIM		UH-60M AAVS Flight Training		6.5		
044	6:00	13:30	KLNA, Hanger 807		UH-60M Flight Line/ Advanced Maneuvers		7.5		

第 2 年第 2 批 AQC

(一)、地面學科課目表

Ground Training Curriculum

Aircraft General	Main Rotor and Hub	Kits and Accessories
Aircraft Lighting and Master Warning	Tail Rotor and Hub	Systems Review, Examination and Critique
Electrical	Hydraulics	Weight and Balance
Auxiliary Power Unit (APU)	Landing Gear and Brakes	Performance
Fuel	Flight Controls	Flight Planning
Powerplant	Automatic Flight Control System and Stabilator	Approved RFM/ROM
Ice and Rain Protection	Avionics	Adverse Weather
Fire Protection	Command Instrument System	CRM / ADM / Risk Management
Powertrain	Environmental	Systems Integration

(二)、學科訓練及模擬機訓練日程表

日期	授課課程
0214 日	開訓 UH-60M Systems Academics. 1.教官與學員互相介紹。 2.實施課程:UH-60M 飛機簡介、座艙內各儀表及開關位置功能簡介、座椅介紹。
0215 日	UH-60M Systems Academics 實施課程: F/MDS 飛行/任務顯示系統講解、FMS 飛行管理系統講解。
0216 日	UH-60M Systems Academics 實施課程: FD/DCP 自動飛行結合與控制系統簡介及操作使用講解。
0217 日	UH-60M Systems Academics 實施課程: Data Transfer System - DTS 資料傳輸系統講解。
0218 日	UH-60M 模擬機訓練 實施課程:開、試車及關車程序。
0219 日	UH-60M 模擬機訓練 實施課程:1.開、試車及關車程序。2.FD/DCP 操作及航線起降。
0224 日	UH-60M Systems Academics 授課教官: RICK、 JASON 實施課程: UH-60 限制和系統指示講解、ENG 系統講解。
0225 日	UH-60M 模擬機訓練 實施進度:緊急程序操作。
0226 日	UH-60M 模擬機訓練 實施進度:緊急程序操作。
0301 日	UH-60M Systems Academics 實施課程: Flight Controls and Hydraulic System –飛行控制及液壓系統講解。
0302 日	UH-60M Systems Academics 實施課程:1.AFCS–自動飛行控制系統講解。2. ESIS –備用儀表說明。3. Powertrain and Rotor–旋翼及傳動系統講解。

0303 日	UH-60M Systems Academics 實施課程:1.APU－輔助動力系統講解。2.燃油系統講解。3.AVCS 系統講解。
0304 日	UH-60M 模擬機訓練 實施進度:緊急程序操作。
0305 日	UH-60M 模擬機訓練 實施進度:緊急程序操作。
0308 日	UH-60M Systems Academics 實施課程:1. Electrical 系統講解。2. IVHMS 系統簡介。3.操作手冊第 5 章－操作限制講解。
0309 日	UH-60M Systems Academics 實施課程:1.操作手冊第 9 章－緊急操作程序講解。2.學科鑑測。
0310 日	UH-60M Systems Academics 實施課程:實體機飛行前檢查講解及實作。
0313 日	UH-60M Systems Academics 實施課程:1.個人及機上求生裝備介紹。2. PPC 計算。
0314 日	UH-60M Systems Academics 實施課程:M10 電腦 PPC 計算講解及實作。
0401 日	UH-60M 模擬機訓練 課程進度:FMS、儀器飛行操作
0402 日	UH-60M 模擬機訓練 課程進度:儀器飛行、緊急程序

(三)、實體機飛行課程三週日程表。

日期	課目進度
0316 日	UH-60M 實體機訓練 實施進度:滯空、滑行、航線起降、滾行。
0317 日	UH-60M 實體機訓練 實施進度:航線起降、滾行、SAS/BOOS OFF、自轉。
0320 日	UH-60M 實體機訓練 實施進度:航線起降、滾行、SAS/BOOS OFF、自轉。
0321 日	UH-60M 實體機訓練 實施進度:斜坡地、滾行、SAS/BOOS OFF、自轉。
0322 日	UH-60M 實體機訓練 實施進度:SAS/BOOS OFF、自轉及緊急程序處置。
0327 日	UH-60M 實體機訓練 實施進度:自轉及緊急程序處置。。
0328 日	UH-60M 實體機訓練 實施進度:斜坡地、滾行、SAS/BOOS OFF 處置。
0329 日	UH-60M 實體機訓練 實施進度:自轉及緊急程序處置。
0330 日	UH-60M 實體機訓練 實施進度:滯空、滑行、航線起降、斜坡地、滾行、SAS/BOOS OFF、自轉及緊急程序處置。

IPC 課表

第 2 年第 1 批 IPC（事故機正駕駛）

This Course Management Plan contains the recommended training sequence (student schedule). It is derived from the Course Map (Mandatory Training Sequence).　Individual units/organizations may adjust training location and/or the order in which lessons are administered to accommodate weather, maintenance, or other similar scheduling issues as long as the Course Map (Mandatory Training Sequence) is not violated.　Academic hours, lesson content, academic/flight evaluations, tasks, flight hours, and simulator hours CAN NOT be altered.

TD	Start Time	End Time	Bldg/Location	Lesson ID	Lesson Title	TTL LSN Time	LSN BLK Time	Instructional Element	Remarks
45	7:00	11:00	KLNA, Hanger 807	TBD	Introduction / Areodynamics	0.5	4.0		
45	12:00	17:00	KLNA, Hanger 808	TBD	Instructing Fundamentals for IPs	4.5	5.0		
46	7:00	11:00	Sim	TBD	Simulator	2.5	4.0		
46	12:00	17:00	KLNA, Hanger 810	TBD	ACT-E / ICAO Airspace	2.0	5.0		
47	7:00	11:00	Sim	TBD	Simulator	2.0	4.0		
47	12:00	17:00	KLNA, Hanger 813	TBD	Flight Information Publications / Engine System	2.0	5.0		
48	7:00	11:00	KLNA, Hanger 813	TBD	Simulator	4.5	4.0		
48	12:00	17:00	KLNA, Hanger 814	TBD	Power Train, Rotor & Tail Rotor	4.0	5.0		
49	7:00	11:00	KLNA, Hanger 815	TBD	Simulator	4.5	4.0		
49	12:00	17:00	KLNA, Hanger 816	TBD	Flight Controls System	4.0	5.0		
50	7:00	11:00	KLNA, Hanger 817	TBD	Simulator	4.5	4.0		
50	12:00	17:00	KLNA, Hanger 818	TBD	Hydraulic System	4.0	5.0		
51	7:00	11:00	KLNA, Hanger 819	TBD	AFCS	4.5	4.0		
51	12:00	17:00	KLNA, Hanger 820	TBD	AFCS II / Stabilator	4.0	5.0		
52	7:00	11:00	KLNA, Hanger 821	TBD	Fly	4.0	4.0		
52	12:00	17:00	KLNA, Hanger 822	TBD	Electrical / Fuel Sytems	1.0	5.0		
53	7:00	10:00	KLNA, Hanger 823	TBD	Fly	150.5	5.5		
53	10:00	12:00	Sim	TBD	Administering Evaluations	1.0	4.0		
54	12:00	14:00	Sim	TBD	Fly Evaluations	150.5	2.0		
54	7:00	12:00	KLNA, Hanger 826	TBD	Fly Evaluations	150.5	5.0		

MPC 課表

第 2 年第 1 批 MPC（事故機正駕駛）

Check Pilot Familiarization Course **February 2017**

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2	3	4
5	6	7 Academics 0800 show – Hangar	8 Runup Checks Up to eng start 0800 show – Hangar	9 Reset (Day Off)	10 Travel to Simulators	11 Simulator Hover Demo/ Practice 3.0 per group 1730 show-Sim
12 Simulator Inflight Demo/ Practice 3.0 per group 1730 show-Sim	13 Travel to Lantana	14 Runup/100% Checks 0800 show – Hangar	15 Fly (Hovers) 0800 show – Hangar	16 Fly (Hovers/ Inflights) 0800 show – Hangar	17 Fly (Inflights) Course Critique 0800 show – Hangar	18
19	20 Graduation! 1800 show – Restaurant	21	22	23	24	25
26	27	28				

附錄 12 CRM 訓練民航通告

U.S. Department
of Transportation
Federal Aviation Administration

Advisory Circular

Subject: CREW RESOURCE MANAGEMENT TRAINING | **Date: 1/22/04** | **Initiated By: AFS-210** | **AC No: 120-51E** | **Change:**

1. PURPOSE. This Advisory Circular (AC) presents guidelines for developing, implementing, reinforcing, and assessing crew resource management (CRM) training for flight crewmembers and other personnel essential to flight safety. CRM training is designed to become an integral part of training and operations. These guidelines were originally intended for Title 14 of the Code of Federal Regulations (14 CFR) part 121 certificate holders who are required by regulation to provide CRM training for pilots and flight attendants, and dispatch resource management (DRM) training for aircraft dispatchers. Fractional ownership program managers, required by 14 CFR part 91, subpart K to provide CRM training to pilots and flight attendants, and those 14 CFR part 135 operators electing to train in accordance with part 121 requirements, should also use these guidelines. Certificate holders and individuals operating under other operating rules, such as parts 91 (apart from
subpart K), 125, and part 135 operators not electing to train in accordance with part 121, and others, should find these guidelines useful in addressing human performance issues. This AC presents one way, but not necessarily the only way, that CRM training may be addressed. CRM training focuses on situation awareness, communication skills, teamwork, task allocation, and decisionmaking within a comprehensive framework of standard operating procedures (SOP).

2. CANCELLATION. AC 120-51D, Crew Resource Management Training, dated 2/8/01, is cancelled.

3. PRINCIPAL CHANGES. Operators of fractional ownership programs under part 91, subpart K, are now required to provide CRM training to pilots and flight attendants, and are mentioned in the PURPOSE paragraph, above. Under paragraph 12 of this AC, the subparagraph on Briefings has been expanded to address safety and security concerns, including evacuation and hijack. A new subparagraph under paragraph 16, entitled Crew Monitoring and Cross-Checking, emphasizes the critical role of the pilot-not-flying (PNF) as a *monitor*. Monitoring is always essential, and particularly so during approach and landing when controlled flight into terrain (CFIT) accidents are most common. Accordingly, previous references to PNF have been changed to pilot monitoring (PM), in accordance with government and industry preference. In appendix 3, attempted hijack has been included as the most serious level of passenger interference requiring effective crew response, and has been included as an appropriate CRM training topic. Minor editorial changes have also been made in this revision. Text that has been changed from AC 120-51D is marked with a vertical bar in the left margin.

4. RELATED REGULATIONS (Title 14 of the Code of Federal Regulations). Part 91, section 91.1073; Part 121, subpart N and O, part 135, subparts E and H; sections 121.400-405, 121.409-422, 121.424, 121.427, 121.432-433, 121.434, 121.440-443, 135.243-245, 135.293-295 135.299-301, 135.321-331 and 135.335-351; Special Federal Aviation Regulation (SFAR) No. 58.

5. DEFINITIONS. The human factors safety challenge and the CRM training response may be defined as follows:

a. Human Factors. The multidisciplinary field of human factors is devoted to optimizing human performance and reducing human error. It incorporates the methods and principles of the behavioral and social sciences, engineering, and physiology. It is the applied science that studies people working together in concert with machines. It embraces variables that influence individual performance and variables that influence team or crew performance. It is recognized that inadequate system design or inadequate operator training can contribute to individual human error that leads to system performance degradation. Further, it is recognized that inadequate design and management of crew tasks can contribute to group errors that lead to system performance degradation.

b. CRM Training. The application of team management concepts in the flight deck environment was initially known as cockpit resource management. As CRM training evolved to include flight attendants, maintenance personnel and others, the phrase “Crew Resource Management” was adopted.

(1) As used in this AC, CRM refers to the effective use of all available resources: human resources, hardware, and information. Other groups routinely working with the cockpit crew, who are involved in decisions required to operate a flight safely, are also essential participants in an effective CRM process. These groups include but are not limited to:

(a) Aircraft dispatchers.

(b) Flight attendants.

(c) Maintenance personnel.

(d) Air traffic controllers.

(2) CRM training is one way of addressing the challenge of optimizing the human/machine interface and accompanying interpersonal activities. These activities include team building and maintenance, information transfer, problem solving, decisionmaking, maintaining situation awareness, and dealing with automated systems. CRM training is comprised of three components: initial indoctrination/awareness, recurrent practice and feedback, and continual reinforcement.

6. RELATED READING MATERIAL.

a. AC 120-35B, Line Operational Simulations: Line-Oriented Flight Training, Special Purpose Operational Training, Line Operational Evaluation.

b. AC 120-48, Communication and Coordination Between Flight Crewmembers and Flight Attendants.

c. AC 120-54, Advanced Qualification Program.

d. AC 120-71, Standard Operating Procedures for Flightdeck Crewmembers

e. AC 121-32, Dispatch Resource Management Training.

NOTE: Many ACs may be downloaded free of charge from the following FAA public Web site:

www.faa.gov
Click on Regulations & Policies
Click on Advisory Circulars

Free ACs may be obtained by mail from:

U.S. Department of Transportation
Subsequent Distribution Office, SVC-121.23
Ardmore East Business Center
3341 Q 75th Ave.
Landover, MD 20785

f. Guidelines for Situation Awareness Training, NAWCTSD/FAA/UCF Partnership for Aviation Team Training. This document may be viewed, downloaded, or printed at the following Web site: http://www.faa.gov/avr/afs/train.htm.

g. Controlled Flight into Terrain Education and Training Aid, Flight Safety Foundation, International Civil Aviation Organization (ICAO), and the FAA. This document may be viewed, downloaded, or printed at the following Web site: http://www.faa.gov/avr/afs/train.htm.

h. International Civil Aviation Organization (ICAO) Annex 13 on Human Factors. This document may be obtained from ICAO Document Sales Unit, Montreal, Quebec, Canada, 514-954-8022.

i. For detailed information on the recommendations made in this AC, the reader is encouraged to review Crew Resource Management: An Introductory Handbook published by the Federal Aviation Administration (FAA) (Document No. DOT/FAA/RD-92/26). Additional background material can be found in Cockpit Resource Management Training: Proceedings of a NASA/MAC Workshop, 1987. The National Aeronautics and Space Administration (NASA) Conference Proceedings (CP) number is 2455. The National Plan for Aviation Human Factors defines research issues related to crew coordination and training. Copies of the preceding publications may be purchased from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161. The telephone numbers for National Technical Information Service are: (800) 553-6847 (553-NTIS), and (703) 605-6000; fax: (703) 605-6900.

j. Descriptions of relevant research findings, methodological issues, and organizational experience can be found in Helmreich, R.L., and Wilhelm, J.A., (1991) "Outcomes of CRM Training," International Journal of Aviation Psychology, 1, 287-300; in Helmreich, R.L., and Foushee, H.C., "Why Crew Resource Management: Empirical and Theoretical Bases of Human Factors Training in Aviation"; in Orasanu, J., "Decisionmaking in the Cockpit"; and in Gregorich, S.E., and Wilhelm, J.A., "Crew Resource Management Training Assessment." Each of the preceding appears as a chapter in E.L. Wiener, B.G. Kanki, and R.L. Helmreich (Eds.), (1993), Cockpit Resource Management, Academic Press, Orlando, FL. For more detail on certain evolving concepts of CRM:

(1) Error management, see: Human Error, J.T. Reason. New York: Cambridge University Press, 1990. Also, Management the Risks of Organizational Accidents, J.T. Reason, Brookfield, VT, Ashgate Publishing, 1997.

(2) Advanced crew resource management (ACRM), see: "Developing Advanced Crew Resource Management (ACRM) Training: A Training Manual," Seamster, Boehm-Davis, Holt, Schultz, 8-1-98. http://www.hf.faa.gov/products/dacrmt/dacrmt.html.

(3) Culture issues, see: "Culture, Error, and Crew Resource Management," book chapter from Applying Resource Management in Organizations: A Guide for Professionals, in press. (Helmreich, Wilhelm, Klinect, and Merritt) (http://www.psy.utexas.edu/psy/helmreich/nasaut.htm).

(4) Situation awareness, see: "Cockpit Distractions and Interruptions," Dismukes, Young, Sumwalt, December, 1998. http://asrs.arc.nasa.gov/directline_issues/dl10_distract.htm.

7. BACKGROUND. Investigations into the causes of air carrier accidents have shown that human error is a contributing factor in 60 to 80 percent of all air carrier incidents and accidents. Long-term NASA research has demonstrated that these events share common characteristics. Many problems encountered by flightcrews have very little to do with the technical aspects of operating in a multi-person cockpit. Instead, problems are associated with poor group decisionmaking, ineffective communication, inadequate leadership, and poor task or resource management. Pilot training programs historically focused almost exclusively on the technical aspects of flying and on an individual pilot's performance; they did not effectively address crew management issues that are also fundamental to safe flight.

a. The National Transportation Safety Board (NTSB), the FAA, and many other parties have identified SOPs as a persistent element in these problems, which sometimes have led to accidents. SOPs define the shared mental model upon which good crew performance depends. Too often, well-established SOPs have been unconsciously ignored by pilots and others; in other cases, they have been consciously ignored. In still other cases, SOPs have been inadequately developed by the operator for use by its pilots, flight attendants, or aircraft dispatchers, or a significant SOP has been omitted altogether from an operator's training program. The Commercial Aviation Safety Team (CAST), a coalition of industry and government organizations, including the FAA, chartered by the White House in 1997, has undertaken to reduce the air carrier accident rate by 80 percent by the year 2007. Initiatives to improve SOPs and adherence to those SOPs are among the top-priority safety initiatives now being implemented by CAST.

b. Industry and government have come to the consensus that training programs should place emphasis on the factors that influence crew coordination and the management of crew resources. The need for additional training in communication between cockpit crewmembers and flight attendants has been specifically identified.

c. Coordinated efforts by representatives from the aviation community have produced valuable recommendations for CRM training. This collaborative process has occurred under the auspices of the Aviation Rulemaking Advisory Committee (ARAC). ARAC comprises representatives from a broad array of aviation organizations, including pilots' and flight attendants' associations, aircraft manufacturers, government offices, and others. ARAC is chaired by the Director of the FAA's Office of Rulemaking and is subdivided into working groups. One of those working groups is the Training and Qualifications Working Group. This AC is one product that has come from that working group and represents the sum of many parts. While compliance with this AC is not mandatory, the recommendations it contains provide a useful reference for understanding and applying the critical elements of CRM training.

d. Continuing NASA and FAA measurements of the impact of CRM training show that after initial indoctrination, significant improvement in attitudes occurs regarding crew coordination and flight deck management. In programs that also provide recurrent training and practice in CRM concepts, significant changes have been recorded in flightcrew performance during line-oriented flight training (LOFT) and during actual flight. CRM-trained crews operate more effectively as teams and cope more effectively with nonroutine situations.

e. Research also shows that when there is no effective reinforcement of CRM concepts by way of recurrent training, improvements in attitudes observed after initial indoctrination tend to disappear, and individuals' attitudes tend to revert to former levels.

8. THE MISSION OF CRM TRAINING. CRM training has been conceived to prevent aviation accidents by improving crew performance through better crew coordination.

9. BASIC CONCEPTS OF CRM. CRM training is based on an awareness that a high degree of technical proficiency is essential for safe and efficient operations. Demonstrated mastery of CRM concepts cannot overcome a lack of proficiency. Similarly, high technical proficiency cannot guarantee safe operations in the absence of effective crew coordination.

a. Experience has shown that lasting behavior changes in any environment cannot be achieved in a short time, even if the training is well designed. Trainees need awareness, practice and feedback, and continuing reinforcement: in brief, time to learn attitudes and behaviors that will endure. To be effective, CRM concepts must be permanently integrated into all aspects of training and operations.

b. While there are various useful methods in use in CRM training today, certain essentials are universal:

(1) CRM training is most effective within a training program centered on clear, comprehensive SOPs.

(2) CRM training should focus on the functioning of crewmembers as teams, not as a collection of technically competent individuals.

(3) CRM training should instruct crewmembers how to behave in ways that foster crew effectiveness.

(4) CRM training should provide opportunities for crewmembers to practice the skills necessary to be effective team leaders and team members.

(5) CRM training exercises should include all crewmembers functioning in the same roles (e.g., captain, first officer, and/or flight engineer, flight attendants) that they normally perform in flight.

(6) CRM training should include effective team behaviors during normal, routine operations.

c. Good training for routine operations can have a strong positive effect on how well individuals function during times of high workload or high stress. During emergency situations, it is highly unlikely (and probably undesirable) that any crewmember would take the time to reflect upon his or her CRM training in order to choose the appropriate behavior. But practice of desirable behaviors during times of low stress increases the likelihood that emergencies will be handled effectively.

d. Effective CRM has the following characteristics:

(1) CRM is a comprehensive system of applying human factors concepts to improve crew performance.

(2) CRM embraces all operational personnel.

(3) CRM can be blended into all forms of aircrew training.

(4) CRM concentrates on crewmembers' attitudes and behaviors and their impact on safety.

(5) CRM uses the crew as the unit of training.

(6) CRM is training that requires the active participation of all crewmembers. It provides an opportunity for individuals and crews to examine their own behavior, and to make decisions on how to improve cockpit teamwork.

(a) LOFT sessions provide an extremely effective means of practicing CRM skills and receiving reinforcement (see section 121.409 and part 121, appendix H).

(b) Audiovisual (taped) feedback during debriefing of LOFT and other training is an excellent way for flight crewmembers to assess their skills as individuals and as team members. Bulk erasure of taped sessions is suggested to encourage candor among participants while assuring their privacy.

(c) In cases where simulators are not available, crewmembers can participate in group problem-solving activities designed to exercise CRM skills. Through taped feedback during debriefing, they can then assess the positive and negative behaviors of all crewmembers.

(d) Crewmembers may also participate in role-playing exercises. Such exercises permit practice in developing strategies for dealing with events or event sets, and enable analysis of behaviors shown while dealing with them. Again, taping the role-playing exercises is useful for assessment and feedback during debriefing. Crewmembers' abilities can be clearly observed in such areas as adherence to SOPs, decisionmaking, teamwork, and leadership.

(e) Attitude and/or personality measures can also be used to provide feedback to participants, allowing them to assess their own strengths and weaknesses.

(7) Success of CRM training depends upon check airmen, instructors, and supervisors who are highly qualified in the operator's SOPs and specially trained in CRM.

10. FUNDAMENTALS OF CRM TRAINING IMPLEMENTATION. Research programs and airline operational experience suggest that the greatest benefits are achieved by adhering to the following practices:

a. Assess the Status of the Organization Before Implementation. It is important to know how widely CRM concepts are understood and practiced before designing specific training. Surveys of crewmembers, management, training, and standards personnel, observation of crews in line observations, and analysis of incident/accident reports can provide essential data for program designers.

b. Get Commitment from All Managers, Starting with Senior Managers. CRM programs are received much more positively by operations personnel when senior managers, flight operations managers, and flight standards officers conspicuously support CRM concepts and provide the necessary resources for training. Flight operations manuals and training manuals should embrace CRM concepts by providing crews with necessary policy and procedures guidance centered on clear, comprehensive SOPs. A central CRM concept is communication. It is essential that every level of management support a safety culture in which communication is promoted by encouraging appropriate questioning. It should be made perfectly clear in pilots' manuals, and in every phase of pilot training, that appropriate questioning is encouraged and that there will be no negative repercussions for appropriate questioning of one pilot's decision or action by another pilot.

c. Customize the Training to Reflect the Nature and Needs of the Organization. Using knowledge of the state of the organization, priorities should be established for topics to be covered, including special issues, such as the effects of mergers or the introduction of advanced technology aircraft. Other special issues might include topics specific to the particular type of operation, such as the specific characteristics that exist in commuter operations, in long-haul international operations or night operations. This approach increases the relevance of training for crewmembers.

d. Define the Scope of the Program and an Implementation Plan. Institute special CRM training for key personnel, including check airmen, supervisors, and instructors. It is highly beneficial to provide training for these groups before beginning training for crewmembers. CRM training may be expanded to combine pilots, flight attendants, and aircraft dispatchers. It may also be expanded to include maintenance personnel and other company team members, as appropriate. It is also helpful to develop a long-term strategy for program implementation.

e. Communicate the Nature and Scope of the Program Before Startup. Training departments should provide crews, managers, training, and standards personnel with a preview of what the training will involve together with plans for initial and continuing training. These steps can prevent misunderstandings about the focus of the training or any aspect of its implementation.

f. Institute Quality Control Procedures. It has proved helpful to monitor the delivery of training and to determine areas where training can be strengthened. Monitoring can be initiated by providing special training to program instructors (often called facilitators) in using surveys to collect systematic feedback from participants in the training.

11. COMPONENTS OF CRM TRAINING. The topics outlined below have been identified as critical components of effective CRM training. They do not represent a fixed sequence of phases, each with a beginning and an end. Ideally, each component is continually renewed at every stage of training.

a. Initial Indoctrination/Awareness.

(1) Indoctrination/awareness typically consists of classroom presentations and focuses on communications and decisionmaking, interpersonal relations, crew coordination, leadership, and adherence to SOPs, among others. In this component of CRM training, the concepts are developed, defined, and related to the safety of line operations. This component also provides a common conceptual framework and a common vocabulary for identifying crew coordination problems.

(2) Indoctrination/awareness can be accomplished by a combination of training methods. Lectures, audiovisual presentations, discussion groups, role-playing exercises, computer-based instruction, and videotaped examples of good and poor team behavior are commonly used methods.

(3) Initiating indoctrination/awareness training requires the development of a curriculum that addresses CRM skills that have been demonstrated to influence crew performance. To be most effective, the curriculum should define the concepts involved and relate them directly to operational issues that crews encounter. Many organizations have found it useful to survey crewmembers. Survey data have helped identify embedded attitudes regarding crew coordination and cockpit management. The data have also helped to identify operational problems and to prioritize training issues.

(4) Effective indoctrination/awareness training increases understanding of CRM concepts. That understanding, in turn, often influences individual attitudes favorably regarding human factors issues. Often the training also suggests more effective communication practices.

(5) It is important to recognize that classroom instruction alone does not fundamentally alter crewmember attitudes over the long term. The indoctrination/awareness training should be regarded as a necessary first step towards effective crew performance training.

b. Recurrent Practice and Feedback.

(1) CRM training must be included as a regular part of the recurrent training requirement. Recurrent CRM training should include classroom or briefing room refresher training to review and amplify CRM components, followed by practice and feedback exercises, such as LOFT, preferably with taped feedback; or a suitable substitute, such as role-playing in a flight training device and taped feedback. It is recommended that these recurrent CRM exercises take place with a full crew, each member operating in his or her normal crew position. A complete crew should always be scheduled, and every attempt should be made to maintain crew integrity. Recurrent training LOFT, which includes CRM, should be conducted with current line crews, and preferably not with instructors or check airmen as stand-ins.

(2) Recurrent training with performance feedback allows participants to practice newly improved CRM skills and to receive feedback on their effectiveness. Feedback has its greatest impact when it comes from self-critique and from peers, together with guidance from a facilitator with special training in assessment and debriefing techniques.

(3) The most effective feedback refers to the coordination concepts identified in Indoctrination/ Awareness training or in recurrent training. Effective feedback relates to specific behaviors. Practice and feedback are best accomplished through the use of simulators or training devices and videotape. Taped feedback, with the guidance of a facilitator, is particularly effective because it allows participants to view themselves from a third-person perspective. This view is especially compelling in that strengths and weaknesses are captured on tape and vividly displayed. Stop action, replay, and slow motion are some of the playback features available during debriefing. Behavioral patterns and individual work styles are easily seen, and appropriate adjustments are often self-evident.

c. Continuing Reinforcement.

(1) No matter how effective each curriculum segment is (the classroom, the role-playing exercises, the LOFT, or the feedback), one-time exposures are simply not sufficient. The attitudes and norms that contribute to ineffective crew coordination may have developed over a crewmember's lifetime. It is unrealistic to expect a short training program to reverse years of habits. To be maximally effective, CRM should be embedded in every stage of training, and CRM concepts should be stressed in line operations as well.

(2) CRM should become an inseparable part of the organization's culture.

(3) There is a common tendency to think of CRM as training only for captains. This notion misses the essence of the CRM training mission: the prevention of crew-related accidents. CRM training works best in the context of the entire crew. Training exercises are most effective if all crewmembers work together and learn together. In the past, much of the flightcrew training has been segmented by crew position. This segmentation has been effective for meeting certain training needs such as seat dependent technical training and upgrade training, but segmentation is not appropriate for most CRM training.

(4) Reinforcement can be accomplished in many areas. Training such as joint cabin and cockpit crew training in security can deal with many human factors issues. Joint training with aircraft dispatchers, maintenance personnel, and gate agents can also reinforce CRM concepts, and is recommended.

12. SUGGESTED CURRICULUM TOPICS. The topics outlined below have been included in many current CRM programs. Specific content of training and organization of topics should reflect an organization's unique culture and specific needs. Appendix 1 offers a set of behavioral markers fitting subtopics within each topic cluster. Sometimes overlapping, these markers may be helpful in curriculum development and in LOFT design. Appendix 3 gives additional CRM training topics.

a. Communications Processes and Decision Behavior. This topic includes internal and external influences on interpersonal communications. External factors include communication barriers such as rank, age, gender, and organizational culture, including the identification of inadequate SOPs. Internal factors include speaking skills, listening skills and decisionmaking skills, conflict resolution techniques, and the use of appropriate assertiveness and advocacy. The importance of clear and unambiguous communication must be stressed in all training activities involving pilots, flight attendants, and aircraft dispatchers. The greater one's concern in flight-related matters, the greater is the need for clear communication. More specific subtopics include the following:

(1) Briefings. Training in addressing both operational and interpersonal issues, and training in establishing and maintaining open communications. A captain's briefings should reaffirm established SOPs and should address the most threatening safety and security situations.

(a) Safety. A captain's briefing should address emergencies that might require an airplane evacuation (e.g., cabin fire or engine fire) and should highlight the functions of flightcrew and flight attendants during an evacuation. A captain's briefing should stress to flight attendants the importance of identifying able-bodied passengers and briefing them, in turn. Passengers in exit rows are particularly important resources, and flight attendants should brief them on what to do during an evacuation.

(b) Security. A captain's briefing should address general security topics, especially hijack, and any known or suspected specific threat pertaining to the flight. Flight attendants should identify able-bodied passengers, including exit row seat occupants, and may enroll them as resources who might be called upon to help contain a disruption caused by a passenger(s).

(2) Inquiry/Advocacy/Assertion. Training in the potential benefits of crewmembers advocating the course of action that they feel is best, even though it may involve conflict with others.

(3) Crew Self-Critique (Decisions and Actions). Illustrating the value of review, feedback, and critique focusing on the process and the people involved. One of the best techniques for reinforcing effective human factors practices is careful debriefing of activities, highlighting the processes that were followed. Additionally, it is essential that each crewmember be able to recognize good and bad communications, and effective and ineffective team behavior.

(4) Conflict Resolution. Demonstrating effective techniques of resolving disagreements among crewmembers in interpreting information or in proposing courses of action. Demonstrating effective techniques for maintaining open communication while dealing with conflict.

(5) Communications and Decisionmaking. Demonstrating effective techniques of seeking and evaluating information. Showing the influence of biases and other cognitive factors on decision quality. There are benefits in providing crews with operational models of this group decision process. Crews may refer to these models to make good choices in situations when information is incomplete or contradictory.

b. Team Building and Maintenance. This topic includes interpersonal relationships and practices. Effective leadership/followership and interpersonal relationships are key concepts to be stressed. Curricula can also include recognizing and dealing with diverse personalities and operating styles. Subtopics include:

(1) Leadership/Followership/Concern for Task. Showing the benefits of the practice of effective leadership through coordinating activities and maintaining proper balance between respecting authority and practicing assertiveness. Staying centered on the goals of safe and efficient operations.

(2) Interpersonal Relationships/Group Climate. Demonstrating the usefulness of showing sensitivity to other crewmembers' personalities and styles. Emphasizing the value of maintaining a friendly, relaxed, and supportive yet task-oriented tone in the cockpit and aircraft cabin. The importance of recognizing symptoms of fatigue and stress, and taking appropriate action.

(3) Workload Management and Situation Awareness. Stressing the importance of maintaining awareness of the operational environment and anticipating contingencies. Instruction may address practices (e.g., vigilance, planning and time management, prioritizing tasks, and avoiding distractions) that result in higher levels of situation awareness. The following operational practices may be included:

(a) Preparation/Planning/Vigilance. Issues include methods to improve monitoring and accomplishing required tasks, asking for and responding to new information, and preparing in advance for required activities.

(b) Workload Distribution/Distraction Avoidance. Issues involve proper allocation of tasks to individuals, avoidance of work overloads in self and in others, prioritization of tasks during periods of high workload, and preventing nonessential factors from distracting attention from adherence to SOPs, particularly those relating to critical tasks.

(4) Individual Factors/Stress Reduction. Training in this area may include describing and demonstrating individual characteristics that can influence crew effectiveness. Research has shown that many crewmembers are unfamiliar with the negative effects of stress and fatigue on individual cognitive functions and team performance. Training may include a review of scientific evidence on fatigue and stress and their effects on performance. The content may include specific effects of fatigue and stress in potential emergency situations. The effects of personal and interpersonal problems and the increased importance of effective interpersonal communications under stressful conditions may also be addressed. Training may also include familiarization with various countermeasures for coping with stressors. Additional curriculum topics may include examination of personality and motivation characteristics, self-assessment of personal style, and identifying cognitive factors that influence perception and decisionmaking.

13. SPECIALIZED TRAINING IN CRM CONCEPTS. As CRM programs have matured, some organizations have found it beneficial to develop and implement additional courses dealing with issues specific to their operations.

a. After all current crewmembers have completed the Initial Indoctrination/Awareness component of CRM training, arrangements are needed to provide newly hired crewmembers with the same material. A number of organizations have modified their CRM initial courses for inclusion as part of the initial training and qualification for new hire crewmembers.

b. Training for upgrading to captain provides an opportunity for specialized training that deals with the human factors aspects of command. Such training can be incorporated in the upgrade process.

c. Training involving communications and the use of automation can be developed for crews operating aircraft with advanced technology cockpits, or for crews transitioning into them.

14. ASSESSMENT OF CRM TRAINING. It is vital that each training program be assessed to determine if CRM training is achieving its goals. Each organization should have a systematic assessment process. Assessment should track the effects of the training program so that critical topics for recurrent training may be identified and continuous improvements may be made in all other respects. Assessment of the training program should include observation and feedback by program administrators and self-reports by participants using standard survey methods.

a. The emphasis in this assessment process should be on crew performance. The essential areas of CRM-related assessment include communications, decisionmaking, team building and maintenance, workload management, and situation awareness, always in balance with traditional technical proficiency. An additional function of such assessment is to determine the impact of CRM training and organization-wide trends in crew performance.

b. For optimal assessment, data on crewmembers' attitudes and behavior should be collected before CRM indoctrination and again at intervals after the last component of CRM training, to determine both initial and enduring effects of the program. The goal should be to obtain an accurate picture of the organization's significant corporate personality traits before formal adoption of CRM training, and to continue to monitor those traits after implementation.

c. Reinforcement and feedback are essential to effective CRM training. Crewmembers must receive continual reinforcement to sustain CRM concepts. Effective reinforcement depends upon usable feedback to crewmembers on their CRM practices and on their technical performance.

d. Usable feedback requires consistent assessment. Crewmembers and those involved in training and evaluation should be able to recognize effective and ineffective CRM behaviors. CRM concepts should be critiqued during briefing/debriefing phases of all training and checking events.

e. To summarize, the assessment process should:

(1) Measure and track the organization's corporate culture as it is reflected in attitudes and norms.

(2) Identify topics needing emphasis within the CRM program.

(3) Ensure that all check airmen, supervisors, and instructors are well prepared and standardized.

15. THE CRITICAL ROLE OF CHECK AIRMEN AND INSTRUCTORS.

a. The success of any CRM training ultimately depends on the skills of the people who administer the training and measure its effects. CRM instructors, check pilots, supervisors, and course designers must be skilled in all areas related to the practice and assessment of CRM. These skills comprise an additional level to those associated with traditional flight instruction and checking.

b. Gaining proficiency and confidence in CRM instruction, observation, and measurement requires special training for instructors, supervisors, and check pilots in many CRM training processes. Among those processes are role-playing simulations, systematic crew-centered observation, administering LOFT, and providing usable feedback to crews.

c. Instructors, supervisors, and check pilots also require special training in order to calibrate and standardize their own skills.

d. Instructors, supervisors, and check airmen should use every available opportunity to emphasize the importance of crew coordination skills. The best results occur when the crews examine their own behavior with the assistance of a trained instructor who can point out positive and negative CRM performance. Whenever highly effective examples of crew coordination are observed, it is vital that these positive behaviors be discussed and reinforced. Debriefing and critiquing skills are important tools for instructors, supervisors, and check pilots. (Behavioral markers of effective LOFT debriefings are shown in appendix 2.)

e. Feedback from instructors, supervisors, and check airmen is most effective when it refers to the concepts that are covered in the initial indoctrination/awareness training. The best feedback refers to instances of specific behavior, rather than behavior in general.

16. EVOLVING CONCEPTS OF CRM.

a. Crew Monitoring and Cross-Checking. Several studies of crew performance, incidents, and accidents have identified inadequate flightcrew monitoring and cross-checking as a problem for aviation safety. Therefore, to ensure the highest levels of safety, each flight crewmember must carefully monitor the aircraft's flight path and systems and actively cross-check the actions of other crewmembers. Effective monitoring and cross-checking can be the last line of defense that prevents an accident because detecting an error or unsafe situation may break the chain of events leading to an accident. This monitoring function is always essential, and particularly so during approach and landing when controlled flight into terrain (CFIT) accidents are most common. (For more information on SOPs that promote effective monitoring, see AC 120-71, as revised, appendix 19.)

b. Joint CRM Training. More carriers are discovering the value of expanding CRM training to reach various employee groups beyond flightcrew and flight attendants. Dissimilar groups are being brought together in CRM training and in other activities. The objective is to improve the effectiveness and safety of the entire operations team as a working system.

(1) The attacks of September 11, 2001, have caused many restrictions on flightdeck access. Among those affected are air traffic controllers, for whom revised access procedures are being studied. Pilots may observe operations in air traffic facilities under certain conditions, and are encouraged to do so. Using real air traffic controllers during LOFT sessions has also proven beneficial to pilots and participating controllers.

(2) Aircraft dispatchers have functioned jointly with flight captains for years. They have been allowed, indeed required to observe cockpit operations from the cockpit jumpseat as part of their initial and recurrent qualification under part 121. Some carriers have included day trips to their aircraft dispatchers' offices to provide the pilot insight into the other side of the joint function scheme. Those trips have commonly been part of the special training offered to first-time captains. Now, real-life aircraft dispatchers are increasingly being used in LOFT sessions. The training experience gained by
the pilot and the dispatcher during LOFT is considered the logical extension of earlier training methods, providing interactivity where CRM (and DRM) principles are applied and discussed.

(3) Under certain conditions, maintenance personnel have had access to the cockpit jumpseat in air carrier operations under part 121; but that access has come under scrutiny because of security concerns following the attacks of 9/11. Training of first-time captains has often included day trips to a carrier's operations control center where a pilot and a maintenance supervisor can meet face to face and discuss issues of mutual interest in a thrumming, real-life setting. Some carriers have included maintenance personnel in LOFT sessions. Dedicated CRM training courses for maintenance personnel have been operating since 1991.

(4) Even broader cross-pollination of CRM concepts has been considered, using other groups such as passenger service agents, mid- and upper-level managers, and special crisis teams like hijack and bomb-threat teams.

(5) Flight attendants are probably the most obvious of the groups other than pilots who may profit from CRM training. Joint CRM training for pilots and flight attendants is not required by FAA regulations, but it is encouraged and has been practiced effectively at some air carriers for years. One fruitful activity in joint training has been that each group learns of the other group's training in shared issues. The joint training has revealed inconsistencies between training for one group and training on the same topic for another group. Examples of shared issues include delays, the use of personal electronic devices in the cabin, evacuation and ditching, and hijack response. When inconsistencies are identified between the contents of pilots' manuals and flight attendants' manuals, for instance, or between widely-held ideas or attitudes in those two populations, those inconsistencies are brought out into the open and often resolved. Other specific topics for joint training include:

(a) Pre-flight briefings;

(b) Post incident/accident procedures;

(c) Sterile cockpit procedures;

(d) Notification procedures (pre-takeoff and pre-landing);

(e) Procedures for turbulence and other weather;

(f) Security procedures;

(g) Passenger-handling procedures;

(h) In-flight medical problems;

(i) Smoke/fire procedures;

(j) Passenger-related regulations such as those relating to smoking (section 121.571), exit row seating (section 121.585), and carry-on baggage (section 121.589); and

(k) Authority of the pilot in command.

(6) CRM principles are made more relevant for pilots, flight attendants, and other groups by treating those principles in a familiar job-related context. Furthermore, each group should benefit from concurrent training in CRM that is complemented by usable knowledge of the other's job.

(7) Communication and coordination problems between cockpit crewmembers and flight attendants continue to challenge air carriers and the FAA. Other measures with positive CRM training value for flightcrews are being considered, such as:

(a) Including flight attendants as participants during LOFT;

(b) Scheduling month-long pairings of pilots and flight attendants; and

(c) Providing experienced flight crewmembers to teach new-hire flight attendant orientation classes.

c. Error Management. It is now understood that pilot errors cannot be entirely eliminated. It is important, therefore, that pilots develop appropriate error management skills and procedures. It is certainly desirable to prevent as many errors as possible, but since they cannot all be prevented, detection and recovery from errors should be addressed in training. Evaluation of pilots should also consider error management (error prevention, detection, and recovery). Evaluation should recognize that since not all errors can be prevented, it is important that errors be managed properly.

d. Advanced CRM. CRM performance requirements or procedures are being integrated into the SOPs of certain air carriers. Specific callouts, checks, and guidance have been included in normal checklists, the quick-reference handbook (QRH), abnormal/emergency procedures, manuals, and job aids. This integration captures CRM principles into explicit procedures used by flightcrews.

e. Culture issues. While individuals and even teams of individuals may perform well under many conditions, they are subject to the influence of at least three cultures – the professional cultures of the individuals themselves, the cultures of their organizations, and the national cultures surrounding the individuals and their organizations. If not recognized and addressed, factors related to culture may degrade crew performance. Hence, effective CRM training must address culture issues, as appropriate in each training population.

17. SUMMARY. Effective CRM begins in initial training; it is strengthened by recurrent practice and feedback; and it is sustained by continuing reinforcement that is part of the corporate culture and embedded in every stage of training.

/s/ James J. Ballough
Director, Flight Standards Service

APPENDIX 1. CREW PERFORMANCE MARKER CLUSTERS

Italicized Markers apply to Advanced Technology Flight Decks. These behavioral markers are provided to assist organizations in program and curriculum development and to serve as guidelines for feedback. They are not presented as a checklist for evaluating individual crewmembers.

1. COMMUNICATIONS PROCESSES AND DECISION BEHAVIOR CLUSTER.

a. Briefings. An effective briefing is interesting and thorough. It addresses coordination, planning, and problems. Although briefings are primarily a captain's responsibility, other crewmembers may add significantly to planning and should be encouraged to do so.

Behavioral Markers.

(1) The captain's briefing establishes an environment for open/interactive communications (e.g., the captain calls for questions or comments, answers questions directly, listens with patience, does not interrupt or "talk over," does not rush through the briefing, and makes eye contact as appropriate).

(2) The briefing is interactive and emphasizes the importance of questions, critique, and the offering of information.

(3) The briefing establishes a "team concept" (e.g., the captain uses "we" language, encourages all to participate and to help with the flight).

(4) The captain's briefing covers pertinent safety and security issues.

(5) The briefing identifies potential problems such as weather, delays, and abnormal system operations.

(6) The briefing provides guidelines for crew actions centered on standard operating procedures (SOP); division of labor and crew workload is addressed.

(7) The briefing includes the cabin crew as part of the team.

(8) The briefing sets expectations for handling deviations from SOPs.

(9) The briefing establishes guidelines for the operation of automated systems (e.g., when systems will be disabled; which programming actions must be verbalized and acknowledged).

(10) The briefing specifies duties and responsibilities with regard to automated systems, for the pilot flying (PF) and the pilot monitoring (PM).

b. Inquiry/Advocacy/Assertion. These behaviors relate to crewmembers promoting the course of action that they feel is best, even when it involves conflict with others.

Behavioral Markers.

(1) Crewmembers speak up and state their information with appropriate persistence until there is some clear resolution.

(2) "Challenge and response" environment is developed.

(3) Questions are encouraged and are answered openly and nondefensively.

(4) Crewmembers are encouraged to question the actions and decisions of others.

(5) Crewmembers seek help from others when necessary.

(6) Crewmembers question status and programming of automated systems to confirm situation awareness.

c. Crew Self-Critique Regarding Decisions and Actions. These behaviors relate to the effectiveness of a group and/or an individual crewmember in critique and debriefing. Areas covered should include the product, the process, and the people involved. Critique may occur during an activity, and/or after completing it.

Behavioral Markers.

(1) Critique occurs at appropriate times, which may be times of low or high workload.

(2) Critique deals with positive as well as negative aspects of crew performance.

(3) Critique involves the whole crew interactively.

(4) Critique makes a positive learning experience. Feedback is specific, objective, usable, and constructively given.

(5) Critique is accepted objectively and nondefensively.

d. Communications/Decisions. These behaviors relate to free and open communication. They reflect the extent to which crewmembers provide necessary information at the appropriate time (e.g., initiating checklists and alerting others to developing problems). Active participation in the decisionmaking process is encouraged. Decisions are clearly communicated and acknowledged. Questioning of actions and decisions is considered routine.

Behavioral Markers.

(1) Operational decisions are clearly stated to other crewmembers.

(2) Crewmembers acknowledge their understanding of decisions.

(3) "Bottom lines" for safety are established and communicated.

(4) The "big picture" and the game plan are shared within the team, including flight attendants and others as appropriate.

(5) Crewmembers are encouraged to state their own ideas, opinions, and recommendations.

(6) Efforts are made to provide an atmosphere that invites open and free communications.

(7) Initial entries and changed entries to automated systems are verbalized and acknowledged.

2. TEAM BUILDING AND MAINTENANCE CLUSTER.

a. Leadership Followership/Concern for Tasks. These behaviors relate to appropriate leadership and followership. They reflect the extent to which the crew is concerned with the effective accomplishment of tasks.

Behavioral Markers.

(1) All available resources are used to accomplish the job at hand.

(2) Flight deck activities are coordinated to establish an acceptable balance between respect for authority and the appropriate practice of assertiveness.

(3) Actions are decisive when the situation requires.

(4) A desire to achieve the most effective operation possible is clearly demonstrated.

(5) The need to adhere to SOPs is recognized.

(6) Group climate appropriate to the operational situation is continually monitored and adjusted (e.g., social conversation may occur during low workload, but not high).

(7) Effects of stress and fatigue on performance are recognized.

(8) Time available for the task is well managed.

(9) Demands on resources posed by operation of automated systems are recognized and managed.

(10) When programming demands could reduce situation awareness or create work overloads, levels of automation are reduced appropriately.

b. Interpersonal Relationships/Group Climate. These behaviors relate to the quality of interpersonal relationships and the pervasive climate of the flight deck.

Behavioral Markers.

(1) Crewmembers remain calm under stressful conditions.

(2) Crewmembers show sensitivity and ability to adapt to the personalities of others.

(3) Crewmembers recognize symptoms of psychological stress and fatigue in self and in others (e.g., recognizes when he/she is experiencing "tunnel vision" and seeks help from the team; or notes when a crewmember is not communicating and draws him/her back into the team).

(4) "Tone" in the cockpit is friendly, relaxed, and supportive.

(5) During times of low communication, crewmembers check in with others to see how they are doing.

3. WORKLOAD MANAGEMENT AND SITUATION AWARENESS CLUSTER.

a. Preparation/Planning/Vigilance. These behaviors relate to crews anticipating contingencies and the various actions that may be required. Excellent crews are always "ahead of the curve" and generally seem relaxed. They devote appropriate attention to required tasks and respond without undue delay to new developments. (They may engage in casual social conversation during periods of low workload and not necessarily diminish their vigilance.)

Behavioral Markers.

(1) Demonstrating and expressing situation awareness (e.g., the "model" of what is happening is shared within the crew).

(2) Active monitoring of all instruments and communications and sharing relevant information with the rest of the crew.

(3) Monitoring weather and traffic and sharing relevant information with the rest of the crew.

(4) Avoiding "tunnel vision" caused by stress (e.g., stating or asking for the "big picture").

(5) Being aware of factors such as stress that can degrade vigilance, and watching for performance degradation in other crewmembers.

(6) Staying "ahead of the curve" in preparing for planned situations or contingencies, so that situation awareness and adherence to SOPs is assured.

(7) Ensuring that cockpit and cabin crewmembers are aware of plans.

(8) Including all appropriate crewmembers in the planning process.

(9) Allowing enough time before maneuvers for programming of the flight management computer.

(10) Ensuring that all crewmembers are aware of initial entries and changed entries in the flight management system.

b. Workload Distributed/Distractions Avoided. These behaviors relate to time and workload management. They reflect how well the crew manages to prioritize tasks, share the workload, and avoid being distracted from essential activities.

Behavioral Markers.

(1) Crewmembers speak up when they recognize work overloads in themselves or in others.

(2) Tasks are distributed in ways that maximize efficiency.

(3) Workload distribution is clearly communicated and acknowledged.

(4) Nonoperational factors such as social interaction are not allowed to interfere with duties.

(5) Task priorities are clearly communicated.

(6) Secondary operational tasks (e.g., dealing with passenger needs and communications with the company) are prioritized so as to allow sufficient resources for primary flight duties.

(7) Potential distractions posed by automated systems are anticipated, and appropriate preventive action is taken, including reducing or disengaging automated features as appropriate.

APPENDIX 2. LOFT DEBRIEFING PERFORMANCE INDICATORS

The effective line-oriented flight training (LOFT) facilitator leads the flightcrew through a self-critique of their own behavior and of their crew performance during the simulation. The debriefing and crew analysis include both technical and crew resource management (CRM) discussion topics. Positive points of crew performance are discussed as well as those needing improvement. At the conclusion of the session, key learning points are summarized covering all participants, including the instructor. A strong sense of training accomplishment and learning is taken away from the session.

The following performance markers may be used to evaluate the LOFT facilitator's performance in the debrief/critique phase of LOFT.

a. Actively states the debriefing and critique agenda and solicits topics from the crew on items that they would like to cover; sets time limits.

b. Asks the crew for their appraisal of the mission overall.

c. States his/her own perceptions of the LOFT while guarding against making the crew defensive. Comments are as objective as possible and focus on performance.

d. Shows appropriate incidents using videotape of the LOFT session, including examples of technical and CRM performance, and selects tape segments for discussion illustrating behaviors that feature the crew performance markers.

e. Effectively blends technical and CRM feedback in the debriefing; does not preach to the crew, but does not omit items worthy of crew discussion.

f. Is patient, and is constructive in probing into key areas where improvement is needed.

g. Ensures that all crewmembers participate in the discussion, and effectively draws out quiet or hostile crewmembers.

h. Provides a clear summary of key learning points.

i. Asks the crew for specific feedback on his/her performance.

j. Is effective in both technical and CRM debriefing.

APPENDIX 3. APPROPRIATE CRM TRAINING TOPICS

1. BACKGROUND INFORMATION.

a. Findings coming from accident investigations have consistently pointed to the fact that human errors contribute to most aviation accidents.

b. Research findings suggest that crew resource management (CRM) training can result in significant improvements in flightcrew performance. CRM training is seen as an effective approach to reducing human errors and increasing aviation safety.

c. Aviation safety information is readily available on the Internet. Many Web sites contain valuable source materials and reference materials that may be helpful in developing CRM training. Web sites commonly link to other Web sites containing related material. Aviation-related Web sites maintained by U.S. Government agencies include the following:

(1) National Aeronautics and Space Administration (NASA), http://www.nasa.gov.

(2) National Transportation Safety Board (NTSB), http://www.ntsb.gov.

(3) Federal Aviation Administration (FAA), http://www.faa.gov.

2. TRAINING TOPICS, PRINCIPLES, AND TECHNIQUES. It is recommended that CRM training include the curriculum topics described in paragraph 12 of the Advisory Circular (AC) and the following topics, principles, and techniques:

a. Theory and practice in using communication, decisionmaking, and team building techniques and skills.

b. Theory and practice in using proper supervision techniques (i.e., captains working with first officers).

c. Theory and practice in selecting and using interventions needed to correct flying errors made by either pilot, especially during critical phases of flight. These interventions may include, but not be limited to, communication, assertion, decisionmaking, risk assessment, and situation awareness skills.

d. During Line Operational Simulation training, information, and practice of nonflying pilot functions (i.e., monitoring and challenging pilot functions, and monitoring and challenging errors made by other crewmembers for flight engineers, first officers, and captains). Training will alert flightcrews of hazards caused by tactical decision errors, which are actually errors of omission. Practice in monitoring, challenging, and mitigating errors, especially during taxi operations, should be included. These skills are important to minimize procedural errors that may occur as a result of inadequately performed checklists.

e. Training for check airmen in methods that can be used to enhance the monitoring and challenging functions of both captains and first officers. The check airmen training should include the message that appropriate questioning among pilots is a desirable CRM behavior and part of the corporate safety culture; further, that such questioning is encouraged, and that there will be no negative repercussions for appropriate questioning of one pilot's decision or action by another pilot.

f. Training for new first officers in performing the role of the pilot monitoring (PM) to establish a positive attitude toward monitoring and challenging errors made by the pilot flying (PF). Training should stress that appropriate questioning is encouraged as a desirable CRM behavior, and that there will be no negative repercussions for appropriate questioning of one pilot's decision or action by another pilot.

g. Training for captains in giving and receiving challenges of errors. Training should stress that appropriate questioning is encouraged as a desirable CRM behavior, and that there will be no negative repercussions for appropriate questioning of one pilot's decision or action by another pilot.

h. Factual information about the detrimental effects of fatigue and strategies for avoiding and countering its effects.

i. Training for crewmembers that identifies conditions in which additional vigilance is required, such as holding in icing or near convective activity. Training should emphasize the need for maximum situation awareness and the appropriateness of sterile cockpit discipline, regardless of altitude. Scenario-based flight simulator training in ground taxi operations should emphasize flightcrew vigilance in avoiding runway incursions.

j. Training that identifies appropriate levels of automation to promote situation awareness and effective management of workload.

k. Use of autopilot in inflight icing. All flightcrew members should clearly understand their aircraft's susceptibility to inflight icing and should monitor inflight ice accretion by all means available. One effective means of monitoring ice accretion might be to disconnect the autopilot at intervals, if doing so is consistent with the approved procedures contained in the airplane flight manual.

l. Training for crewmembers in appropriate responses when passengers intimidate, abuse, or interfere with crewmember performance of safety duties. Training should address crew coordination and actions, which might defuse the situation. See AC 120-65, Interference with Crewmembers in the Performance of their Duties, dated October 18, 1996. Training should include specific communication topics, such as conflict resolution, with particular attention to the most serious passenger interference, attempted hijack.

m. Line-oriented flight training (LOFT) or special purpose operational training (SPOT) for cockpit crewmembers, which addresses appropriate responses to the effects of pitot-static system anomalies, such as a blocked pitot tube. Emphasis should be on situation awareness, inquiry/advocacy/ assertion, and crew coordination, when flight instruments act abnormally.

n. LOFT or SPOT for cockpit crewmembers that contain a controlled flight into terrain scenario. Emphasis should be on prevention through effective communication and decision behavior. The importance of immediate, decisive, and correct response to a ground proximity warning should also be addressed.

o. Training for pilots in recognizing cues that indicate lack or loss of situation awareness in themselves and in others, and training in countermeasures to restore that awareness. Training should emphasize the importance of recognizing each pilot's relative experience level, experience in specific duty positions, preparation level, planning level, normal communication style and level, overload state, and fatigue state. Pilots should assess these characteristics actively and continuously, in their fellow crewmembers and in themselves. Training should also emphasize the importance that improper procedures, adverse weather, and abnormal or malfunctioning equipment may have in reducing situation awareness. "Guidelines for Situation Awareness Training" contains expanded guidance on cues and countermeasures, and may by viewed or downloaded from the FAA Web site at: http://faa.gov/avr/afs/train.htm.

p. Training in communication of time management information among flightcrew and cabin crewmembers during an emergency. Training should stress that the senior or lead flight attendant can effectively brief other flight attendants and passengers and prepare the cabin only if the time available in the emergency is clearly communicated by the flightcrew. Other information elements that are vital in effective time management are the nature of the emergency and any special instructions relating to the planned course of action.

3. APPROPRIATE TRAINING INTERVENTIONS.

a. The most effective CRM training involves active participation of all crewmembers. LOFT sessions give each crewmember opportunities to practice CRM skills through interactions with other crewmembers. If the training is videotaped, feedback based on crewmembers' actual behavior, during the LOFT, provides valuable documentation for the LOFT debrief.

b. CRM training can be presented using a combination of the following training interventions:

(1) Operator in-house courses.

(2) Training center courses.

(3) SPOT.

(4) LOFT sessions.

(5) Computer-based training courses.

附錄 13　CFIT 民航通告

U.S. Department
of Transportation
Federal Aviation Administration

Advisory Circular

Subject: GENERAL AVIATION CONTROLLED FLIGHT INTO TERRAIN AWARENESS	**Date: 4/1/03** **Initiated By: AFS-800**	**AC No: 61-134** **Change:**

1. PURPOSE. This advisory circular (AC) highlights the inherent risk that controlled flight into terrain (CFIT) poses for general aviation (GA) pilots. This AC includes the Federal Aviation Administration's (FAA) common definition of the term CFIT, identifies some, but not all, of the risks associated with GA CFIT accidents, and provides some recommendations and strategies to combat CFIT within the GA community. This AC is not an all-inclusive document on CFIT; rather, this AC is designed to help flight instructors, FAA Aviation Safety Program Managers, and other trainers develop CFIT training materials by identifying some of the factors involved in GA CFIT accidents. Some common references are included to aid instructors in preparing CFIT presentations. Pilots can benefit from reading this AC to check their own knowledge of CFIT and factors involved to avoid having a GA CFIT accident. This AC will break the study of GA CFIT into three broad categories. One will focus on visual flight rules (VFR) pilots without an instrument rating operating in marginal VFR weather conditions (visual meteorological conditions (VMC)) or instrument flight rules (IFR) weather conditions (instrument meteorological conditions (IMC)) commonly known as scud running. The second category will focus on GA IFR operations in IMC conditions on an IFR flight. The third category will focus on low-flying aircraft operating in VFR conditions. This AC does not address CFIT in Title 14 of the Code of Federal Regulations (14 CFR) part 121 or part 135 operations.

2. BACKGROUND.

a. According to FAA information, general aviation CFIT accidents account for 17 percent of all general aviation fatalities. More than half of these CFIT accidents occurred during IMC. The FAA is working in partnership with industry to develop an action plan and revise guidance material to reduce the incidence of CFIT within the GA segment of aviation. However, one of the problems in reviewing GA CFIT accidents is the lack of data, particularly human factors data. Since many of the pilots involved in GA CFIT accidents are fatalities and most GA aircraft are not equipped with data recording systems, the lack of GA CFIT accident data will continue to remain a problem for investigators.

b. Although many CFIT accidents have some common factors that are applicable for all types of aircraft, we want to stress the difference between a crewed aircraft with two pilots in the cockpit and a single-pilot aircraft. In crewed cockpits, the second pilot may make the difference between a safe flight and a CFIT accident. Conversely, a second pilot can also be a distraction in certain circumstances unless the crew has been trained to work well together and is following good crew resource management (CRM) techniques. As a general rule of thumb, whether an air carrier type aircraft or a GA aircraft, the crewed aircraft is generally better equipped with more safety equipment, such as an autopilot, radar altimeter, or ground proximity warning system (GPWS) onboard, than a typical single-pilot, small GA aircraft.

c. Because a single-piloted, small GA aircraft is vulnerable to the same CFIT risks as a crewed aircraft but with only one pilot to perform all of the flight and decisionmaking duties, that pilot must be better prepared to avoid a CFIT type accident. In some cases, a GA pilot may be more at risk to certain CFIT type accidents because the pilot does not have the company management or government oversight that a corporate or commercial operator may be exposed to. Without such oversight, such as detailed standard operating procedures and higher mandatory safety requirements, it is the responsibility of the single-pilot to ensure he or she is well trained, qualified for the intended flight, meets all regulatory requirements for the flight, and has the self-discipline to follow industry recommended safety procedures that can minimize CFIT type accidents.

3. RELATED 14 CFR REFERENCES.

a. Part 91, sections 91.103, 91.119, 91.121, 91.123, 91.155, 91.175, 91.177, 91.179, 91.181, 91.515.

b. Part 97, Standard Instrument Approach Procedures.

4. RELATED PUBLICATIONS.

a. Advisory Circulars.

(1) The current version of AC 61-23C, Pilot's Handbook of Aeronautical Knowledge, may be purchased from the Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954, or from U.S. Government Printing Office bookstores located in major cities throughout the United States.

(2) The current versions of the following ACs may be obtained at no cost from: Department of Transportation, Subsequent Distribution Office, Ardmore East Business Center, 3341 Q 75th Ave., Landover, MD 20785.

(a) AC 90-97, Use of Barometric Vertical Navigation (VNAV) for Instrument Approach Operations Using Decision Altitude.

(b) AC 120-51D, Crew Resource Management Training.

b. Manuals and Handbooks. The current versions of the following documents may be purchased from the Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954:

(1) Aeronautical Information Manual (AIM), especially paragraph 7-5-3, Obstructions to Flight, Appendix 2.

(2) Rotorcraft Flying Handbook (FAA-H-8083-21).

(3) Airplane Flying Handbook (FAA-H-8083-3).

c. Checklists.

(1) Personal Minimums Checklist, <http://flysafe.faa.gov/Flysafe/pclvideo/default.htm>

(2) Flight Safety Foundation, CFIT Checklist, Appendix 1, and <http://www.flightsafety.org/pdf/cfit_check.pdf>. To order a laminated copy, send a written request to

The Director of Programs, Flight Safety Foundation, 601 Madison Street, Suite 300, Alexandria, VA 22314.

d. Pilot Practical Test Standards. The current versions of the these documents may be purchased from the Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954.

e. Controlled Flight Into Terrain, Education and Training Aid. Historically, most of the research related to CFIT accidents and the development of recommended safety practices have been done for air carrier type operations. The Controlled Flight Into Terrain, Education and Training Aid, is a good example of such research done by industry and government. Produced by the Flight Safety Foundation, the International Civil Aviation Organization (ICAO), and the FAA, the aid provides a good history, lists common dangers, and provides some recommended means of combating CFIT accidents for air carrier operations. In addition, the document is a valuable resource for anyone developing a CFIT training course. The document is available on the FAA's Internet website at: <www.faa.gov/avr/afs/cfit/volume1/titlepg.pdf>

5. DEFINITIONS.

a. Controlled Flight into Terrain (CFIT). CFIT occurs when an airworthy aircraft is flown, under the control of a qualified pilot, into terrain (water or obstacles) with inadequate awareness on the part of the pilot of the impending collision.

b. Loss of Control. The term, loss of control, refers to emergency situations from which a pilot may have been able to recover but did not, such as problems with situation awareness, recovery from windshear, mishandling of an approach, and recovery from a stall.

c. Situational Awareness. As used in this AC, situational awareness means the pilot is aware of what is happening around the pilot's aircraft at all times in both the vertical and horizontal plane. This includes the ability to project the near term status and position of the aircraft in relation to other aircraft, terrain, and other potential hazards.

d. Crewed Aircraft. In this AC, crewed aircraft refers to an aircraft or flight operation in which more than one pilot is required by aircraft certification or type of operation.

e. Single-Pilot Aircraft. In this AC, single-pilot means only one pilot is required by the aircraft certification. Normally, only one pilot flies such an aircraft.

6. SCOPE.

a. In visual meteorological conditions, the pilot in command (PIC) is responsible for terrain and obstacle clearance (See and Avoid) whether operating under VFR or IFR. Although this AC addresses the issue of pilots operating under VFR in marginal VMC or IMC conditions, the FAA does not endorse or approve of pilots operating under VFR in IMC. The paragraphs dealing with such operations are only designed to highlight the risks of such operations. The FAA expects pilots to comply with the appropriate flight rules for all flight operations.

b. This AC addresses CFIT operations in the United States, only. Flight operations outside of the United States have added risks that can contribute to a CFIT accident. These risks include air traffic control (ATC) instructions from controllers to whom English is a second language or controllers with a limited ATC vocabulary. Other international factors include different types of altimeter settings, terrain elevation, runway data in units other than feet, and a general lack of knowledge with the international ICAO standards and country specific operating standards. U.S. pilots planning on operating outside the

United States need to carefully review the appropriate international requirements and operating procedures to ensure that an inadvertent mistake or failure to comply with local procedures does not result in a GA CFIT accident.

7. TOP 10 RECOMMENDED INTERVENTION STRATEGIES.

a. The following is a list of 10 safety recommendations from the FAA's and industry's Safer Skies: A Focused Safety Agenda, General Aviation Controlled Flight Into Terrain Joint Safety Implementation Team Report, February 2000. The list was derived from 55 ideas the CFIT Joint Safety Analysis Team (JSAT) developed after reviewing 195 GA CFIT accidents from 1993 and 1994. As the report noted, GA includes everything from pilot training, corporate, agricultural and external-load operations, fire-fighting, airborne surveillance, air shows, aircraft maintenance related flights, to personal and recreational flying. Types of aircraft vary from single-place home-builts to helicopters to business jets. GA aircraft also includes gliders, balloons, and aerial application aircraft. As the report says, GA is "...basically everything except the military and scheduled air carriers." Although some of the safety recommendations go beyond the capability of instructors or trainers interested in developing training materials for GA CFIT safety presentations or CFIT lesson plans, they all contain information that will improve CFIT safety in flight, on or near airports and obstructions.

b. The CFIT JSAT's Top 10 Recommended Intervention Strategies.

(1) Increase pilot awareness on accident causes.

(2) Improve safety culture within the aviation community.

(3) Promote development and use of a low cost terrain clearance and/or a look ahead device.

(4) Improve pilot training (i.e., weather briefing, equipment, decision-making, wire and tower avoidance, and human factors.

(5) Improve the quality and substance of weather briefs.

(6) Enhance the flight review and/or instrument competency check.

(7) Develop and distribute mountain-flying technique advisory material.

(8) Standardize and expand use of markings for towers and wires.

(9) Use high visibility paint and other visibility enhancing features on obstructions.

(10) Eliminate the pressure to complete the flight where continuing may compromise safety.

8. VFR-ONLY PILOTS OPERATING IN MARGINAL VFR/IMC CONDITIONS.

a. Operating in marginal VFR/IMC conditions is more commonly known as scud running. According to National Transportation Safety Board (NTSB) and FAA data, one of the leading causes of GA accidents is continued VFR flight into IMC. As defined in 14 CFR part 91, ceiling, cloud, or visibility conditions less than that specified for VFR or Special VFR is IMC and IFR applies. However, some pilots, including some with instrument ratings, continue to fly VFR in conditions less than that specified for VFR. The result is often a CFIT accident when the pilot tries to continue flying or maneuvering beneath a lowering ceiling and hits an obstacle or terrain or impacts water. The accident may or may not be a result of a loss of control before the aircraft impacts the obstacle or surface. The importance of complete weather information, understanding the significance of the weather information, and being able to correlate the pilot's skills and training, aircraft capabilities, and operating environment with an accurate forecast cannot be emphasized enough.

b. Continued flight in reduced visual conditions compounded by night operations and/or overwater flight poses some risks. VFR pilots in reduced visual conditions may develop spatial disorientation and lose control, possibly going into a graveyard spiral, or descend to an unsafe altitude while trying to maintain visual contact with the surface. The pilot then impacts terrain, the surface, or an obstacle while trying to maneuver. The following are some of the CFIT risks associated with such flight.

(1) Loss of aircraft control.

(2) Loss of situational awareness.

(3) Reduced reaction time to see and avoid rising terrain or obstacles.

(4) Inability of the pilot to operate the aircraft at its minimum controllable airspeed.

(5) Getting lost or being off the preplanned flightpath and impacting terrain or obstacle.

(6) Reduced pilot reaction time in the event of an aircraft maintenance problem because of a low or lowering altitude.

(7) Failure to adequately understand the weather conditions that resulted in the reduced conditions.

(8) Breakdown in good aeronautical decisionmaking.

(9) Failure to comply with appropriate regulations.

(10) Failure to comply with minimum safe altitudes.

(11) Increased risk of hitting one of many new low altitude towers installed for cellular telephones and other types of transmissions. This risk is especially great along major highways if VFR pilots try to follow a highway when lost or trying to stay under a lowering ceiling.

(12) Failure to turn around and avoid deteriorating conditions when first able.

9. GA IFR OPERATIONS IN IMC CONDITIONS ON AN IFR FLIGHT. These operations also pose special risks. Whether it is failure to follow safe takeoff and departure techniques, recommended en route procedures — which includes loss of situational awareness — or failure to maneuver safely to a landing, IFR operations can be dangerous for those not prepared to operate or not current and proficient in the IMC and IFR environments. Many of these accidents result in fatalities. Techniques or suggestions for avoiding some of these IFR risk factors include:

a. Importance of the pilot in command being qualified, current, and proficient for the intended flight.

b. Importance of the aircraft being properly equipped for the intended flight.

c. Having the proper charts and approach plates for the intended flight. VFR charts, although not required, should be onboard because they can provide important obstacle and terrain data for an IFR flight.

d. Knowing the planned procedure well enough to know if air traffic is issuing an unsafe clearance or if the pilot flying, when a crewed aircraft, is not following the published procedure.

e. If in a crewed aircraft, both pilots have adequately briefed the flight and operation of the aircraft, including shared responsibilities.

f. Having complete weather data for the flight, including knowing where visual meteorological conditions exist or a safe alternative is since many GA aircraft flown IFR have limited range or speed to fly out of un-forecasted weather conditions.

g. Importance of maintaining situational awareness, both horizontal and vertical, throughout the flight to avoid flying into hazardous terrain or known obstacles.

h. Complete knowledge on how to operate all equipment onboard the aircraft. This includes the limitations and operations of new types of navigation equipment.

i. If a crewed aircraft, the crew is aware of and follows FAA and industry recommended crew resource management principles. If a single-piloted flight, the pilot knows to use all available resources including air traffic control to help ensure a safe flight as well as any onboard resource such as a passenger or onboard charts or manuals.

j. Pilot in command follows the rules for making a missed approach and is prepared to make a missed approach when conditions fall below minimums as specified in the regulations, company policy, pilot's personal minimums checklist, or the approach becomes destabilized.

k. Knowledge of minimum safe or sector altitudes and of the highest terrain in the area.

l. Pilot in command is aware of the risks involved when transitioning from visual to instrument or from instrument to visual procedures on takeoff or landing.

m. Pilot in command uses all available safety equipment installed in the aircraft and on the ground.

n. Pilot in command is aware of the risks involved in setting the aircraft's altimeter including inherent limitations of barometric altimeters.

o. Knowing the air traffic control system well enough to be proficient in it.

p. Knowing when not to fly.

q. Properly using an installed autopilot, if so equipped, to reduce pilot workload.

r. Proper use of checklists as outlined in the aircraft manual or if not listed, before reaching 1,000 feet above ground level (AGL) to minimize any distractions when operating close to the ground.

s. The importance of flying a stabilized approach. A common definition of a stabilized approach is maintaining a stable speed, descent rate, vertical flightpath, and configuration throughout the final segment of the approach. Although originally designed for turbojet aircraft, a stabilized approach is also recommended for propeller-driven aircraft. The idea is to reduce pilot workload and aircraft configuration changes during the critical final approach segment of an approach. The goal is to have the aircraft in the proper landing configuration, at the proper approach speed, and on the proper flightpath before descending below the minimum stabilized approach height. The following are recommended minimum stabilized approach heights.

(1) 500 feet above the airport elevation during VFR weather conditions.

(2) MDA or 500 feet above airport elevation, whichever is lower, for a circling approach.

(3) 1,000 feet above the airport or touch down zone elevation during IMC.

t. The increased CFIT risk of nonprecision approaches.

u. The increased CFIT risk of high descent rates near the ground.

v. The importance of good communications between the pilot and air traffic control concerning any flight instruction or clearance. The old rule of asking for clarification whenever in doubt about any instruction or clearance applies.

w. The dangers of complacency for the single-pilot, as well as multi-piloted crews, when making routine flights.

x. The dangers of misunderstanding air traffic control instructions or accepting an incorrect clearance.

y. The dangers of not knowing the safe altitudes for your en route as well as your terminal area.

10. LOW-FLYING AIRCRAFT OPERATING IN VFR CONDITIONS. Although many of the factors listed previously apply to low-flying aircraft operating in VFR conditions, this is a special category for those pilots flying below minimum safe altitudes. Such operators include agriculture applicators and helicopter pilots who routinely operate near trees, telephone lines and power lines, or other such obstacles. In many cases, the pilot was aware of the obstacles but environmental factors such as time of day, minimal light, shadows, darkness, sun glare, cockpit blind spots, fatigue, or other such factors resulted in the pilot losing situational awareness and hitting an obstacle or impacting the ground. In some cases, pilots may have been aware of an obstacle, but because of some of these environmental factors, they were unable to avoid a collision because they did not see the danger in time or they saw the danger but failed to react in time to avoid an accident. Density altitude and aircraft performance limitations may also pose risk factors for such flights. These same factors can also result in a CFIT accident for someone flying in mountainous terrain. Some common low altitude CFIT factors are:

a. Windshear and loss of flying speed.

b. Density altitude.

c. Failure to operate aircraft within operating limitations.

d. Failure to check an area from a safe altitude before descending into it (high reconnaissance and low reconnaissance).

e. Flying between hills or over rivers below hill tops can result in a CFIT accident if a power line or cable is strung between the hills. Not all such lines are marked or charted.

f. Flying up a box canyon and not being able to fly up and out of it before impacting terrain.

g. Flying over rising terrain that exceeds an aircraft's ability or performance to climb away from the terrain.

h. Errors in pilot judgement and decisionmaking.

i. Diversion of pilot attention.

j. Buzzing.

k. Crew distractions or a breakdown in crew resource management.

l. Operating in an unsafe manner.

m. Failure to maintain control of the aircraft when taking off or landing.

n. Failure to properly pre-plan the flight.

o. Operating in unfamiliar areas or depending upon untrained people to provide important flight data.

p. Not having an objective standard to make go-no go decisions for launching.

q. Failure to review all available data for the flight (particularly applicable to medical evacuation flights).

r. Lack of terrain knowledge and elevation of the highest obstacles within your immediate operating area.

s. Failure to properly plan your departure route when departing from unprepared areas such as helicopters or aircraft operating off an airport. Such factors include weight and balance, aircraft performance, height of obstacles, wind direction, trees, density altitude, rising terrain, length of takeoff area, and safe abort areas.

11. AERONAUTICAL INFORMATON MANUAL (AIM), SECTION 5. Potential Flight Hazards, paragraph 7-5-1, Accident Cause Factors, lists the following 10 most frequent cause factors for general aviation accidents that involve the PIC. The following list contains many of the same factors listed for CFIT accidents. This listing of major reasons why GA pilots continue to have accidents has remained constant over time. With the possible exception of subparagraph f, these factors can all be CFIT factors.

a. Inadequate preflight preparation and/or planning.

b. Failure to obtain and/or maintain flying speed.

c. Failure to maintain directional control.

d. Improper level off.

e. Failure to see and avoid objects or obstructions.

f. Mismanagement of fuel.

g. Improper in-flight decisions or planning.

h. Misjudgment of distance and speed.

i. Selection of unsuitable terrain.

j. Improper operation of flight controls.

12. DECIDE MODEL. Many CFIT accident reports discuss the lack of good decisionmaking on the part of the pilot or flight crew. The following D-E-C-I-D-E model is included in many manuals and books on decisionmaking.

a. Detect change (or identify problem).

b. Estimate significance (of the change).

c. Choose the (best) objective or outcome.

d. Identify options (that meet objective or desired outcome).

e. Do best option.

f. Evaluate (the outcome--if the outcome is not what is desired then do a new DECIDE model).

13. TECHNICAL SOLUTIONS.

a. The development of the first Ground Proximity Warning Systems (GWPS) has contributed to a marked decline in CFIT accidents in air carrier operations. The use of GWPS and the newer generation Terrain Awareness and Warning Systems (TWAS) in GA aircraft has the potential to provide a similar savings in lives and loss of GA aircraft. As noted in various CFIT documents, the proper use of terrain awareness and warning systems is important to their effectiveness. Pilots are expected to execute the proper emergency escape maneuvers when their ground warning system activates.

b. Title 14 CFR sections 91.223, 121.354, and 135.154 mandate the installation of terrain awareness warning systems in turbine-powered aircraft as outlined in the appropriate section. The type of operation also includes specific passenger seat requirements/limitations for the operations involved as well as the required type of equipment.

c. As digital-mapping systems combined with satellite positioning data become less expensive, GA pilots may soon be able to graphically see their horizontal and vertical location at all times. Expanded situational awareness should help pilots avoid some types of CFIT accidents. Then the challenge will be to eliminate descent type CFIT accidents during the landing phase of flight.

14. SUMMARY.

a. Controlled flight into terrain, normally occurs at speed with the result that many such accidents are fatal. A common thread throughout this AC is the importance of proper planning, good decisionmaking, and being able to safely operate the aircraft throughout is entire operating range. Since CFIT implies that the aircraft is operating properly, the main reason for such accidents is what is commonly called pilot error. Therefore, it is the pilot's responsibility to ensure that he or she is qualified for the flight, that the aircraft is properly equipped for the flight, and that the flight is flown according to the appropriate regulations and aircraft operating limitations. According to the CFIT, Education and Training Aid, about 25.0 percent of all accidents occur during the takeoff and initial climb segment of flight. Approximately 7.0 percent of the accidents occur during the climb portion. Only about 4.5 percent occur during cruise. About 19.5 percent occurs during descent and initial approach. But 41.4 percent of the accidents occur during final approach and landing. Takeoff, initial climb, final approach, and landing represent only about 6.0 percent of the total flight time of a given flight. But as these numbers point out, that 6.0 percent of a flight's total time can be deadly. Ground proximity warning systems and the newer terrain awareness and warning systems using GPS have the potential to reduce CFIT accidents on takeoffs and landings. These systems provide one more tool for pilots to use to increase their safety margin when operating close to terrain and obstacles. However, every pilot must know the limitations of his or her database and what objects are included in the database.

b. The solution to combating CFIT accidents starts on the ground. Pilots need to properly prepare to safely execute the maneuvers required during takeoff, initial climb, final approach, and landing phases of flight. Whether VFR or IFR, each flight has critical flight segments. How the flight segments are planned for and handled determines, to a great extent, the safety of the flight. Appendix 1, Flight Safety Foundation's CFIT Checklist, provides one example of how to calculate CFIT risk. It states, "Use the checklist to evaluate specific flight operations and to enhance pilot awareness of the CFIT risk." Page 4 of the checklist tells how pilots can obtain copies of the checklist or reproduce it.

c. Recommendations.

(1) Noninstrument rated VFR pilots should not attempt to fly in IMC.

(2) Know and fly above minimum published safe altitudes. VFR: Fly a minimum of 1,000 feet above the highest terrain in your immediate operating area in nonmountainous areas. Fly a minimum of 2,000 feet in mountainous areas.

(3) If IFR, fly published procedures. Fly the full published procedure at night, during minimum weather conditions, or operating at an unfamiliar airport.

(4) Verify proper altitude, especially at night or over water, through use of a correctly set altimeter.

(5) Verify all ATC clearances. Question an ATC clearance that assigns a heading and/or altitude that, based upon your situational awareness, places the aircraft in a CFIT environment.

(6) Maintain situational awareness both vertically and horizontally.

(7) Comply with appropriate regulations for your specific operation.

(8) Don't operate below minimum safe altitudes if uncertain of position or ATC clearance.

(9) Be extra careful when operating outside the United States or in an area which you are not familiar.

(10) Use current charts and all available information.

(11) Use appropriate checklists.

(12) Know your aircraft and its equipment.

/s/
Louis C. Cusimano for
James J. Ballough
Director, Flight Standards Service

APPENDIX 1. CFIT CHECKLIST

Flight Safety Foundation

CFIT Checklist

Evaluate the Risk and Take Action

Flight Safety Foundation (FSF) designed this controlled-flight-into-terrain (CFIT) risk-assessment safety tool as part of its international program to reduce CFIT accidents, which present the greatest risks to aircraft, crews and passengers. The FSF CFIT Checklist is likely to undergo further developments, but the Foundation believes that the checklist is sufficiently developed to warrant distribution to the worldwide aviation community.

Use the checklist to evaluate specific flight operations and to enhance pilot awareness of the CFIT risk. The checklist is divided into three parts. In each part, numerical values are assigned to a variety of factors that the pilot/operator will use to score his/her own situation and to calculate a numerical total.

In *Part I: CFIT Risk Assessment,* the level of CFIT risk is calculated for each flight, sector or leg. In *Part II: CFIT Risk-reduction Factors,* Company Culture, Flight Standards, Hazard Awareness and Training, and Aircraft Equipment are factors, which are calculated in separate sections. In *Part III: Your CFIT Risk,* the totals of the four sections in *Part II* are combined into a single value (a positive number) and compared with the total (a negative number) in *Part I: CFIT Risk Assessment* to determine your CFIT Risk Score. To score the checklist, use a nonpermanent marker (do not use a ball-point pen or pencil) and erase with a soft cloth.

Part I: CFIT Risk Assessment

Section 1- Destination CFIT Risk Factors	**Value**	**Score**
Airport and Approach Control Capabilities:		
ATC approach radar with MSAWS	0	_____
ATC minimum radar vectoring charts	0	_____
ATC radar only	-10	_____
ATC radar coverage limited by terrain masking	-15	_____
No radar coverage available (out of service/not installed)	-30	_____
No ATC service	-30	_____
Expected Approach:		
Airport located in or near mountainous terrain	-20	_____
ILS	0	_____
VOR/DME	-15	_____
Nonprecision approach with the approach slope from the FAF to the airport TD shallower than 2 ¾ degrees	-20	_____
NDB	-30	_____
Visual night "black-hole" approach	-30	_____
Runway Lighting:		
Complete approach lighting system	0	_____
Limited lighting system	-30	_____
Controller/Pilot Language Skills:		
Controllers and pilots speak different primary languages	-20	_____
Controllers' spoken English or ICAO phraseology poor	-20	_____
Pilots' spoken English poor	-20	_____
Departure:		
No published departure procedure	-10	_____
Destination CFIT Risk Factors Total		(-)_____

APPENDIX 1. CFIT CHECKLIST – Continued

Section 2 – Risk Multiplier	Value	Score
Your Company's Type of Operation (select only one value):		
Scheduled	1.0	_____
Nonscheduled.	1.2	_____
Corporate	1.3	_____
Charter	1.5	_____
Business owner/pilot	2.0	_____
Regional	2.0	_____
Freight	2.5	_____
Domestic	1.0	_____
International	3.0	_____
Departure/Arrival Airport (select single highest applicable value):		
Australia/New Zealand	1.0	_____
United States/Canada	1.0	_____
Western Europe	1.3	_____
Middle East	1.1	_____
Southeast Asia	3.0	_____
Euro-Asia (Eastern Europe and Commonwealth of Independent States)	3.0	_____
South America/Caribbean.	5.0	_____
Africa	8.0	_____
Weather/Night Conditions (select only one value):		
Night — no moon	2.0	_____
IMC	3.0	_____
Night and IMC	5.0	_____
Crew (select only one value):		
Single-pilot flight crew	1.5	_____
Flight crew duty day at maximum and ending with a night nonprecision approach	1.2	_____
Flight crew crosses five or more time zones	1.2	_____
Third day of multiple time-zone crossings	1.2	_____
Add Multiplier Values to Calculate Risk Multiplier Total		_____
Destination CFIT Risk Factors Total X Risk Multiplier Total = CFIT Risk Factors Total		(-) _____

Part II: CFIT Risk-Reduction Factors

Section 1- Company Culture	Value	Score
Corporate/company management:		
Places safety before schedule	20	_____
CEO signs off on flight operations manual	20	_____
Maintains a centralized safety function	20	_____
Fosters reporting of all CFIT incidents without threat of discipline	20	_____
Fosters communication of hazards to others	15	_____
Requires standards for IFR currency and CRM training	15	_____
Places no negative connotation on a diversion or missed approach	20	_____

115-130 points	Tops in company culture	
105-115 points	Good, but not the best	**Company Culture Total** (+)_____
80-105 points	Improvement needed	
Less than 80 points	High CFIT risk	

APPENDIX 1. CFIT CHECKLIST – Continued

Section 2 - Flight Standards	Value	Score
Specific procedures are written for:		
Reviewing approach or departure procedures charts	10	_____
Reviewing significant terrain along intended approach or departure course	20	_____
Maximizing the use of ATC radar monitoring	10	_____
Ensuring pilot(s) understand that ATC is using radar or radar coverage exists	20	_____
Altitude changes	10	_____
Ensuring checklist is complete before initiation of approach	10	_____
Abbreviated checklist for missed approach	10	_____
Briefing and observing MSA circles on approach charts as part of plate review	10	_____
Checking crossing altitudes at IAF positions	10	_____
Checking crossing altitudes at FAF and glideslope centering	10	_____
Independent verification by PNF of minimum altitude during stepdown DME (VORNME or LOC/DME) approach	20	_____
Requiring approach/departure procedure charts with terrain in color, shaded contour formats.	20	_____
Radio-altitude setting and light-aural (below MDA) for backup on approach	10	_____
Independent charts for both pilots, with adequate lighting and holders	10	_____
Use of 500-foot altitude call and other enhanced procedures for NPA	10	_____
Ensuring a sterile (free from distraction) cockpit, especially during IMC/night approach or departure.	10	_____
Crew rest, duty times and outer considerations especially for multiple-time-zone operation	20	_____
Periodic third-party or independent audit of procedures	10	_____
Route and familiarization checks for new pilots		
Domestic	10	_____
International	20	_____
Airport familiarization aids, such as audiovisual aids	10	_____
First officer to fly night or IMC approaches and the captain to monitor the approach	20	_____
Jump-seat pilot (or engineer or mechanic) to help monitor terrain clearance and the approach in IMC or night conditions	20	_____
Insisting that you fly the way that you train	25	_____

300-335 points	Tops in CFIT flight standards
270-300 points	Good, but not the best
200-270 points	Improvement needed
Less than 200	High CFIT risk

Flight Standards Total (+)_____

Section 3 - Hazard Awareness and Training	Value	Score
Your company reviews training with the training department or training contractor	10	_____
Your company's pilots are reviewed annually about the following:		
Flight standards operating procedures	20	_____
Reasons for and examples of how the procedures can detect a CFIT "trap"	30	_____
Recent and past CFIT incidents/accidents	50	_____
Audiovisual aids to illustrate CFIT traps	50	_____
Minimum altitude definitions for MORA, MOCA, MSA, MEA, etc.	15	_____
You have a trained flight safety officer who rides the jump seat occasionally	25	_____
You have flight safety periodicals that describe and analyze CFIT incidents	10	_____
You have an incident/exceedance review and reporting program	20	_____
Your organization investigates every instance in which minimum terrain clearance has been compromised	20	_____

APPENDIX 1. CFIT CHECKLIST – Continued

	Value	Score
You annually practice recoveries with GPWS in the simulator	40	_____
You train the way that you fly	25	_____

285-315 points	Tops in CFIT training	
250-285 points	Good, but not the best	**Hazard Awareness and Training Total** (+)_____
190-250 points	Improvement needed	
Less than 190	High CFIT risk	

Section 4 – Aircraft Equipment

	Value	Score
Radio altimeter with cockpit display of full 2,500-foot range - captain only	20	_____
Radio altimeter with cockpit display of full 2,500-foot range - copilot	10	_____
First-generation GPWS	20	_____
Second-generation GPWS or better	30	_____
GPWS with all approved modifications, data tables and service bulletins to reduce false warnings	10	_____
Navigation display and FMS	10	_____
Limited number of automated altitude callouts	10	_____
Radio-altitude automated callouts for nonprecision approach (not heard on ILS approach) and procedure	10	_____
Preselected radio altitudes to provide automated callouts that would not be heard during normal nonprecision approach	10	_____
Barometric altitudes and radio altitudes to give automated "decision" or "minimums" callouts	10	_____
An automated excessive "bank angle" callout	10	_____
Auto flight/vertical speed mode	-10	_____
Auto flight/vertical speed mode with no GPWS	-20	_____
GPS or other long-range navigation equipment to supplement NDB-only approach	15	_____
Terrain-navigation display	20	_____
Ground-mapping radar	10	_____

175-195 points	Excellent equipment to minimize CFIT risk	
155-175 points	Good, but not the best	Aircraft Equipment Total (+)_____*
115-155 points	Improvement needed	
Less than 115	High CFIT risk	

Company Culture ______ + Flight Standards ______ + Hazard Awareness and Training ______

+Aircraft Equipment = CFIT Risk-reduction Factors Total (+)________

***If any section in Part II scores less than "Good," a thorough review is warranted of that aspect of the company's operation.**

Part III: Your CFIT Risk

Part I CFIT Risk Factors Total (-)______+ Part II CFIT Risk-reduction Factors Total (+)_____

= CFIT Risk Score (±)______

A negative CFIT Risk Score indicates a significant threat; review the sections in Part II and determine what changes and improvements can be made to reduce CFIT risk.

 To request more information or to offer comments about the FSF CFIT Checklist, contact James M.. Burin, director of technical programs, Flight Safety Foundation, 601 Madison Street, Suite 300, Alexandria, VA 22314 U.S., Telephone: +1 (703) 739-6700 • Fax: +1 (703) 739-6708.

APPENDIX 2. AERONAUTICAL INFORMATION MANUAL, EXCERPTS

Excerpts from the Aeronautical Information Manual are reprinted below. They contain information that GA pilots should be aware of when operating at low altitude.

[Some additional editorial comments have been added to a few paragraphs to highlight certain CFIT risks or possible operating methods to reduce such risks. Aviation will always have an element of risk. A knowledgeable pilot will try to reduce these risks to an acceptable level. These additional comments are in italic and identified as AC Comments.]

7-5-3, OBSTRUCTIONS TO FLIGHT.

a. General. Many structures exist that could significantly affect the safety of your flight when operating below 500 feet AGL, and particularly below 200 feet AGL. While 14 CFR Part 91.119 allows flight below 500 AGL when over sparsely populated areas or open water, such operations are very dangerous. At and below 200 feet AGL there are numerous power lines, antenna towers, etc., that are not marked and lighted as obstructions and therefore may not be seen in time to avoid a collision. Notices to Airmen (NOTAM) are issued on those lighted structures experiencing temporary light outages. However, some time may pass before the FAA is notified of these outages, and a NOTAM issued, thus pilot vigilance is imperative.

b. Antenna Towers. Extreme caution should be exercised when flying less than 2,000 feet AGL because of numerous skeletal structures, such as radio and television antenna towers, that exceed 1,000 feet AGL with some extending higher than 2,000 feet AGL. Most skeletal structures are supported by guy wires which are very difficult to see in good weather and can be invisible at dusk or during periods of reduced visibility. These wires can extend about 1,500 feet horizontally from a structure; therefore, all skeletal structures should be avoided horizontally by at least 2,000 feet. Additionally, new towers may not be on your current chart because the information was not received prior to the printing of the chart.

[Every pilot must remember that not every tower has to be published on aeronautical charts. Chart clutter may limit the printing of some towers. Other towers are not required to be listed because they are not tall enough. A builder may simply not report a new tower. Equally dangerous is a new tower's position may be wrong. Because of these factors, pilots are cautioned to be particularly careful when operating at low altitude. The "see and avoid" rule becomes critical close to the ground. A lesson taken from the helicopter community is to fly overhead at a safe altitude and check the area for towers and hazards before descending to a lower altitude where a CFIT accident is likely to occur.]

[AC Comment: In some cases, the information is published in the next Airport/Facility Directory's Aeronautical Chart Bulletin section, but the pilot fails to make the necessary corrections to the chart.]

c. Overhead Wires. Overhead transmission and utility lines often span approaches to runways, natural flyways such as lakes, rivers, gorges, and canyons, and cross other landmarks pilots frequently follow such as highways, railroad tracks, etc. As with antenna towers, these high voltage/power lines or the supporting structures of these lines may not always be readily visible and the wires may be virtually impossible to see under certain conditions. In some locations, the supporting structures of overhead transmission lines are equipped with unique sequence flashing white strobe light systems to indicate that there are wires between the structures. However, many power lines do not require notice to the FAA and, therefore, are not marked and/or lighted. Many of those that do require notice do not exceed 200 feet AGL or meet the Obstruction Standard of 14 CFR Part 77 and, therefore, are not marked and/or lighted.

All pilots are cautioned to remain extremely vigilant for these power lines or their supporting structures when following natural flyways or during the approach and landing phase. This is particularly important for seaplane and/or float equipped aircraft when landing on, or departing from, unfamiliar lakes or rivers.

d. Other Objects/Structures. There are other objects or structures that could adversely affect your flight such as construction cranes near an airport, newly constructed buildings, new towers, etc. Many of these structures do not meet charting requirements or may not yet be charted because of the charting cycle. Some structures do not require obstruction marking and/or lighting and some may not be marked and lighted even though the FAA recommended it.

7-5-4. AVOID FLIGHT BENEATH UNMANNED BALLOONS.

a. The majority of unmanned free balloons currently being operated have, extending below them, either a suspension device to which the payload or instrument package is attached, or a trailing wire antenna, or both. In many instances, these balloon subsystems may be invisible to the pilot until the aircraft is close to the balloon, thereby creating a potentially dangerous situation. Therefore, good judgment on the part of the pilot dictates that aircraft should remain well clear of all unmanned free balloons and flight below them should be avoided at all times.

b. Pilots are urged to report any unmanned free balloons sighted to the nearest FAA ground facility with which communication is established. Such information will assist FAA ATC facilities to identify and flight follow unmanned free balloons operating in the airspace.

[AC Comment: In addition to unmanned free balloons, the U.S. Government operates unmarked balloons thousands of feet into the sky tethered to cables. These balloons are contained in published restricted areas. Located primarily along the southern U.S. border, pilots are advised to check their charts for the location of these unmarked tethered balloons when flying through areas they are not familiar with. These balloons may be at an altitude of more than 10,000 feet AGL.]

7-5-5. MOUNTAIN FLYING.

a. Your first experience of flying over mountainous terrain (particularly if most of your flight time has been over the flatlands of the Midwest) could be a never-to-be-forgotten nightmare if proper planning is not done and if you are not aware of the potential hazards awaiting. Those familiar section lines are not present in the mountains; those flat, level fields for forced landings are practically nonexistent; abrupt changes in wind direction and velocity occur; severe updrafts and downdrafts are common, particularly near or above abrupt changes of terrain such as cliffs or rugged areas; even the clouds look different and can build up with startling rapidity. Mountain flying need not be hazardous if you follow the recommendations below.

[AC Comment: As in all types of new flying, you should find a qualified and currently certificated flight instructor for a local area checkout.]

b. File a flight plan. Plan your route to avoid topography which would prevent a safe forced landing. The route should be over populated areas and well-known mountain passes. Sufficient altitude should be maintained to permit gliding to a safe landing in the event of engine failure.

c. Don't fly a light aircraft when the winds aloft, at your proposed altitude, exceed 35 miles per hour. Expect the winds to be of much greater velocity over mountain passes than reported a few miles from them. Approach mountain passes with as much altitude as possible. Downdrafts of from 1,500 to 2,000 feet per minute are not uncommon on the leeward side.

d. Don't fly near or above abrupt changes in terrain. Severe turbulence can be expected, especially in high wind conditions.

e. Some canyons run into a dead end. Don't fly so far up a canyon that you get trapped. ALWAYS BE ABLE TO MAKE A 180 DEGREE TURN!

f. VFR flight operations may be conducted at night in mountainous terrain with the application of sound judgment and common sense. Proper pre-flight planning, giving ample consideration to winds and weather, knowledge of the terrain and pilot experience in mountain flying are prerequisites for safety of flight. Continuous visual contact with the surface and obstructions is a major concern and flight operations under an overcast or in the vicinity of clouds should be approached with extreme caution.

g. When landing at a high altitude field, the same indicated airspeed should be used as at low elevation fields. *Remember:* that due to the less dense air at altitude, this same indicated airspeed actually results in higher true airspeed, a faster landing speed, and more important, a longer landing distance. During gusty wind conditions which often prevail at high altitude fields, a power approach and power landing is recommended. Additionally, due to the faster groundspeed, your takeoff distance will increase considerably over that required at low altitudes.

h. Effects of Density Altitude. Performance figures in the aircraft owner's handbook for length of takeoff run, horsepower, rate of climb, etc., are generally based on standard atmosphere conditions (59 degrees Fahrenheit (15 degrees Celsius), pressure 29.92 inches of mercury) at sea level. However, inexperienced pilots, as well as experienced pilots, may run into trouble when they encounter an altogether different set of conditions. This is particularly true in hot weather and at higher elevations. Aircraft operations at altitudes above sea level and at higher than standard temperatures are commonplace in mountainous areas. Such operations quite often result in a drastic reduction of aircraft performance capabilities because of the changing air density. Density altitude is a measure of air density. It is not to be confused with pressure altitude, true altitude, or absolute altitude. It is not to be used as a height reference, but as a determining criteria in the performance capability of an aircraft. Air density decreases with altitude. As air density decreases, density altitude increases. The further effects of high temperature and high humidity are cumulative, resulting in an increasing high-density altitude condition. High-density altitude reduces all aircraft performance parameters. To the pilot, this means that the normal horsepower output is reduced, propeller efficiency is reduced and a higher true airspeed is required to sustain the aircraft throughout its operating parameters. It means an increase in runway length requirements for takeoff and landings, and decreased rate of climb. An average small airplane, for example, requiring 1,000 feet for takeoff at sea level under standard atmospheric conditions will require a takeoff run of approximately 2,000 feet at an operational altitude of 5,000 feet.

NOTE: A turbo-charged aircraft engine provides some slight advantage in that it provides sea level horsepower up to a specified altitude above sea level.

[AC Comment: A turbo-charged aircraft can provide a significant operating advantage if operated within its approved limitations. In some cases, a turbo-charged, high performance aircraft may be the only safe way to fly into and out of some mountain landing areas.]

(1) Density Altitude Advisories. At airports with elevations of 2,000 feet and higher, control towers and FSSs will broadcast the advisory "Check Density Altitude" when the temperature reaches a predetermined level. These advisories will be broadcast on appropriate tower frequencies or, where available, ATIS. FSSs will broadcast these advisories as a part of Local Airport Advisory, and on TWEB.

(2) These advisories are provided by air traffic facilities, as a reminder to pilots that high temperatures and high field elevations will cause significant changes in aircraft characteristics. The pilot retains the responsibility to compute density altitude, when appropriate, as a part of preflight duties.

NOTE: All FSSs will compute the current density altitude upon request.

附錄 14 「安全考量因素」之訓練宣導手冊

1. DEGRADED VISUAL ENVIRONMENT (DVE)

A continuing significant number of accidents are due to pilot disorientation in a degraded visual environment (DVE). Research has demonstrated the strong relationship between helicopter handling characteristics and available visual cues.

This has clearly shown that there are likely to be visual cueing conditions, helicopter handling characteristics and pilot capabilities which, although manageable individually, can be predicted to be unmanageable when in combination.

Analysis indicates that any, or a combination of, the following three scenarios could result in a serious accident:

A ›› Loss of control when attempting a manoeuvre to avoid a region of impaired visibility, i.e. backtracking, climbing above or descending below the DVE.

B ›› Spatial disorientation or loss of control when transferring to instrument flight following an inadvertent encounter with IMC.

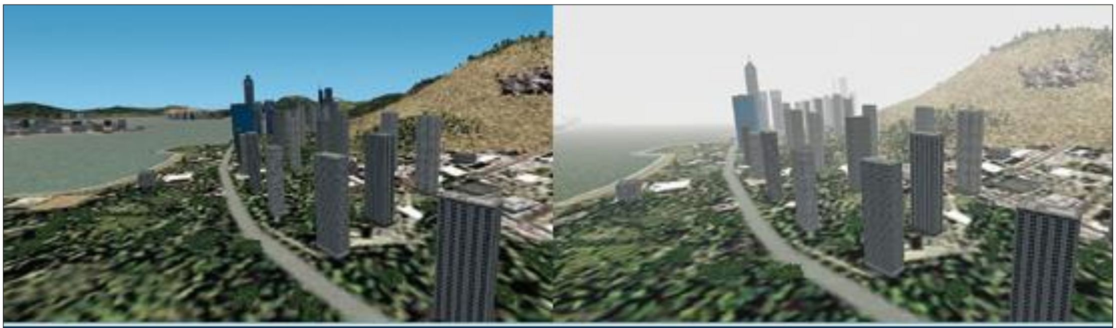
C ›› Loss of situational awareness resulting in controlled flight into terrain/sea/ obstacles or a mid air collision.

1.1 Helicopter Handling Characteristics

The inherent instability of the helicopter is a major factor in such accidents. For small un-stabilised helicopters, it is the pilot who has to provide the stability and he needs visual cues to do so.

1.2 Pilot Capabilities

Whilst most pilots receive limited basic training in 'flight with sole reference to instruments', the competence in this skill can deteriorate rapidly and therefore cannot always be relied upon to safely extricate the unprepared pilot from an inadvertent IMC situation.



1.3 Visual Cues

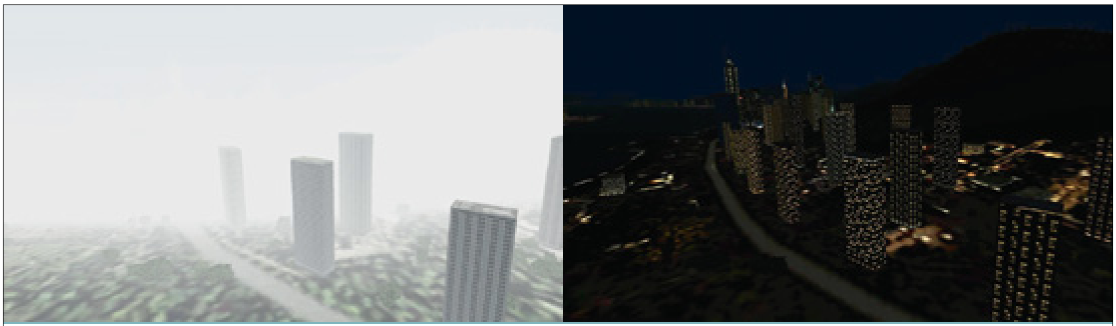
Evidence shows that for a significant number of fatal accidents the primary causal factor was degraded visual cues. Common factors, which act to degrade the available visual cues, include:

A ›› Low levels of ambient light leading to a general reduction in the quality of the visual scene and the available optical cues, e.g. at dusk/night.
B ›› Reduced visual range and/or loss of sight of the ground/surface of the sea due to the effects of fog or cloud.
C ›› The presence of atmospheric haze or sun glare.
D ›› A lack of surface texture or features such as buildings, roads and rivers, or lack of street lighting etc. when flying at night.
E ›› A lack of texture on the surface of the sea/water, i.e. calm water.
F ›› Poorly delineated sloping or rising ground contours i.e. snowfields.
G ›› Misleading cues such as a false horizon from, for example, a distant row of street/road lights.
H ›› Obscuration due to precipitation or misting on the cockpit windows.

1.4 Risk Analysis

When planning a visual reference flight 'with the surface in sight', there are a number of obvious risk factors which should be taken into consideration prior to take-off:

1 ›› The aircraft is certificated for VFR/VMC flight only.
2 ›› The pilot is not trained/current for instrument flight operations.
3 ›› The pilot is not trained/current in recoveries from unusual attitudes.
4 ›› The navigation will be by map and visual reference, perhaps with GPS backup.
5 ›› The flight is planned to take place at a height at which the surface cannot be clearly defined.
6 ›› A segment of the route involves over-flight of a rural, unpopulated area or large featureless areas such as water, snow etc.
7 ›› The flight is at night or in conditions of atmospheric 'gloom'.
8 ›› Flight at night when there is no moon, or the stars and moon are obscured.
9 ›› There are, or are likely to be, significant layers of low level cloud en-route (4/8 – 8/8).
10 ›› The visibility is, or is likely to be, limited en-route, i.e. visual range at or close to the minimum required for conducting a safe flight,(which may be significantly higher than the stated state minima).
11 ›› There is a significant probability of encountering mist/fog/haze en-route.
12 ›› There is a significant probability of encountering precipitation en-route.



If these risk factors are considered as a risk assessment checklist, it can be seen that the magnitude of risk increases with the number of risks 'ticked'. For example:

- If risks 1 to 4 were to be ticked, this would only pose a normal, acceptable level of risk provided that the flight were to be undertaken in good VMC conditions.
- If risks 1 to 9 are ticked, experience indicates that the flight should not be undertaken.
- Risks 7 to 12 all add to the type of conditions that would make it extremely unlikely that a pilot would be able to maintain control of the aircraft's attitude by visual references alone.

1.5 In Flight

Once a flight is underway other risk factors may come into play:

13 ›› There is a low level of ambient light.
14 ›› There is no visual horizon, or the horizon is only weakly defined at best.
15 ›› There are few, if any, visual cues from the ground plane.
16 ›› Changes of speed and height are not perceivable, or only poorly perceivable by visual reference alone.
17 ›› Reducing height does not improve the perception of the horizon or cues on the ground.
18 ›› The view from the cockpit is obscured due to precipitation/misting.
19 ›› The cloud base is lowering causing an unintended descent to retain similar forward visual cues.

These factors will add to the inherent risk of the flight already assessed by the risks ticked prior to the flight. For example:

- Even if only risks 1 to 4 were to be ticked prior to flight, the overall risk would increase significantly were any of risks 13 to 19 to be subsequently encountered en-route.
- Risks 13 to 19 all point to the need for extreme caution (i.e. gentle manoeuvres only!) and serious consideration should be given to terminating the flight and conducting a safe, controlled precautionary landing as soon as is safe to do so.

1.6 Loss of Visual References

If external visual references are lost then to prevent spatial disorientation, a pilot will need to transfer his attention immediately onto the aircraft instruments and use them to establish a safe flight profile. A rapid risk assessment, taking into consideration the weather, terrain, aircraft limitations, fuel and pilot's capability is critical to a speedy establishment of a nominated safe flight profile. This may require the pilot, once established on instruments, to conduct a turn back, a descent or a climb to a safe altitude or a combination of these.

1.7 Conclusion

Risk analysis and timely decision-making are essential tools to be used by the pilot during both the planning and the flight stages. Constant updating and evaluation of all of the available information should assist the pilot to recognize dangers inherent to a degraded visual environment. This will assist the pilot to carry out the appropriate actions in order to prevent the situation from developing into a critical stage for which the pilot may not have the relevant skill level, capabilities and/or helicopter instrumentation to cope with safely.