Aviation Safety Council

Taipei, Taiwan

GE 235 Occurrence Investigation Factual Data Collection Group Report

General Information

July 02, 2015

ASC-FRP-15-07-001

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Aviation Occurrence Preliminary Report

FILING INFORMATION

Headline: TransAsia Airways GE 235 Occurrence	
State reporting: Taiwan, ROC	Date entered: 2015.02.17
State file number:ASC-AOR-15-02-PR1	Reporting org.: Aviation Safety Council
Report identification: GE235	Report status: Preliminary
Reporter's name: Thomas Wang	
Telephone: +886-2-8912-7388	Email: wang@asc.gov.tw
Scope of Investigation: Full (ICAO Annex 13 Format)	

CLASSIFICATION

Occurrence class: Accident	Occurrence category: TBD

WHEN

Local date: 2015.02.04 10:54	UTC date: 2015.02.04 02:54

WHERE

State of occurrence: Taiwan, ROC	FIR: Taipei
Altitude of inflight occurrence: N/A	
Location of occurrence: 5.4 km ESE of RCSS end of RWY 10 Aerodrome ID/ Name of Aerodrome: RCSS/Taipei Songshan	Latitude Deg/ Min/ Sec: E 121° 37:04 Longitude Deg/ Min/ Sec: N 25° 03:48

SEVERITY

Damage aircraft: Destroyed	Injury level: Fatal
Third party damage: Yes	

INJUSR TOTALS

	Fatal	Serious	Minor	None	Unknown	Total
Total on Ground	0	1	1	0	0	2
Total on Aircraft:	43	14	1	0	0	58
Crew:	4	1	0	0	0	5
Passengers:	39	13	1	0	0	53
Other:	0	0	0	0	0	0
Unknown:	0	0	0	0	0	0
Total:	43	15	2	0	0	60

GENERAL WEATHER CONDITIONS

Weather conditions: VMC	Light conditions: Day Light

AIRCRAFT IDENTIFICATION

Manufacturer/model: ATR72-600	State of registry: Taiwan, ROC
Aircraft Serial Number: 1141	Aircraft registration: B-22816

AIRCRAFT OPERATION

Operator: TransAsia Airways	Operation type: Commercial Air Transport Scheduled revenue ops Domestic Passenger

HISTORY OF FLIGHT

Last departure point: RCSS	Flight phase: Takeoff Duration of flight: 3 minutes
Planned destination: RCBS	Occ. on ground: No

TERRAIN AT WREKAAGE

Terrain type: Level/flat	Surface type: River
Any special requirement to reach the site: None	

EVENTS

Propeller control, during initial climb
Flight systems/flight crew mismatch, during initial climb
Aircraft collision with level terrain/water, during initial climb

NARRATIVE

On February 4th, 2015, TransAsia Airways flight GE 235, an ATR72-600, registration B-22816, took off from Taipei Songshan Airport for Kinmen, Taiwan. There were 58 people onboard, including 3 flight crew (one as observer), 2 cabin crew, and 53 passengers. At 1054 hrs, the aircraft crashed into Keelung River at 5.4 km ESE from the end of RWY 10 of Songshan Airport, 43 onboard received fatal injuries, 14 received serious injuries, 1 received minor injury, and 2 people on ground also received injuries to different extent. Preliminary data indicates that about 36 seconds after takeoff the engine no.2 auto-feathered, about 46 seconds subsequent to auto-feather the engine no.1 was shut off.

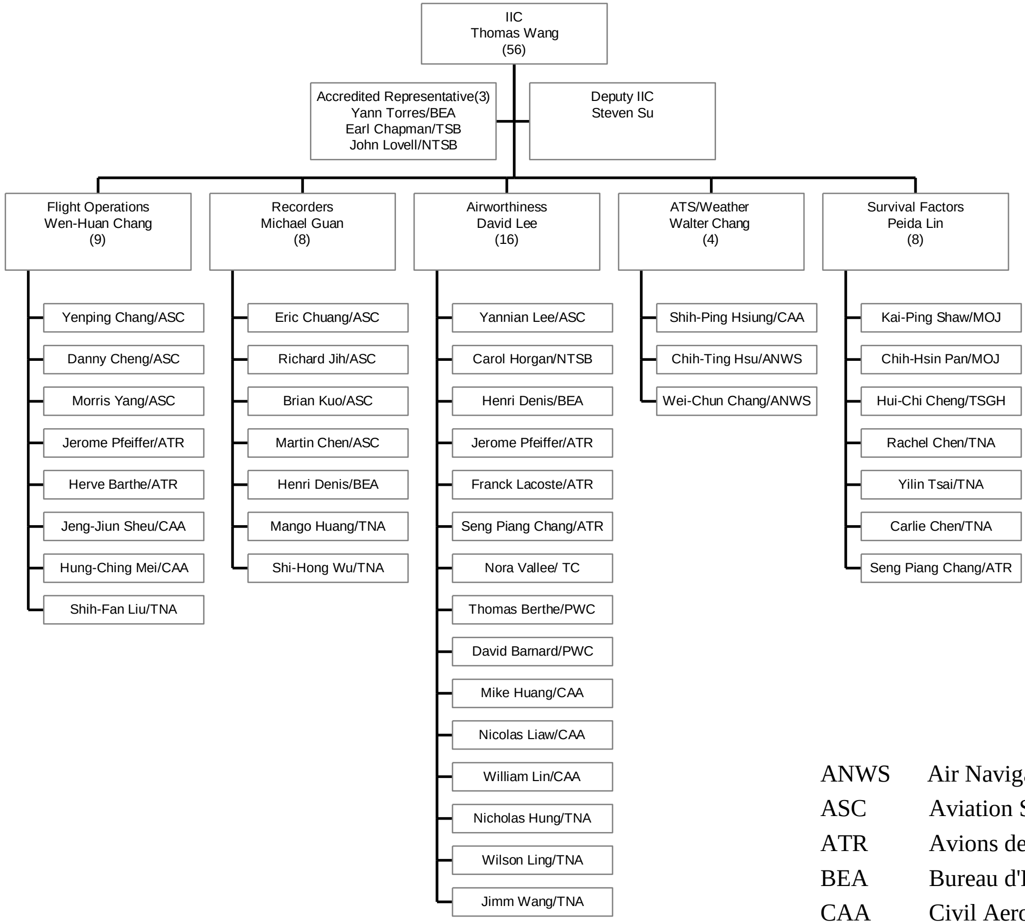
On February 4, 2015, TransAsia Airways passenger flight GE 235, an ATR 72-600 aircraft, registration number B-22816, took off from Songshan Airport at 1053 Taipei time for Kinmen Airport. The aircraft carried 58 people, including 3 flight crew members, 2 cabin crew members, and 53 passengers. The aircraft lost contact immediately after took off and crashed into Keelung River, 43 people perished, 15 people on board and 2 people on ground received injuries.

According to ICAO Annex 13 and Aviation Occurrence Investigation Act, Aviation Safety Council (ASC), an independent government organization of Taiwan responsible for civil aviation occurrence investigation, has immediately formed a team to conduct the investigation of this occurrence. The states of manufacture include Bureau d'Enquêtes et d'Analyses (BEA) of France, Transportation Safety Board (TSB) of Canada, and National Transportation Safety Board (NTSB) of the United States joined the investigation team as the Accredited Representatives. Based on the nature of this occurrence, the investigation team is organized into 5 groups: Flight Operations, Airworthiness, ATS/Weather, Survival Factors, and Recorders. Organization of the investigation team is shown in Appendix 0-1.

After nearly 5 months of investigation including on-scene investigation and data collection, the investigation team presents the factual data collected relevant to this occurrence. It should be noted that these reports contain only factual information. The analysis portion of the investigation process will commence immediately after the release of these reports. It is expected that the draft report will be furnished to the Accredited Representatives and parties for comments in November 2015 and the final report will be published in April 2016. Should any new factual data surface during the time of the analysis, ASC shall notify the Accredited Representatives immediately and the factual report will be modified accordingly.

The factual report is organized by the reports from each individual group. Individual group report contains the name of the group members and their background, histories of activities, factual description of the group, and data list. The factual description in each group report will follow the format of Chapter 1 of ICAO Annex 13. It should be noted that since each group conducted its own data collection, similar information may appear in the report of several groups. Text of the report will be published on ASC web site: http://www.asc.gov.tw

Appendix 0-1 Organization Chart of GE 235 Occurrence Investigation Team



ANWS	Air Navigation and Weather Services, CAA Taiwan
ASC	Aviation Safety Council, Taiwan
ATR	Avions de Transport Régional
BEA	Bureau d'Enquêtes et d'Analyses, France
CAA	Civil Aeronautics Administration, Taiwan
MOJ	Institute of Forensic Medicine, Ministry of Justice
NTSB	National Transportation Safety Board, U.S.A.
PWC	Pratt & Whitney Canada
TC	Transport Canada
TNA	TransAsia Airways
TSB	Transportation Safety Board, Canada
TSGH	Tri-Service General Hospital

Overall Logistics: Brian C. Kuo

Aviation Safety Council

Taipei, Taiwan

GE235 Occurrence Investigation
Factual Data Collection
Group Report

Flight Operations Group

July 2, 2015

ASC-FRP-15-07-002

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Contents

I. Team Organization

Chairman:
Wen-huan Chang Aviation Safety Council (ASC), Taiwan ROC
Members:
1. Captain Yen-Ping Chang Aviation Safety Council (ASC), Taiwan ROC
2. Captain Hung-Ching Mei Civil Aeronautics Administration (CAA), Taiwan ROC
3. Captain Jeng-Jiun Sheu Civil Aeronautics Administration (CAA), Taiwan ROC
4. Captain Jerome Pfeiffer ATR, France
5. Captain Herve Bathe ATR, France
6. Capt Shih-fan Liu TransAsia Airways
7. Danny Cheng Aviation Safety Council (ASC), Taiwan ROC
8. Morris Yang Aviation Safety Council (ASC), Taiwan ROC

II. History of Activities

Date	Activities
2/04/15	1. Conducted the preliminary on scene investigation, including the preliminary examination of initial impact point, the flight track and major wreckage site. Checked the wreckages and took photo, the first impact point could be the fence and an electrical pole on the elevated bridge. The main wreckages are in the middle of the Keelung River. 2. Visited TNA FLT OPS Dept. for information: including dispatch file, load sheet, manifest, briefing materials (NOTAM, METAR, FLT Plan…) roster, crew information, dispatched schedules. 3. Interviewed dispatcher. 4. Got the occurrence aircraft flight path and review it 5. Conducted interview with one dispatcher 6. Got the crew's previous flight information 7. Reviewed ATR-600's FCOM and SOP 8. On scene wreckages recovery monitoring, negotiated with the prosecutor and rescue commander.
2/05/15	1. Checked the wreckage and took photo 2. Inspected the wreckage cockpit and gathered the information from instrument panel, the control column, power control quadrant and switch. 3. Interviewed Air Traffic controller. 4. Reviewed the preliminary FDR data. 5. Supported the wreckage transport. 6. Secured the relevant documents of flight records.
2/06/15	1. Organized the FLT OPS group include ASC, ATR, BEA, TNA 2. Briefed and discussed the FLT OPS work items. 3. Checked the wreckage with advisers from ATR and took photos. 4. Inspected the wreckage cockpit included instrument panel, throttle quadrant and discussed the cockpit rebuild

Date	Activities
	planning with TNA personnel. 5. Interviewed the standard training manger. 6. Interviewed the ATR-600 flight crew 7. Provided the FLT OPS data for the press conference. 8. Reviewed ATR-600 SOP. 9. Reviewed the required documents from CAA, TNA and ATR. 10. Collaborated with BEA, ATR representatives in confirming contents integrity of FDR (Flight Data Recorder) read-outs and rationalize the history of flight profile. 11. Reviewed the function of ATPCS system. Logic, normal and abnormal operations, technical description, history.
2/07/14	1. Finalized the FLT OPS Group advisers of CAA, TNA. 2. Integrated and documented the materials. 3. Wrote the field notes and interview notes. 4. Final rationalization of the history of flight profile with BEA, ATR. 5. Group members listened to CVR including ASC, CAA, and TNA. 6. Group meeting: discussed the work assignments. 7. Reviewed ATR-600 SOP including before T/O & after T/O 8. Sorted and reviewed the abnormal & emergency procedures at T/O and after T/O. 9. Received ECL software and related information. 10. Clarified the chime sound happened on ground for the occurrence flight.
2/08/15	1. Checked and reviewed the transient training program from ATR72-500 to ATR72-600. 2. Clarified the standard callout of engine flameout in SOP or FCTM. 3. Reviewed and studied the use of ECL. 4. Reviewed and studied the ATR ‘mini-trainers software’.

Date	Activities
	5. Asked TNA or the ATR training center requested to provide more flight crew difference training records. 6. Engine out ECL procedures presentation and discussion. 7. Simulator test requirements discussion 8. ATR72-600 Training syllabus discussion 9. ATR72-600 Cockpit warning system discussion 10. Reviewed the ATR fleet flight crew interview plan. 11. Reviewed the occurrence crew training records 12. Discussed the crew operations after takeoff 13. Discussed the operation of ATPCS fault procedures. 14. Discussed the Check Pilot interview who conducted the CM1 flight check 15. Prepared the documents need for CRM data factual. 16. Assisted to work on the CVR transcript. 17. Wrote the interview notes.
2/09/15	1. Completed the simulator test plan outline and budget requirements. 2. Studied the TNA FLT OPS new organization. 3. Discussed the CAA policy(or background) for issuing the ATR type rating between 500 and 600 4. Discussed the detailed TNA training program and approved process for ATR72-600 5. Studied the AC-120-010A, flight operations training spec. published by CAA. 6. Discussed the organization & function of technical review board of TNA 7. Checked if the occurrence flight crew experienced the engine problem while they flew ATR72-600 8. Reviewed and studied FOD Operations Manual of TNA 9. Checked if there is any OEB related to retard both throttle to idle during single eng. flameout 10. Checked if the crew who received the ATR72-600 difference training has any comments to the training program

Date	Activities
	11.Reviewed the type rating issuance and procedures of CAA 12.Checked if TNA had the letter to ATR ask about difference training program 13.Accomplished the crew interview plan 14.Reviewed CM1's and CM2's flight time & schedule. There was no work time violation and high flight time issue. 15.Confirmed that CM1 and CM2 arranged sleep location by themselves. So we need to interview with their family if we want to have sleep data last 72 hrs before occurrence. 16.Reviewed the FDR data about crew response right after no.2 engine anomalies occurred. 17.Assisted the CVR transcript. 18.Finished the interview notes: 1 dispatcher and 1 training supervisor.
2/10/15	1. Conducted the CVR transcript verification. 2. Reviewed the emergency procedures "engine flameout at takeoff" on FCOM paragraph 03.02.03 3. Sorted out "Engine no.2 flameout at takeoff" procedure on ECL. 4. Reviewed the OEB 14: procedure display in case of engine flame out 5. Reviewed the difference training program from ATR500 to 600 in FTMM.(2.18) 6. Finished the draft" History of flight". 7. Interviewed the senior IP/CP in TNA ATR fleet (4) 8. Wrote up the preliminary sequence of events 9. Reviewed and discussed the AC-120-010A:" Flight operation spec" issued by CAA. 10.Turned in the document requirements list. 11.Reviewed the action log 12.Finished the interview notes: 1 flight crew.

Date	Activities
2/11/15	1. Reviewed FOM & FCOM which related to this occurrence. 2. Reviewed the detailed sequence of events. 3. Checked crew training related information 4. Continued to interview the TNA flight crew 5. Planned OBS flight for ATR-600 6. Reviewed the detailed crew training records and selection process, including: selection, oral, simulator and flight. 7. Reviewed the FOM： 7.1 Chapter 3 Duties and Responsibilities 7.2 Chapter 4 Crewmembers Operational Regulations 7.3 Chapter 5 Crew Resource Management 8. Acquired the ATR-72-600 runway analysis manual. 9. Explained the brief history of flight to the AR from CAAC 10. Reviewed the detailed ATPCS function 11. Reviewed and discussed the difference training program from ATR500 to 600 12. Interviewed two flight crew in TNA ATR fleet 13. Reviewed and updated the action log 14. Wrote up the interview notes. 15. Assisted the CVR transcript 16. Confirmed the recorded gross weight (parameter Gross Weight 1): 20,340 kg at take off. End of the flight: 20,300 kg.
2/12/15	1. Group meeting to discuss the MEL of ATPCS system. 2. Reviewed and discussed FOM CH 6, CH 7, CH8, CH 9 and CH11. 3. Attended the CVR verification. 4. Checked and reviewed crew training related information 5. Continued to interview the TNA flight crew

Date	Activities
	6. Planned and negotiated the OBS flight.
2/13/15	1. Preliminary group discussion about CVR (Cockpit Voice Recorder) transcript. 2. Discussed the detailed flight crew training related issues. 3. Interviewed two flight crews in TNA ATR fleet. There were totally 11 flight crew interview task have been completed up to date 4. Reviewed and updated the action log, 23 action items have been logged on the action log. 5. Wrote up the interview notes, 4 interview notes have been done up to date 6. Attended the CVR transcript verification, the required CVR transcript has been completed today. 7. Discussed the contents of OEB 14
2/16/15	1. Group meeting to discuss the CVR transcript. 2. Wrote up the interview notes, 3 more interview notes have been done today 3. Preliminary FDR study. 4. Reviewed and discussed the FCTM and FTMM
2/24/15 To 3/08/15	1. Acquired the crew's activities on the occurrence day and the crew's families contact information. 2. Provided the FDR data to group members for them to review. 3. Worked out the required document list for the FLT OPS. 4. Conducted the preliminary review of the crew training records and found some anomalies. 5. Found the cockpit sterile policy which is in FOM 7.5.8 Sterile Cockpit Environment 6. Sorted out the before T/O SOP 7. Phone interviewed with the spouse of CM1 & CM2. 8. Reviewed and discussed the draft sequence of events
3/09/15	1. Wrote up the interview notes.

Date	Activities
	2. Initialized the detailed sequence of events
3/13/15	1. Group meeting to discuss the factual status 2. Reviewed the sequence of events 3. Initialized potential safety factors of GE235
3/18/15	1. Group meeting to discuss the factual status 2. Reviewed the sequence of events and potential safety factors. 3. Discussed the detailed SIM test requirements and scenario.
3/23/15	1. Attended the progress meeting 2. Studied the SID procedures and runway analysis data of Songshan airport and compare it with the flight track. 3. FCOM and SOP review and comparison
3/25/15	1. Group meeting to discuss the factual report outline. 2. Defined the work assignment of FLT OPS group factual report. 3. Reviewed the crew's 72 hours activities.
3/27/15	1. Reviewed and discussed the flight crew training manual 2. Reviewed the OEB on Feb. 15
4/14/15	1. Group meeting to discuss the factual report and the detailed requirements of simulator test. 2. Continually reviewed the sequence of events and potential safety factors. 3. Mapped out the safety factors map
4/17/15	Reviewed the FDR data and discussed the flight track with FDR group.
4/20/15	1. Wrote up the factual data report. 2. Prepared the interview question to the training department of TNA
4/21/15	Wrote up the factual data report.
4/23/15	1. Wrote up the factual data report.

Date	Activities
	2. Interviewed with the training manager of TNA
4/24/15	1. Wrote up the factual data report. 2. Discussed the factual progress and follow on task
4/29/15	1. Group meeting for the progress 2. Conducted the cockpit display test
4/30/15	1. Progress meeting to review the draft factual report and potential safety factors.
5/05/15	1. Conducted the cockpit display test
5/06/15 To 5/15/15	1. Wrote up the functions and the displays of ATPCS paragraph and added in to the factual report 2. Prepared for the TNA PT/PC SIM training observation task; included OBS plan, data requirements, detailed procedures and ATR72-600 SOP study
5/20/15 To 5/23/15	1. Conducted the TNA PT/PC SIM observation task in BKK. 2. Wrote the observation notes of BKK PT/PC/training
5/25/15 To 6/18/15	1. Discussed and wrote up the SIM test plan to TLS 2. Negotiate ATR for the SIM test task 3. Reviewed and discussed the draft factual report

III. Factual Description

1.1 History of Flight

On February 4, 2015, an ATR72-212A(600 version) aircraft, registered B-22816, was operating as a TransAsia Airways (TNA) flight GE235 with 58 occupants on board, including 2 captains, 1 first officer, 2 cabin crews and 53 passengers. At 1054 [1] Taipei Local Time, approximately 3 minutes after taking off from runway 10 of Songshan Airport (RCSS), the flight crashed into Keelung River approximately 3 nautical miles east of RCSS. The airplane was destroyed on impact and more than half of the main wreckage was immersed in the middle of the river (Figure 1.1-1). Forty-three occupants, including 3 flight crewmembers, 1 cabin crew and 39 passengers, were fatally injured. The other 13 passengers and 1 cabin crew sustained serious injuries and 1 passenger received minor injuries. When GE235 flew over an overpass before crashing into water, its left wing hit a taxi with two occupants. The taxi driver sustained serious injuries and the passenger sustained minor injuries.

Figure 1.1-1 GE235 main wreckage

[1] Unless otherwise noted, all time in this report are Taipei Local Time (UTC+8 hours) based on a 24-hour clock.

On the date of occurrence, the flight crew was assigned to fly 2 round trips from RCSS to Kinmen Airport (RCBS) dispatched with two captains and one observer for a total of 4 flights with the B-22816. The flight legs began at RCSS as flight GE231, departed at 0744 and arrived in RCBS at 0850. The turnaround flight GE232 departed at 0917 and arrived in RCSS at 1012. There was no anomaly reported for the previous 2 flights.

The third flight, GE235, the occurrence flight, was scheduled to depart at 1045 from RCSS for RCBS. Captain A, who was the pilot-in-command (PIC), occupied the left seat and was the pilot flying (PF) for the takeoff, while the Captain B occupied the right seat and was the pilot monitoring (PM). The first officer occupied the observer seat as an observer pilot (OBS). The flight track was shown in figure 1.1-2.

Figure 1.1-2 GE235 departure flight track

According to Flight Data Recorder (FDR) and Cockpit Voice Recorder (CVR) data[2], GE235 took off from RCSS runway 10 at 1052, and followed MUCHA 2 Quebec Standard Instrument Departure (SID) procedure bound for RCBS. The airplane started to takeoff rolling at 1051:39, 4 seconds latter (1051:43), the PM mentioned that the Automatic Take-off Power Control System (ATPCS) was not armed. The PF responded with "*really*" and then said "*ok continue to take off*". PM followed "*we will continue*". Seven seconds later the PM stated "*oh there it is ATPCS armed*", then the aircraft reached V1 (107 knots[3]) and became airborne at 1052:01. The landing gear was retracted after achieving a positive rate of climb, the airplane accelerated and continued to climb. The selected altitude was 5,000 feet (ALT SEL 5,000) and the speed selected was 115 knots. The left coupling autopilot was engaged with

[2] Some of CVR transcript is in Chinese and has been translated into English in this report.

[3] The speed described in this report is computed air speed.

LNAV and IAS mode. At 1052:34 the tower informed GE235 to contact Taipei approach while the airplane was climbing through an altitude[4] of 1,000 feet and started turning to the right.

At 1052:38, the airplane was climbing through 1,200 feet and continued turning to the right, FDR recorded parameters indicating that number 1 engine (ENG1) was in up-trim condition and its bleed valve was closed, which corresponded to the beginning of ATPCS sequence, that also included the auto feathering of number 2 engine (ENG2) propellers. Master Warning sounded in the cockpit and ENG2 propeller pitch angles started to increase to feather position after the beginning of the ATPCS sequence. "ENG 2 FLAME OUT AT TAKE OFF" procedure was displayed on the Engine and Warning Display (EWD).

At 1052:41, the airplane climbed through an altitude of 1,300 ft and the autopilot was manually disconnected. Three seconds later at 1052:44 the ATPCS sequence ended, ENG2 propeller was fully feathered. At 1052:43 PF said "*i will pull back engine one throttle*", PM responded "*wait a second cross check*", but ENG1 power lever Angle (PLA[5]) was already retarded from 75 degrees to 66 degrees. PF and PM then announced heading mode, and continued the flight. At 1052:51, the airplane was climbing through 1,485 feet at 106 knots, and the heading was 131 degrees, the Automatic Flight Control System (AFCS) modes showed HDG SEL and IAS mode. At 1052:57 the selected heading was 092 degrees, the airplane then started turning to the left, and the speed was 106 knots.

At 1053:00, PM stated "*okay engine flame out check*", PF responded "*check"* and PM continually stated "*check uptrim yes, auto feather yes*". At 1053:05 PF responded "*okay*", almost at the same time PM stated "*watch the speed*", the speed at that moment was 101 knots, and then PF stated "*pull back number one*", the ENG1 PLA was retarded to 49 degrees. While the ENG1 PLA was retarded, almost simultaneously PM said "*okay now number two engine flameout confirmed*", and PF responded "*okay*" but the ENG1 PLA still remained at 49 degrees.

At 1053:09, the airplane reached 1,630 ft. It was the highest altitude recorded in this flight, and the speed was 102 knots. AFCS IAS mode reverted into PITCH HLD mode, one second later the stall warning

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4 The altitude described in this report is radio altitude.

5 The PLA signal is from Mechanical Fuel Control Unit(MFCU) angle on airplane and is recorded on FDR, rather than the pedestal angle.

sounded in the cockpit for 1 second, then the PF stated "*terrain ahead*", PM stated " *okay lower…*" and the OBS said "*you are low*". At 1053:13 the stall warning sounded for 4 seconds with the stick shakers and in that time periods, PM stated "*okay push, push back*", PF stated "*shut*", PM responded "*wait a second…throttle throttle*". During the time period between 1053:13 and 1053:15, the ENG2 PLA was advanced to 86 degrees and the ENG1 PLA was retarded to around 34.5 degrees (idle position). At 1053:18, the speed was 101 knots and the altitude was 1,526 ft and continually descending, the heading was 087-degrees, and continuously turned to the left with 10 to 20 degree bank. At 1053:19 PF said "*number one*" and followed "*feather shut off*", in the mean time PM called *"number feather*", then the stick shaker and stick pusher warnings were triggered several times until 1053:27. At 1053:24, the FDR indicated the ENG1 condition lever was at fuel shut off position, and 6 seconds later the ENG1 propeller reached the feather position, the speed was 110 knots at 1,165 ft descending.

At 1053:35, PM declared mayday to ATC, the airplane heading was 050 degrees and started to bank to the right. At the time period of 1053:46 to 1054:04, the flight crew tried to engage the AP twice, but did not succeed. At 1053:53, OBS said "*how come it becomes like this*". At 1054:05, PM stated "*we lost both sides*", two seconds later, PM realized and stated "*both engines were flameout*". At 1054:09, PF stated "*restart the engine*", and the altitude was 545 ft with speed of 105 knots, he repeated "*restart the engine*" 8 times in total after then. From that time on, the airplane entered stall conditions until the end of the flight.

At 1054:20, the ENG1 condition lever was moved out of shut off position, at 1054:25,the ENG1 high pressure speed (NH1) rose to 30 % and the speed at that moment was 106 knots, the altitude was 400 ft, and the airplane started to bank to the left. At 1054:27, PF said "*wow pulled back the wrong side throttle*".

At 1054:34, Enhanced Ground Proximity Warning System (EGPWS) "Pull-up" warning sounded in the cockpit. At 1054:35 the airplane increased bank from 10 to 80 degree left side, made first impact with a taxi driving on the overpass, then hit the fence and a light pole at the edge of the overpass located southwest of the crash site near Keelung river (Figure 1.1-3), and continued to bank left after impact, then crashed into the river with an upside down attitude.

Figure 1.1-1 GE235 lost control and first impact picture

1.5 Personnel Information

1.5.1 Flight Crew's Background and Experience

1.5.1.1 Captain A

Captain A had the nationality of the Republic of China, and served in the Air Force as a pilot. He joined other Airlines in September 2009 after retired from the Air Force and left that Airline in March 2010.

Captain A joined TNA in August 2010, completed initial training in February 2011, and served as a first officer in the ATR72-500 fleet. In August 2014, he completed ATR72-500 upgrade training and was promoted as a captain. In November 2014, he completed differences training and transferred to the ATR72-600 fleet as a captain.

As of the date of the occurrence, he accumulated 4,914 total flight hours, including 3,151 hours in the ATR72-500, and around 250 hours in the ATR72-600 respectively.

Captain A held an Air Transport Pilot License (ATPL) issued by the Civil Aeronautics Administration (CAA) of the Republic of China with Multi-Engine Land rating, type rating in both ATR72-500 and ATR72-600, endorsed with privileges for operation of radiotelephone on board an aircraft with no limitation, and remarked with "English Proficient: ICAO Level 4 Expiry Date 2017-01-02".

1.5.1.2 Captain B

Captain B had the nationality of the Republic of China. He joined TNA on June 5, 2006, completed his first officer training on August 14, 2007, and served as a first officer in the ATR72-500 fleet. On September 3, 2011, captain B completed his upgrade training and was promoted as a captain. On February 25, 2014, captain B completed ATR72-600 differences training and transferred to the ATR72-600 fleet as a captain.

As of the date of occurrence, he accumulated 6,922 total flight hours, including 5,687 hours in the ATR72-500, and 795 hours in the ATR72-600 respectively.

Captain B held an Air Transport Pilot License (ATPL) issued by the CAA of the Republic of China with ratings of Multi-Engine Land, Instrument Aero plane, type ratings on the ATR72-500 and ATR72-600, and endorsed with privileges for operation of radiotelephone on board an aircraft with no limitation, and remarked with "English Proficient: ICAO Level 6 with Perpetual valid."

1.5.1.3 First Officer

The first officer had the nationality of the Republic of China. He had the flight experience in MD-80S in his previous company, and joined TNA on October 4, 2008. He completed his transition training on November 18, 2009 and served as a first officer in the ATR72-500 fleet. On January 12, 2015, he began to receive ATR72-600 differences training, and was still under training on the date of occurrence.

As of the date of occurrence, he accumulated 16,121 total flight hours, including 7,911 hours in the MD-80S, 5,306 hours in the ATR72-500, and 8 hours in the ATR72-600 respectively.

The first officer held an Air Transport Pilot License (ATPL) issued by the CAA of the Republic of China with ratings of Multi-Engine Land, Instrument Aeroplane, type ratings on the ATR72-500 and ATR72-600, MD-80S, and endorsed with privileges for operation of radiotelephone on board an aircraft with limitations of “ATR72-500 F/O; ATR72-600 F/O”, and remarked with “English Proficient: ICAO Level 4 Expiry Date 2016-09-13”.

Table 1.5-1 Flight crew's basic information

Item	Captain A	Captain B	First officer
Gender	Male	Male	Male
Age	42	45	63
Date of hiring in TNA	16 August 2010	5 June 2006	4 October 2008
License issued	ATPL – Aeroplane	ATPL – Aeroplane	ATPL– Aeroplane
Type rating Date of expiry	ATR72-600 04 November 2019	ATR72-600 29 December 2018	ATR72-600 22 June 2017
Medical certificate issued Date of expiry	First class 31 March 2015	First class 31 March 2015	First class 28 February 2015
Total flight time	4,914 hrs and 51 min.	6,922 hrs and 58 min.	16,121 hrs and 57 min.
Total flight time of ATR 72-600	250 hrs and 44 min.	794 hrs and 55 min.	8 hrs and 6 min.
Total flight time last 12 months	877 hrs and 29 min.	788 hrs and 27 min.	888 hrs and 16 min.
Total flight time last 90 days	246 hrs and 30 min.	202 hrs and 23 min.	165 hrs and 51 min.
Total flight time last 30 days	82 hrs and 38 min.	68 hrs and 21 min.	9 hrs and 52 min.
Total flight time last 7 days	18 hrs and 15 min.	22 hrs and 42 min.	8 hrs and 6 min.
Total flight time last 24 hours	2 hrs and 23 min.	2 hrs and 23 min.	0 hrs and 0 min.
Rest period before occurrence	16 hrs 35 min	16 hrs 35 min	20 hrs 30min.

1.5.2 Flight Crew Training Record

1.5.2.1 Captain A

Initial Training in Previous Airlines

Captain A received the A330 initial transition training form September 2009 to March 2010. The detailed records and summary referred to Attachment 1-1.

Initial Training in TNA

Captain A received his ATR72-500 initial training from 16 August 2010 to 18 February 2011. He completed the initial training and passed the first officer line check on 4 March 2011.

Upgrade Training

Captain A received his upgrade training of ATR72-500 from 14 April 2014. He passed ground school and simulator sessions, but failed in simulator check on 31 May 2014 with unsatisfactory items of "ABNORMAL ENG START", "BOTH HYD SYS LOSS", and "S/E APP GO AROUND". The check airman's comments were as follows:

- Incompletion in procedure check and execution;
- Insufficient knowledge of QRH (ENG FLAME OUT AT T/O, BOTH HYD SYS LOSS);
- Did not fully advanced power levers to ramp position during the SINGLE ENGINE APP GO AROUND;
- Did not follow SOP of ENG FIRE operation while on short final and altitude below 400 ft;
- Cockpit management and flight planning should be improved.

After a TRB held on 19 June 2014, the flight operations division decided to provide Captain A one more simulator session plus one more simulator check on 29 to 30 June 2014, conducted with the Assistant Vise-President (AVP), Flight Operations Department (FOD) serving as an Instructor Pilot (IP) and the ATR chief pilot serving as a Check Pilot (CP). He completed that additional session and passed the simulator check afterward, and was qualified as a captain on 1 July 2014.

He then completed line training from 2 July to 10 August 2014. During the process, the comments addressed by the instructors were summarized as follows:

- Prone to be nervous and may make oral errors during the engine start procedure;
- Insufficient knowledge leading to hesitations in “Both EEC Failure” and “Engine Failure after V1” situation during the oral test;
- Lack of confidence and being nervous while answering the Smoke procedure during the oral test;
- Incompletion in certain procedure check and execution;
- Prone to be hesitated when facing situation that requires making decisions;
- Flight planning should be improved.

Differences Training

Captain A received a one-week ATR72-500/600 difference training from ATR Training Center in Singapore from 27 to 31 October 2014. The training syllabus referred to Appendix 1-1.

The results of the VHP[6] sessions in the first 4 days were “*Progress is Normal*” with instructors’ comments of “*Good Job*”.

The result of the FFS session in the final day was “*May Need extra training*” with instructor’s comment of “*Check EFATO*[7] *call out and task sharing and GA single engine*”.

Captain A passed the session check and was qualified as a captain of ATR72-600 on 2 November 2014; All described weak items have been checked again during this session with positive result. "Satisfactory" - "all STD". He then passed the line check on 11 November 2014.The certificate was issued on 14 November 2014 by the ATR Training Center.

Captain A then passed the line check on 11 November 2014 and started to serve as a captain of ATR72-600.

Recurrent Training

The latest two annual proficiency trainings and checks for Captain A were consolidated with his Upgrade and Differences Training in 2014 addressed above respectively. The results showed in the records were both “passed”.

---

[6] VHP: Virtual Hardware Platform Trainer.

[7] EFATO: Engine Flame Out at Take Off.

1.5.2.2 Captain B

Initial Training

Captain B received his ATR72-500 first officer initial training from 22 March 2007, including phase one “basic ground training”, phase two “airplane type ground training”, phase three “observation flights”, phase four “simulator training”, phase five “local training”, and phase six “Initial Operating Experience (IOE) line training”. He completed the initial training successfully on 14 August 2007, and was qualified as an ATR72-500 first officer; there were no significant comments regarding checks of these training.

Upgrade Training

Captain B received his ATR72-500 upgrade training from 27 June 2011, including ground training, simulator training, and line training. He completed upgrade training successfully on 03 September 2011 and was qualified as an ATR72-500 captain; there were no significant comments regarding these checks.

Differences Training

Captain B received his ATR72-600 differences training from 16 December 2013, including ground training, simulator training, and line training. The ground training and simulator training were conducted in the ATR Singapore training center. He completed the check for difference simulator training on 21 December, 2013, and the comment from the JAA certified examiner was “Standard Session”. Line check was conducted successfully on 25 February 2014, and the comment from the JAA certified examiner was “Good Job, Satisfactory”. There were no other significant comments regarding these checks.

Recurrent Training

The annual recurrent ground training was conducted on 4 December, 2014 for eight hours in total. The syllabus included adverse weather operations, normal/abnormal procedure, such as PF/PM and other flight crew task sharing, positive transfer of aircraft control, consistent checklist philosophy, emphasis on an "aviate, navigate, communicate" priority, proper use of all levels of flight automation, proper crew response to system malfunction, and aircraft type systems and limitations.

The latest proficiency training (PT) was conducted on 6 December, 2014. The syllabus included stall recovery, unusual attitude recovery, and engine flame out at takeoff. The result of training was “Satisfactory”; the

JAA certified IP comment was “Satisfactory, Good Job”.

The latest proficient check (PC) was conducted on 7 December, 2014. The result of check shows on the proficiency check records was “pass”, and the comment for the captain B was “aircraft maneuvering and procedures are conducted in accordance with standards, general handling of emergency, general CRM. The result of check was “pass.”

The latest proficiency line check was completed on 25 February 2014, same as the line check of difference training.

1.5.2.3 First Officer

<u>Transition Training</u>

The first officer had experience as an MD-82 captain with his previous company. After joining TNA, he was hired as a first officer in accordance with the Civil Aviation Law.

He began his ATR72-500 transition training from 16 June, 2008. The training syllabus included ground training 254 hours, line observation training 25 hours minimum, simulator training 11 sessions, local training 2 hours 56 minutes, and line training 3 phases.

The first officer failed his first simulator check; the comment from the examiner was “Could not properly identify abnormal engine start. Not properly handle standard callouts, engine flame out, engine fire, and go around.”

He passed his simulator check after remedial training on 19 September, 2008. He completed transition training on 8 November, 2008 and the line check result was “pass”.

<u>Recurrent Training</u>

The latest recurrent ground training was conducted on 12 September, 2014, for eight hours in total. The syllabus included adverse weather operations, normal/abnormal procedure, such as PF/PM and other flight crew task sharing, positive transfer of aircraft control, consistent checklist philosophy, emphasis on an "aviate, navigate, communicate" priority, proper use of all levels of flight automation, proper crew response to system malfunction, and aircraft type systems and limitations.

The latest proficiency training was conducted on 17 September, 2014. The syllabus included stall recovery, unusual attitude recovery, and engine flame out at takeoff. The result of training was “Satisfactory”.

The latest proficient check was conducted on 18 September, 2014.

Check items included stall recovery, unusual attitude recovery, and engine flame out at takeoff. The result of check was “pass”.

The latest annual line check was completed on 26 November, 2014. The result of check was “pass”.

<u>Differences Training</u>

The first officer received his ATR72-600 differences training from 12 January 2015, including ground training, simulator training, and line training.

The ground training and simulator training were conducted in the ATR Singapore training center. He completed the check for difference simulator training on 19 January. 2015. The result of check was “pass”, but part of the comment from the examiner were “*will need some time to get used to the 600 (ATR72-600), flying with an experienced captain is strongly recommended*.”

As the date of occurrence, the first officer was still under his ATR72-600 differences training, the occurrence flight was an observation flight for him.

1.5.3 Flight Crew Medical Information

1.5.3.1 Captain A

The latest first class medical certificate of captain A was issued by CAA on 03 September 2014 with limitations on “Holder shall wear corrective lenses”.

1.5.3.2 Captain B

The latest first class medical certificate of captain B was issued by CAA on 12 September 2014 with no limitations.

1.5.3.3 First Officer

The latest first class medical certificate of first officer was issued by CAA on 2 October 2014 with limitations on “Holder shall wear corrective lenses”.

1.5.4 Flight Crews’ Activities within 72 Hours before the Occurrence

1.5.4.1 Captain A

1. February 1st, 2015: rest period before flight duty was 19 hours and 44

minutes. Reported to Songshan airport at 0640 and carried out scheduled flights of Songshan → Kinmen → Songshan → Kinmen → Songshan, total flight time was 4 hours 26 minutes, and then the assigned flight duty ended at 1405.

2. February 2nd, 2015: day off, no assigned flight or ground duty.

3. February 3rd, 2015: rest period before flight duty was 40 hours 35 minutes. Reported to Songshan airport at 0640 and carried out scheduled flights of Songshan → Kinmen → Songshan → Kinmen → Songshan, total flight time was 4 hours 30 minutes, and then the assigned flight duty ended at 1405.

4. February 4th, 2015: rest period before flight duty was 16 hours 35 minutes. Reported to Songshan airport at 0640 to carry out the flight duty of the occurrence date.

1.5.4.2 Captain B

1. February 1st, 2015: rest period before flight duty was 17 hours 26 minutes. Reported to Songshan airport at 1320 and carried out scheduled flights of Songshan → Kinmen → Songshan → Hualien → Songshan, total flight time was 3 hours 44 minutes, and then the assigned flight duty ended at 1935.

2. February 2nd, 2015: day off, no assigned flight or ground duty.

3. February 3rd, 2015: rest period before flight duty was 35 hours 5 minutes. Reported to Songshan airport at 0640 and carried out scheduled flights of Songshan → Kinmen → Songshan → Kinmen → Songshan, total flight time was 4 hours 30 minutes, then the assigned flight duty ended at 1405.

4. February 4th, 2015: rest period before flight duty was 16 hours 35 minutes. Reported to Songshan airport at 0640 to carry out the flight duty of the occurrence date.

1.5.4.3 First Officer

1. February 1st, 2015: day off, no assigned flight or ground duty.

2. February 2nd, 2015: went to office for self-study from 0830 to 1730,

and then went home.

3. February 3rd, 2015: day off, no flight or ground duty assigned.

4. February 4th. 2015: reported to Songshan airport at 0640 for the flight duty of the occurrence date as an observer.

1.6 Airplane Information

1.6.1 The ATPCS

The ATPCS is one of a sub-system of propulsion unit, which provides in case of an engine failure during takeoff the uptrimmed takeoff power and auto-closing of bleed valves on the live engine combined with an automatic feathering of the failed engine. This system enables to reduce the power normally used for takeoff by an amount of about 10% below the power certified by the engine manufacturer. This is favorable to engine/propeller life without affecting the takeoff performance in case of an engine failure. Full ATPCS (uptrim and auto feathering) is only available for takeoff.

The ATPCS operates with an Auto Feathering Unit (AFU) on each engine. The AFU conditions torque signal and send it to the MFCs (Multi Function Computers) which includes autofeather/uptrim logic functions. The MFC delivers signals to the Engine Electronic control (EEC) to enable power increase from takeoff power to reserved takeoff power, to the feather solenoid mounted on the Propeller Valve Module (PVM), and the feathering electric pump installed on the reduction gear box on each engine.

The control in the cockpit includes the ATPCS push button on the cockpit center panel, the power lever (PL) position (switch set to 49°) and a test selector located on the pedestal. The arming conditions are shown in Figure 1.6-1. The trigger condition is one of the engine torques below 18% and the sequence after trigger is shown in Figure 1.6-2.

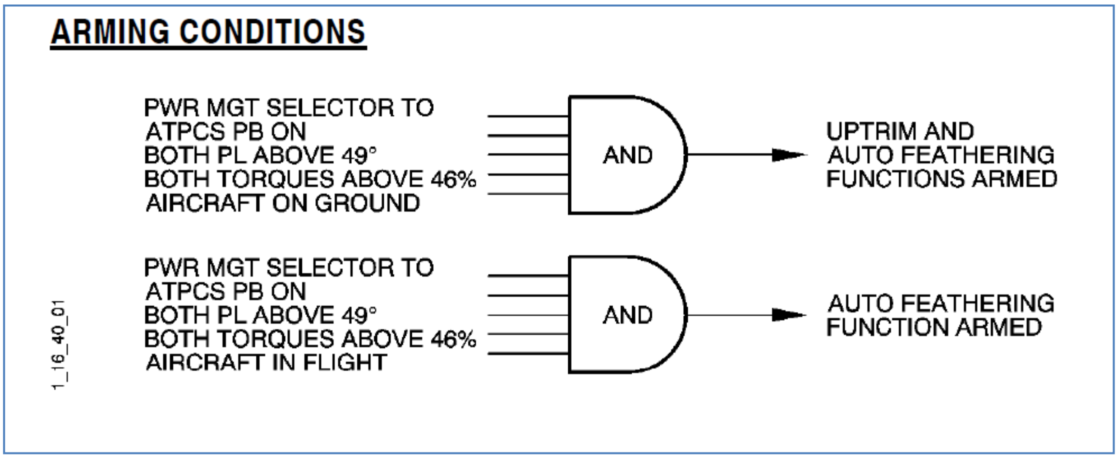

Figure 1.6-1 The ATPCS arming conditions

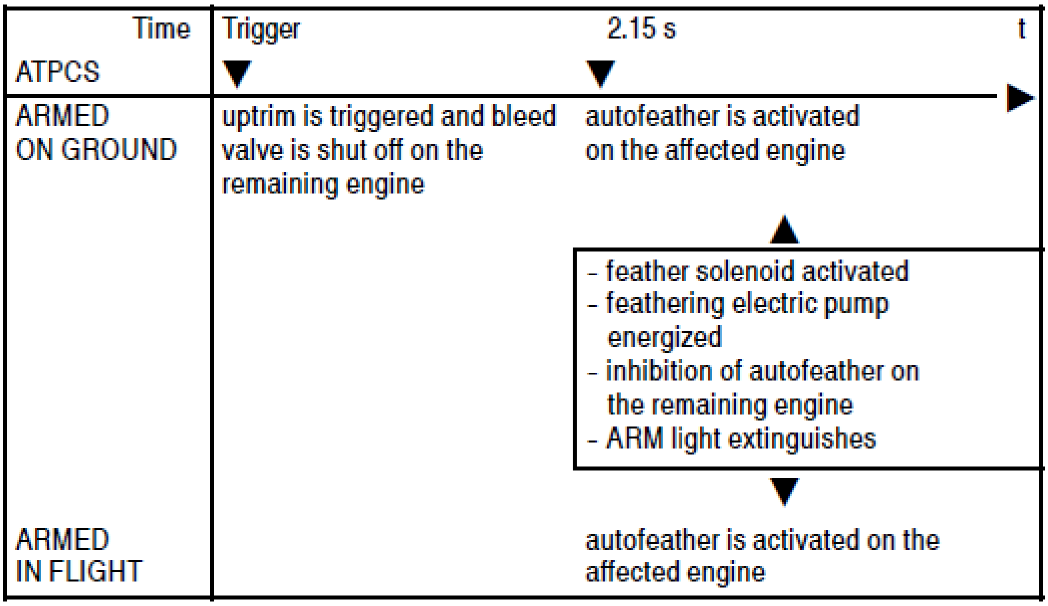

Figure 1.6-2 The ATPCS sequence after trigger

Once the sequence has been triggered, its cancellation can only result from either of the following actions: PWR MGT selector not in TO position, ATPCS Push Button set to OFF position or retard both PL bellow 49°. When the ATPCS is triggered, the Engine and Warning Display (EWD) will show "UP TRIM" on live engine, "AUTO FTR" on affected engine and the procedure of ENG1(2) FLAME OUT AT TAKE OFF. Figure 1.6-3 and Figure 1.6-4 illustrate simulated EWD displays of engine #2 autofeathering and the "ENG 2 FLAME OUT AT TAKE OFF" procedure.

Figure 1.6-3 Simulated EWD display of ENG 2 autofeathering at takeoff

Figure 1.6-4 Simulated EWD display of ENG 2 FLAME OUT AT TAKE OFF procedure

1.6.2 Weight and Balance Information

The actual takeoff weight of this airplane was 44,890 lb. and was loaded within Weight and Center of Gravity (CG) limits. The center of gravity of takeoff was located at 27.6% MAC and was within the certified limitations between 20.8% and 37% Mean Aerodynamic Chord (MAC). The center of gravity envelope of ATR72-600 is shown in Figure 1.6-1. Table 1.6-1 shows the weight and balance data.

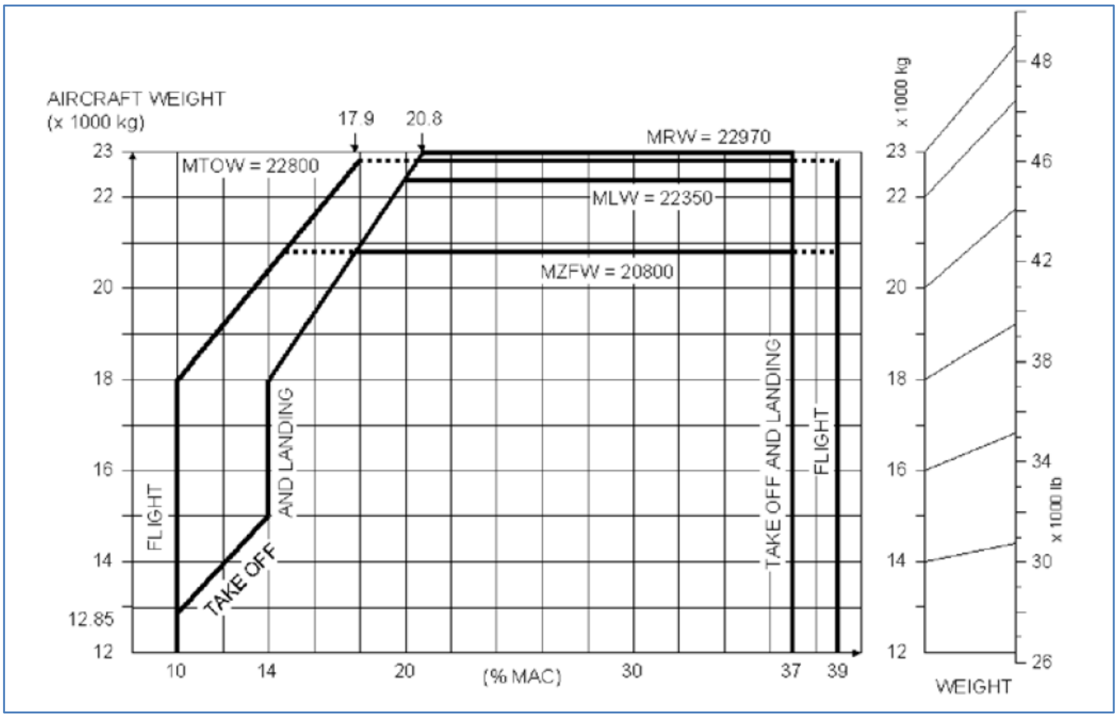

Figure 1.6-4 The center of gravity envelope of ATR72-600

Table1.6-1 Weight and balance data

Max. zero fuel weight	45,856 Lbs
Actual zero fuel weight	39,989 Lbs
Max. takeoff weight	50,265 Lbs
Actual takeoff weight	44,890 Lbs
Take off fuel	4,901 Lbs
Estimated trip fuel	1,720 Lbs
Max. landing weight	49,273 Lbs
Estimated landing weight	43,170 Lbs
Takeoff Center of Gravity	27.6% MAC*

*MAC: Mean Aerodynamic Chord

1.16 Tests and Research

1.16.1 TNA Simulator Training Observation

In May 2015, three members of the Flight Operations Group took 2 days to observe 6 sessions of TNA’s ATR72-600 fleet annual recurrent training and check (PT/PC) in Bangkok Airways training center, Bangkok. Four of 6 were PT, Another 2 were PC, the crew paring include a captain and a FO play PF and PM in each session, and conducted by the instructor pilot/check pilot. The task/events of the specific PT/PC are shown as Appendix 1-2. The detailed OBS report referred to Attachment 1-2. The observations summary is briefed as below:

The ATPCS test was not performed in the sessions(include the PC sessions); the takeoff briefing did cover the single engine procedures and the acceleration altitude, the flight crew did conduct the ATPCS callout “ARM” during the airplane takeoff rolling. The PF was responsible for the PL and PM was responsible for CL during the single flameout procedures operations, however, the PF operated both of the PL and CL during the emergency descend and engine fire during takeoff operations.

1.17 Organizational and Management Information

1.17.1 Flight Operations Division

The TNA FOD is headed by an AVP and consists of Administration & Scheduling Department, Fleet Management Department and Standard, Training & Development Department (STDD). The organization chart of Flight Operations Division refers to Figure 1.17-1.

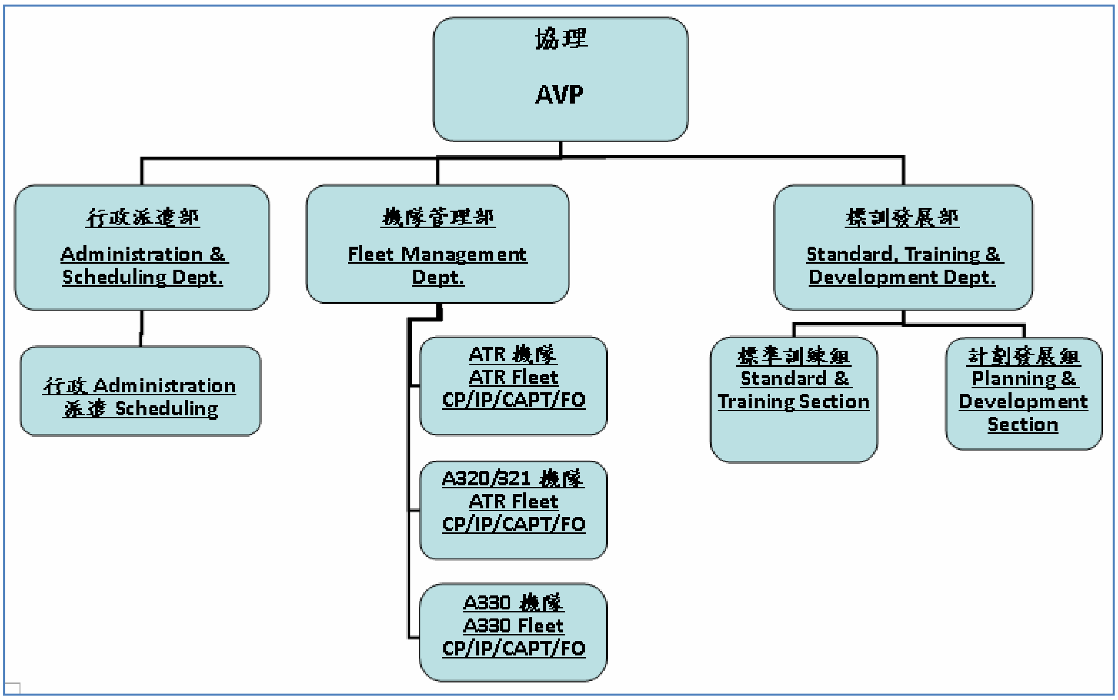

Figure 1.17-1 Organization chart of TNA Flight Operations Division

The Standard Training & Development Department is responsible for the flight trainings and checks of pilots in TNA. This department provides the following trainings and checks for all fleets, including the ATR fleet:

(a) Aircraft type training;
(b) Ground school;
(c) Initial training;
(d) Recurrent training;
(e) Transition training;
(f) Upgrade training;
(g) Instructor and examiner training;
(h) Ab-initio training;
(i) Re-qualification training;
(j) Cross crew qualification (for airbus fleet) or differences (for ATR fleet) training.

In addition to the aforementioned trainings, the STDD also provides dangerous goods training and special operations training, such as RVSM (Reduced Vertical Separation Minimum), PBN (Performance Based Navigation), ETOPS (Extended Range Two Engine Operations), LVO (Low Visibility Operations), Cold Weather Operations and High Elevation Airport Operations.

The specific first officer upgrade training referred to 1.17.2.

1.17.1.1 Initial Training

The aircraft initial training comprises of the following:

(a) Ground school: may be conducted by e-learning or in the class room for teaching aircraft systems, aircraft performance, related regulations, safety related and emergency procedures;

(b) Line observation: There are totally 8 flights, four of it must be completed before commencing simulator training; another 4 will be conducted before Initial Operating Experience (IOE);

(c) Simulator training: There are totally 18 sessions covering normal, abnormal and emergency procedures, including wind shear, CFIT, TCAS, and Unusual Attitude Recovery. This training of 7 sessions is conducted in fixed based, and 11 sessions of full flight simulator;

(d) Local training: The local training includes two training flights and one check flight;

(e) IOE: contains three different phases. The first phase focuses on the PM duties, the second phase focuses on the PF duties, and the last phase emphasizes total performance;

(f) Trainees will be required to pass a final line check prior to be a fully qualified line pilots.

1.17.1.2 Recurrent Training

The Standard Training & Development Department also provides a recurrent training program for pilots every 6 months or annually. The program consists of ground school and simulator sessions. The ground school shall not be less than 20 hours each year. Within the twelve calendar months valid period of type rating certificate, two recurrent trainings and checks shall be conducted. The training shall be completed before the check, and the interval between two checks shall be within four to eight calendar months.

1.17.2 First Officer to Captain Upgrade Process and Training

1.17.2.1 Captain Upgrade Selection Process

First Officer to Captain Upgrade (hereinafter "upgrade") procedures in TNA is described in section 5-3 of the Flight Operations Division (FOD) Operations Manual (See 1.18.1.6). The section 5-3-1 "Selection Procedures" indicates that the FOD shall hold a meeting which at least has the presence of two-thirds of the fleet Instructor Pilot (IPs) and Check Pilots (CPs) to carry out a review and oral test for determination of final scores and ranking of the candidates for upgrade training. A candidate, whose score of oral test below 60 points given by one-third of the interviewers, cannot be recommended to attend upgrade training.

Three ATR First Officers including Captain A of the GE235 attended the above oral test on April 7, 2014. The interviewers of the test consisted of 6 ATR IP/CPs (12 IP/CPs at that time in total). One interviewer gave below 60 points to all interviewees, another one gave exactly 60 points to all interviewees and the others gave above 60 points to all interviewees.

1.17.2.2 Upgrade Training

Upgrade training in TNA comprises ground training, flight simulator training and line training as described in section 2.4 of the Flight Training Management Manual (Ref. 1.18.1.5). The section 2.4.2 "Ground Training" indicates that the ground test shall be conducted after the completion of all ground courses.

Four ATR First Officers attended the upgrade training in 2014. Three of the trainees including Captain A completed all ground courses after they had the ground test on May 12, 2014. The reason was they were assigned flight duty during the ground training periods.

1.17.3 ATR72-500 to ART72-600 Differences Training

1.17.3.1 EASA Operational Evaluation Board Report

The ATR72-500 to ATR72-600 differences (hereinafter "ATR72-600 differences") training program in TNA was developed according to the EASA Operational Evaluation Board (OEB) report [8]. Two types of ATR72600 differences training programs are recommended in OEB report, including 5-day or 10-day programs respectively. As described in section 6.4.1 of OEB report, the 5-day program requires trainees to be current and qualified on the ATR72-500 and have a minimum experience on ATR aircraft of 500 hours in total, or 100 hours in the last twelve months; Pilots not meeting the above pre-requisites of ATR72-500 experience should follow the 10-day program.

The section 6.7.1 of the OEB report indicates that several items should receive special emphasis on the differences training, such as:

- Engine malfunctions during take-off;
- Use of avionics in normal and abnormal / emergency operations, including Flight Mode Annunciation (FMA) annunciations, caution and warning messages on the Engine & Warning Display, and associated human factors issues;
- Use of flight management system;
- Use of electronic checklist.

Familiarization flights following ATR72-600 differences training are described in section 9.3.2 of the OEB report. Pilots who attend to the 5-day program should receive familiarization flights ranging from 6 to 10 sectors; Pilots who attend to the 10-day program should receive familiarization flights ranging from 25 to 30 sectors.

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[8] European Aviation Safety Agency Operational Evaluation Board Report, ATR 42/72 Flight Crew Qualifications Revision 3, 23 August 2013.

1.17.3.2 TNA ATR72-600 Differences Training Program

A current ATR72-500 aircraft pilot selected to fly an ATR72-600 aircraft shall complete an ATR72-600 Difference training in advance. The TNA ATR72-600 Differences training shall be conducted by ATR as described in section 2.18 of the Flight Training Management Manual (Ref. 1.18.1.5). The training syllabus is described in Appendix 1-1. An extra simulator check shall be conducted by the Designated Examiner (DE) or CAA inspector following the ground and simulator training.

After passing the simulator check, the pilot who holds the ATR72-600 type rating shall have at least 8 sectors of line training and 2 sectors of line check for Initial Operating Experiences of an ATR72-600 aircraft.

1.17.4 Crew Resources Management Training

1.17.4.1 Training Policy

The TNA Crew Resource Management (CRM) training policy for flight crew is described in the Flight Training Management Manual. The TNA latest edition (33rd Edition) of the Flight Training Management Manual (FTMM) was updated on January 8, 2015 (See 1.18.1.5), within one month prior to the GE235 occurrence. The CRM training for the GE235 flight crew was still based on the previous edition of the FTMM.

The requirements of CRM training for flight crew in the latest and the previous edition (the 32nd) of the FTMM are summarized respectively as follows:

The 33rd Edition of the FTMM

- There shall be one course (four hours) of LOFT[9] FFS[10] training in the initial/ upgrade/ transition training respectively;
- There shall be 4 hours CRM ground course in the initial training. The course content includes: definition of CRM, automation, logic of CRM application, CRM policy, CRM development, CRM skills, error avoidance, decision making process, threat and error management, communication, and case introduction;
- After the completion of initial training, all flight crew shall have recurrent CRM ground course every 24 months. There is no training

[9] Line-Oriented Flight Training.

[10] Full Flight Simulator.

hour requirement of recurrent CRM ground course in the FTMM;

- The philosophy and practices of CRM skills shall be an integral part of training courses in a simulator and an aircraft, and be conducted both in initial and annually recurrent trainings.

<u>The 32nd Edition of the FTMM</u>

- There shall be 4 hours CRM ground course in the initial training. There is no any requirement for CRM ground course content in the FTMM;
- After the completion of initial training, all flight crew shall have recurrent CRM ground course at least every 3 years. The recurrent CRM ground course should be included in the safety recurrent training which is conducted by the Safety and Security Office. There is no training hour requirement of recurrent CRM ground course in the FTMM (the duration of the training was one hour every two years according to the training record and Safety Management Manual) ;
- The CRM training shall be incorporated into courses of recurrent simulator training at least once a year;
- The recurrent simulator training (4 hours) shall be designed with LOFT concept once a year. Such training shall be administered real-time in a line environment setting, and an uninterrupted planned scenario with specific CRM objectives where such skills are observed and debriefed up completion.

The TNA flight crew training supervisor and assistant manager stated in the interviews: prior to the GE 235 occurrence, the way to teach trainees how to use CRM skills in simulator trainings depended on IP’s experience. The TNA did not provide relevant course to guide IPs how to incorporate the practice of CRM skills into simulator trainings, and also not develop detailed LOFT or CRM scenarios plan with specific CRM objectives for simulator training. In addition, IPs rarely used videos of the simulator training for discussion the CRM performance with trainees during the training debriefing.

1.17.4.2 Materials of CRM and Human Factors Ground Courses

The main content of CRM course to flight crew focused on the introduction of CRM development history. Each instructor has his/her own training materials. In accordance with the statements of TNA safety staff; the training materials of CRM skills are basically followed the chapter 5 of TNA flight operations manual which included: CRM skills, errors avoidance, threat management, errors management and decision making.

1.17.5 Training Records Management

An operator shall establish a system to keep all training records for CAA's inspection as described in Article 21 of the Aircraft Flight Operation Regulations.

The management of flight operations records and data in TNA is described in the FOD Operations Manual (See 1.18.1.6). The section 11-9 indicated that flight crew training records shall be maintained during the employment period.

Before the GE 235 occurrence, the ART72-600 differences training records of all ATR72-600 pilots were not completely maintained by the Flight Operations Division. The above records are kept by the manufacturer ATR.

1.17.6 ATPCS Associated Policy and Procedure

The ATPCS is a subsystem of power plant unit. The ATPCS provides, in case of an engine failure during take-off, up-trimming take-off power for the remained engine combined with an automatic feathering of the failed engine.

The TNA Flight Operations Division issued two technical notices to ATR pilots[11], in order to reduce the aborted take-off rates due to the ATPCS not armed during take-off rolling in 2011 and 2012 respectively as follows:

- Technical notice No.1001130p in 2011

  The notice required flight crew to add an extra item in take-off briefing as follows: flight crew shall check the regulatory take-off weight (RTOW) limitation during take-off briefing. In case of the actual take-off weight below the limitation of the RTOW, flight crew can continue to take off even if the ATPCS is not armed during take-off rolling. Otherwise, flight crew shall abort take-off.

- Technical notice No. m1010604x in 2012

  The notice included detailed procedures and attachments (Airplane Flight Manual (AFM) Supplement 7_02.10, see Appendix 1-2) regarding to the ATPCS not armed as follows:

---

[11] The TNA only had ATR72-500 aircrafts at that time.

1. Before engines start, flight crew shall check the RTOW chart according to weather conditions to acquire take-off weight limitation and performance data;
2. In case of the ATPCS not armed, CM1 shall apply reserved take-off (RTO) power by pushing both power levers to the RAMP position, and order CM2 to select ATPCS "OFF" and bleed valves "OFF";
3. After take-off, set both power levers into Notches position, and then select both bleed valves to "ON" while conducting an after take-off checklist.

The TNA flight crew training supervisor stated in the interview: the above technical notices only apply to operations of ATR72-500. The ATR72-600 pilots were trained to abort takeoff while the ATPCS was not armed during take-off rolling.

The ATPCS related operational procedures in TNA are listed as follows:

- Dispatch with ATPCS OFF procedure

  This procedure (Appendix 1-2) is described in Airplane Flight Manual (AFM) Supplement 7_02.10. While the ATPCS may be inoperative, flight crew can follow this procedure to dispatch the aircraft.

- ATPCS Static Test procedure

  This procedure is described in Preliminary Cockpit Preparation Page 5-17 of the ATR72-600 SOP.(See 1.18.1.2) The flight crew shall conduct this test procedure to check the function of the ATPCS during the preliminary cockpit preparation.

- ATR72-600 Normal checklist

  The flight crew shall check "ATPCS off (Inoperative) Takeoff Weight" while conducting takeoff briefing. (See 1.18.1.2)

- Takeoff procedure

  This procedure is described in Takeoff Page 12-1 of the ATR72-600 SOP. The CM1 shall check if the ATPCS is armed or not and then announce the result. (See 1.18.1.2)

- ATPCS Dynamic Test procedure

  This procedure is described in Daily Checks Page 23-1 of the ATR72-600 SOP. The flight crew shall conduct this procedure to check the function of ATPCS in the end of final flight sector of a day. (See 1.18.1.2)

The TNA flight crew training supervisor in the interview stated: it was emphasized in the flight crew training that the ATR72-600 pilots should abort takeoff while the ATPCS is not armed during the takeoff rolling. There are several procedures shall be conducted while the ATPCS is not armed, but it is inappropriate to do those procedures during takeoff rolling. This is why need to abort takeoff. However, the above policy was not clearly described in any manuals and notices to flight crew.

1.18 Additional Information

1.18.1 Manual Information

TNA provided flight operations related policies, requirements, procedures, and guidance to flight crews in several document, the detailed are shown as below:

1.18.1.1 Flight Operations Manual

The current TNA Flight Operations Manual (FOM) (Attachment 1-3) is revision 42, published on January 26, 2015 which establishes general procedures and provides instructions and guidance for use by flight operations personnel in the performance of their duties. The related paragraphs are:

> *Chapter 3 Duties and Responsibilities*
>
> ***3.8 PF/PM Task Sharing***
>
> 1. *Whenever irregularities occur during flight that have effects on aircraft operation or result in serious failure, the Captain shall immediately take over the control from FOs and serve as PF. If the PF/CM2 is a Captain, the other Captain (CM1) shall exercise CRM principle and take over the control if necessary for safety concerns.*
> 2. *For tasks sharing between PF/PM for normal operations, see relevant SOPs.*
> 3. *The general task sharing shown below applies to both emergency and abnormal procedures.*
>   a. *The pilot flying remains pilot flying throughout the procedure.*
>   b. *For Airbus 320/321/330:*
>
> ……

c. *For ATR72:*

PF is responsible for:

- *power lever*
- *flight path and airspeed control*
- *aircraft configuration*
- *navigation*
- *communications*

PM is responsible for:

- *Monitoring and check list reading*
- *execution of required actions*
- *actions on overhead panel*
- *condition lever*

Note: The Automatic Flight Control System (AFCS) is always coupled to the PF side (Couple selection).

Chapter 5 Crew Resource Management (CRM)

5.4 TNA CRM Policy

TAN believes that optimally safe and efficient flight operations are best achieved when crewmembers work together as a coordinated team, fully utilizing all resources available to them –human resources, hardware and information.

To achieve this optimal level of performance, TNA further believes that all flight crewmembers must embrace CRM principles and techniques and apply them consistently in all aspects of flight operations.

Accordingly, the company has established the following CRM policy:

1. *CRM ability and a facility for teamwork will be criteria for flight crewmember selection.*
2. *CRM principles and practices will be fully integrated into all aspects of flight operations training.*
3. *All crewmembers will share the responsibility for establishing an environment of trust and mutual commitment prior to each flight, encouraging his fellow crewmember(s) to speak out and to accept mutual responsibility for the safety and well-being of the passengers and equipment entrusted to them. "What's right, not who's right" will be the motto of TNA crews.*
4. *Each flight crewmember will be responsible for notifying the pilot in command if any condition or circumstance exists that could endanger the aircraft or impair the performance of any crewmember.*

5.7 Error Avoidance

- *High levels of training and proficient.*
- *Following SOP's.*
- *Proper use of checklists.*
- *Minimizing distractions.*
- *Planning ahead.*
- *Open two-way communication.*
- *Maintaining situational awareness.*

5.9 Error Management

Reasons for making errors: lack of experience; rushed; distractions; stress.Crews make mistakes several times during each flight, most of which are unimportant. However it can be beneficial to recognize and learn from errors, since it will help crewmembers manage resources better during the next flight.

Types of Error:

- *Intentional Noncompliance - Violations. Ex) Checklist from memory.*
- *Procedural - followed procedures with incorrect execution Ex) Wrong altitude setting dialed.*
- *Communication - Missing information or misinterpretation. Ex) Miscommunication with ATC.*
- *Proficiency - Lack of knowledge or skill. Ex) Lack of knowledge with automation.*
- *Decision - Crew decision unbounded by procedures that unnecessarily increased risk. Ex)*

Managing Errors:

Once an error is committed, it is difficult for a crewmember to catch (trap) his/her own error. Other people are more likely to catch his/her error. Therefore, redundancy is one strong defense against error.

Execution: Monitor/crosscheck; workload management; vigilance; automation management.

Guidelines and techniques for effective challenging: timely; with respect; constructive intent; specific; use questions.

5.10 Decision Making Processes

5.10.1 General

The company has chosen a standard mnemonic – S A F E – to help remember the steps for effective decision-making. SAFE means:

S State the problem

A Analyze the options

F Fix the problem

E Evaluate the result

5.10.2 Priorities of Flight

Always take into account the following priorities when invoking the decision-making process:

a. Safety
b. Punctuality
c. Passenger Comfort
d. Economy

Chapter 7 Flight Operations Procedure

7.3 Callouts

1. Call Outs shall not interfere with ATC communications.

2. To establish CRM, the communications between flight crewmembers shall be based on verbal standard callouts, rather than using looks.

3. Except for the flight controls, power levers and deceleration systems, all switches and push buttons have to be changed or executed by PM under PF command (except as otherwise noted in specific aircraft type's SOP), who is responsibility to cross check these positions are in the right position while the aircraft is in manual flight.

4. All switches and push buttons are set by PF and cross - checked by PM when it is in auto pilot operation.

5. Either auto pilot flight or manual flight; all the appeared flight mode indications (ATR) and FMA (Airbus) have to be called out and crosschecked by PF or PM according to respective SOPs. Any deviation or movement of CDI shall be reported by PM and verified by PF.

6. To hand over the aircraft controls, the PF has to call: a. "YOU HAVE CONTROL". As soon as positive control has been taken, PM must call: "I HAVE CONTROL".b. The PIC shall make a go-around immediately and call out "I have control" if the aircraft not stabilized during approach. c. For seamless radio communications, when PM is busing in dictating metrological information or liaison with other units, he or she shall tell PF "YOU HAVE RADIO", then takes action after PF responses.

7. Use of Checklist:

a. The PIC shall ensure that the flight crew utilizes checklists to comply with standard operating procedures and provisions of the certificate of airworthiness, which may include safety check, originating/receiving, before start, after start, before taxi, before takeoff, after takeoff, climb, enroute, before landing, landing, *after landing, parking, emergency, non-normal, abnormal procedures checklists.*

b. Normal Operation Checklist (placed in the cockpit)

Checklist Job Description:

Commander /Checklist Holder

Give command to checklist holder to execute the check, regularly, check the regulation and main procedure first, after completing the check, and inform checklist holder to read checklist. Apply the check procedure as per one's habit flow pattern. Visually check the item being called and report its current position or function. Check the prescribed checklist item with the response and execute the next checklist item. (Visually check the item, its position or its function if workload permits.) If the response is different from the checklist, a correction shall be made before proceeding to the next item. The checklist will not be completed if any item is standby unless the item is accomplished. Example: Checklist will be completed by _______. When ________ has been done, then call ***"CHECKLIST COMPLETED"****. Example: During approach, if the seat belt light is not on, the Approach Checklist will be completed by Seat Belt on, when the seat belt light is on the Approach Checklist is complete.*

c. Abnormal/Emergency Checklist (also QRHs, placed in the cockpit)

(i) During an abnormal or emergency condition, PF gives command to check and checklist is executed by PM with "Read and Do". PF is responsible for confirmation on the operations of switches and push buttons while maintaining aircraft in safe attitude.

(ii) All failing switches must be confirmed before turned off.

7.5.8 Sterile Cockpit Environment

1. The company prohibits all activities in the cockpit not required for the safe operation of the aircraft during critical phases of flight. These prohibited activities include non-safety related company calls, PA's, logbook entries, and non-essential conversations. Critical phases of flight include all ground operations involving taxi, takeoff, and landing, and all other flight operations conducted below 10,000 ft (for Airbus) or 5,000 ft (for ATR), except cruise flight.

2……….

7.5.10 Crew Monitoring And Cross-Checking

1. The PF will monitor/control the aircraft, regardless of the level of automation employed.

2. The PM will monitor the aircraft and actions of the PF.

……

……

……

8. *Pilots shall make a cross-check by dual response before actuation of critical controls, including: i)thrust lever reduction of failed engine; ii) fuel Master/Control switch; iii) fire handle and extinguisher switch; iv) IDG Disconnect Switch.*

1.18.1.2 TNA Standard Operations Procedure

The current TNA standard Operations Procedure (SOP) (Attachment 1-4) is revision 1, published on January 20, 2015 which established ATR72-600 operating procedures and provided specific procedures and techniques for flight crew. The related paragraphs are shown as below:

1.5 Sterile Cockpit Environment

- *The company prohibits all activities in the cockpit not required for the safe operation of the aircraft during critical phases of flight. These prohibited activities include non-safety related company calls, PA's, logbook entries, and non-essential conversations. Critical phases of flight include all ground operations involving taxi, takeoff, and landing, and all other flight operations conducted below 5,000 ft, except cruise flight.*
- During the periods mentioned below, calls from the cabin to the cockpit shall, except in case of an emergency, not be made:
  a. After takeoff: Until the turning off of seat belt sign.
  b. Before landing: After being notified b y the cockpit of reaching 5,000 ft. In case the period mentioned above is anticipated to become longer than usual, proper information shall be given from the cockpit.

1.6 Crew Monitoring and Cross-Checking

- *If an indication is not in compliance with a performed action, crew members must check that involved system is correctly set and/or take any necessary action to correct the applicable discrepancy. PM can be temporarily busy (ATC message, listening to weather, reading operating manuals,performing related procedure action, etc). Any significant status change (AFCS, FMA, systems...) must be reported to PM when his attention is restored.*
- *When making auto flight systems inputs, comply with following items in the acronym CAMI:*
  - **C**onfirm FMS inputs or performance calculations with the other pilot when airborne.
  - **A**ctivate the input.
  - **M**onitor Flight Mode Annunciator (FMA) to ensure the auto pilot system performs as desired.
  - **I**ntervene if necessary.

During high workload periods FMS inputs will be made by the PM, upon the request of PF. Examples of high workload include when flying below 10 000 ft and when within 1 000 ft of level off or Transition Altitude. Flight crewmembers shall include scanning of the Flight Mode Annunciator as part of their normal instrument scan, especially when automation changes occur (e.g., course changes, altitude level off, *etc.). Changes to the Automated Flight System (AFS)/Flight Management System (FMS) and radio navigation aids during the departure and or approach phases of flight shall be monitored and crosschecked.*

- ATPCS TEST.. PERFROM

ATPCS: STATIC TEST

Check the following results on EWD.

- Turn the ATPCS knob to the left to the arm position and check:
  - ARM light ....ILLUMINATES
  - TQ needles.. > 60 %
- Turn the ATPCS knob to ENG 1 position and check:
  - ENG 2 ....UPTRIM
  - TQ 1 needle indicates ....ZERO
  - After 2.15 s:
    - ARM light .... EXTINGUISHES
    - ENG 1 ....AUTO FTR
- Turn the ATPCS knob to the right to the arm position and check:
  - ARM light ....ILLUMINATES
  - TQ needles.. > 60 %
- Turn the ATPCS knob to ENG 2 position and check:
  - ENG1 ....UPTRIM
  - TQ 1 needle indicates...ZERO
  - After 2.15s:
  - ARM light .... EXTINGUISHES
  - ENG 2 ....AUTO FTR

- TRIMS.. CHECK

- PEC 1+2 .... DEPRESSED IN/NO LIGHT

- PWR MGT rotary selector .... TO

- IESI .... CHECK NO FLAG

- EWD:

- EWD FLIGHT CONTROL window .... CHECK

Check TRIMS and FLAPS, indications

- ENG 1 & 2 INSTRUMENTS .... CHECK

Check TQ, RTO TQ, TO TQ, NP, ITT

- TAT / SAT .... CHECK

ENG PANEL:

- EEC 1 & 2 P/B .... CHECK DEPRESSED IN / NO LIGHT

- ATPCS P/B .... CHECK DEPRESSED IN / NO LIGHT

- CAB PRESS PANEL .... CHECK

Check no light

Check the rotary selector is facing the green mark

- AUTO PRESS PANEL .... TEST / CHECK

Depress the TEST P/B and check

- On local panel:

- Cycling display between -8800 and 18800 .... CHECK

- MC + SC + AIR AUTO PRESS on Alerting Window (1 flash) .... CHECK

- MODE SEL P/B FAULT amber light (1 flash) .... ILLUMINATED

- CABIN SD page:

CAB ALT / VS / ΔP .... CHECK

ANTISKID PANEL P/B depressed in, no LIGHT .... CHECK

GLARESHIELD:

- GPWS P/B TEST .... PERFORM

CM1

LEFT LATERAL CONSOLE

- COCKPIT COM HATCH .... OPEN

Cockpit com hatch must be opened until engine 1 start, in order to avoid that the extract fan suction creates a depressurization when passenger doors is closed, (ref procedure and techniques 2.02.03).

PF **- TO BRIEFING .... PERFORM**

- Take off briefing should usually be a brief confirmation of the departure briefing made at the parking bay, and should include any change (RWY, SID...)

- Standard calls
- For significant failure before V1, CAPTAIN will call "STOP" and will take any necessary stop actions.
- Above V1 take off will be continued and no action will be taken except on CAPTAIN command;
  - Single Engine procedure is.............
  - Acceleration Altitude is...................
  - Departure clearance is...................

CM1 **- CABIN REPORT..OBTAIN FROM CABIN ATTENDANT**

ALL **- TAXI C/L .... COMPLETED**

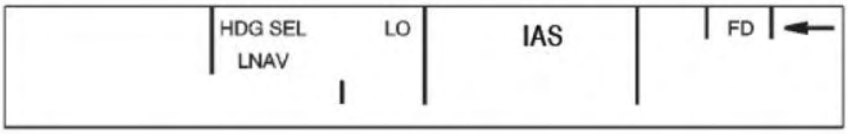
12 TAKEOFF

CM1 - **"TAKE OFF AT XX: XX, V1XXX"** .... **ANNOUNCE**

CM1 - **BRAKES** .... **RELEASED**

CM1 - **PL 1 + 2** .... **SET IN THE NOTCH**

CM1 - **FMA** .... **ANNOUNCE**



CM1 - **FMA** .... **CHECK**

CM2 - **"ATPCS ARM"** .... **CHECK then ANNOUNCE**

CM2 - **ENGINE PARAMETERS** .... **CHECK**

Note: Parameters should be obtained at around 60 Kt

ACTUAL TQ .... MATCH T.O BUG

Note: If necessary, adjust PLs to obtain TO TQ (bugs)

RTO BUG .... CHECK

NP .... ~ 100 %

Note: NP =100 % -- 0.6%/+0.8%

ITT .... CHECK

CM2 - **TO INHIB** .... **CHECK**

CM2 - **"POWER SET"** .... **ANNOUNCE**

When reaching 70 Kt

CM2 - **"SEVENTY KNOTS"** .... **ANNOUNCE**

CM1 - **SPEED** .... **CROSS CHECK on PFD**

And cross check speeds with IESI

ALL - **"I HAVE CONTROL" / "YOU HAVE CONTROL"** .... **ANNOUNCE**

- If CM1 becomes PF, CM1 announce only "I HAVE CONTROL"
- If CM2 becomes PF, CM1 announce "YOU HAVE CONTROL" & CM2 answer "I HAVE CONTROL"

PM - **"V1"** .... **ANNOUNCE**

When reaching VR:

PM - **"ROTATE"** .... **ANNOUNCE**

PF - **ROTATION** .... **PERFORM**

Note: Pitch rotates smoothly and follow FD bar.

After LIFT OFF:

PM - "POSITIVE RATE" .... ANNOUNCE
PF - "GEAR UP" .... ORDER
PM - LDG GEAR LEVER .... SELECT UP
PM - YAW DAMPER........ ENGAGE
PM - TAXI & TAKE OFF LIGHT........ OFF
PM - LDG GEAR LIGHTS........ CHECK EXTINGUISHED

At ACCELERATION ALTITUDE:

PF - "AFTER TAKE OFF PROCEDURE" .... ORDER
PM - AFTER TAKE OFF PROCEDURE:
- PL1 + 2 .... CHECK IN THE NOTCH
- PWR MGT .... CLIMB
- NP .... CHECK
- BLEEDS .... CHECK ON

Note: Pack 2 valve FAULT will illuminate during 10 seconds. A 10 seconds delay is used for pack 2 valve to avoid pressure shocks.

- SPEED TARGET .... MAGENTA 170 kt CHECK
- "AFTER TAKE OFF PROCEDURE COMPLETED" .... ANNOUNCE

PNF - FMA MODE .... ANNOUNCE
PF - FMA .... CHECK

When passing WHITE bug (F SPEED: White in Normal conditions)

PF - "FLAPS ZERO" .... ORDER
PM - FLAPS ZERO .... SELECT
PM - "FLAPS ZERO SET" .... ANNOUNCE WHEN INDICATED

When passing ICING bug (F SPEED: Amber in Icing conditions)

PF - "FLAPS ZERO" .... ORDER
PM - FLAPS ZERO .... SELECT
PM - "FLAPS ZERO SET" .... ANNOUNCE WHEN INDICATED

When cleared to a FL :

ALL - ALTIMETERS 1+2 .... SET STD & CROSS CHECK

Note: Set Standard pressure by pushing BARO SET P/B

ALL - AFTER TAKE OFF C/L .... PERFORM
PM - AFTER TAKE OFF procedure .... COMPLETED

20 AFTER LANDING

When runway vacated :

CM1 - "AFTER LANDING PROCEDURE" .... ORDER

CM2 - AFTER LANDING PROCEDURE:

- TRIMS .... RESET
- FLAPS 0 .... SELECT
- GUST LOCK .... ENGAGE
- FLIGHT CONTROL .... CHECK LOCKED
- TCAS .... STBY
- XPDR .... AS RQD
- RADAR .... STBY
- LANDING LIGHT AND STROBE .... OFF
- PROBES HTG / ANTI ICING / DE ICING .... OFF

CM2 - ATPCS TEST (Last flight of the day) .... PERFORM

> CAUTION
>
> Do not perform ENG TEST while taxiing as ACW is temporary lost and, subsequently, both main HYD pumps are temporarily lost as well.

ATPCS TEST (dynamic test: once a day) .... Refer to FCOM 2.03.24

After at least one minute :

CM1 - "CL1 FEATHER" .... SELECT&ANNOUNCE

CM2 - "ACW BTC TIDE HYD PRESS NORMAL" .... CHECK

After 20 SECONDS :

CM1 - CL1 .... FUEL SO

CM2 - DC BTC TIDE HYD PRESS NORMAL .... CHECK

ALL - AFTER LANDING C/L .... COMPLETE

> CAUTION
>
> Prior to ENG FTR, select HYD SD page, to check HYD pressure for Normal brake efficiency

Note : Keep running at least one minute at GI power before shutting down to assist in reducing residual heat build up in the engine nacelle.

Note : After the last flight of the day, maintain feather position for 20 seconds before selecting FUEL SO to allow oil level check by maintenance.

ATPCS TEST (dynamic test: once a day) (autofeather and uptrim while engines running)

Conditions: - PL 1 + 2 in GI - CL 1 + 2 in AUTO.

- ATPCS P/B depressed in, OFF light extinguished
- PWR MGT on TO position

Check the following results on EWD:

- Turn the ATPCS knob to the left to the arm position and check
  - ARM light .... ILLUMINATES
  - TQ INDICATION .... INCREASE
  - NP & NH INDICATION .... DECREASE
- Turn the ATPCS knob to ENG 1 position and check :
  - ENG 2 UPTRIM LIGHT .... ILLUMINATES
  - TQ 2 .... NO CHANGE
  - NP, NH .... INCREASE SLIGHTLY
  - TQ 1 needles indication .... DECREASE BELOW 18 %
  - After 2.15 s : associated propeller is automatically feathered
    - ARM light .... EXTINGUISHED
    - PROP 1 AUTO FTR LABEL .... DISPLAYS
- Turn the ATPCS knob to the right to the arm position and check :
  - ARM light .... ILLUMINATES
  - TQ INDICATION .... INCREASE
  - NP & NH INDICATION .... DECREASE

- Turn the ATPCS knob to ENG 2 position and check :
  - ENG 1 UPTRIM LIGHT .... ILLUMINATES
  - TQ 1 .... NO CHANGE
  - NP, NH .... INCREASE SLIGHTLY
  - TQ 2 needles indication .... DECREASE BELOW 18 %
  - After 2.15 s : associated propeller is automatically feathered
    - ARM light .... EXTINGUISHED
    - PROP 2 AUTO FTR LABEL .... DISPLAYS

CAUTION: Do not perform ENG TEST while taxiing as ACW is temporarily lost and consequently, both HYD pumps are temporarily lost as well.

Note: If ENG TEST must be repeated, wait 10minutes before setting ATPCS selector in ENG position in order not to damage feathering pumps. (Winding heating).

24. STANDARD CALLOUTS

24.1 COMMUNICATIONS AND STANDARD TERMS

Standard phraseology is essential to ensure effective crew communication. The phraseology should be concise and exact. The following Chapter lists the callouts that should be used as standard. They supplement the callouts identified in the SOP.

These standard ATR callouts are also designed to promote situational awareness, and to ensure crew understanding of systems and their use in line operation.

24.2 CHECKLIST CALLOUTS

- "CHECK": A command for the other pilot to check an item.
- "CHECKED": A response that an item has been checked.
- "CROSSCHECKED":A callout verifying information from both pilot stations.

If a checklist needs to be interrupted, announce: "HOLD CHECKLIST AT" and "RESUME CHECKLIST AT __" for the continuation.

Upon completion of a checklist announce: "__CHECKLIST COMPLETE".

24.3 ALTITUDE

The PM calls out "ONE THOUSAND TO GO" when passing 1 000 ft before the cleared altitude or FL, and the PF calls out "CHECKED".

24.4 TASK SHARING

FGCP INPUTS	MCDU INPUTS
Are performed by: – PF when the AP is ON – PM on request from PF when AP is OFF. All FGCP inputs must be called. All FGCP inputs must be checked by the PF on the FMA. PM must cross-check (FMA, PFD and ND) and called "CHECK".	Are performed by: – PF when the input has an operational benefit and could quickly be done. Example: **DIR TO**, activation of **SEC F-PLN**, speed or Alt constraint, Enable Alternate. – PF during a temporary transfer of command to the PM (Approach preparation). – PM upon request of the PF to decrease PF workload. Before pressing "EXEC" key, the input must be cross checked by the other crew member and calls "CHECK". Time consuming inputs should be avoided below FL 100.

24.9 SUMMARY FOR EACH PHASE

FINAL COCKPIT PREPARATION		
EVENT	**CM1**	**CM2**
Preliminary cockpit preparation complete	"FINAL COCKPIT PREPARATION PROCEDURE"	"FINAL COCKPIT PREPARATION PROCEDURE COMPLETE"
FINAL COCKPIT PREPARATION PROCEDURE COMPLETE	"FINAL COCKPIT PREPARATION CHECKLIST"	"FINAL COCKPIT PREPARATION CHECKLIST COMPLETE"

BEFORE PROPELLER ROTATION		
EVENT	**CM1**	**GND Mech**
Ready to start engine 2 in HOTEL mode	"GROUND FROM COCKPIT, READY TO START ENG 2 IN HOTEL MODE, CONFIRM SERVICE DOOR CLOSED AND AREA CLEAR" "LEFT SIDE CLEAR" "RIGHT SIDE CLEAR (CM2) " "STARTING ENG"	"CLEAR TO START ENG. 2"
When engines start completed	"GROUND FROM COCKPIT DISCONNECT GPU"	"DISCONNECT GPU"
When ready for pushback, and pushback clearance received from ATC	"GROUND (from) COCKPIT, CLEARED FOR PUSH"	"COCKPIT (from) GROUND, RELEASE BRAKES"
Start of push	"PARKING BRAKES RELEASED, NOSE WHEEL OFF, READY TO PUSH"	
When pushback complete	"PARKING BRAKES SET"	"SET PARKING BRAKES"
When ready to disconnect (after engine started, and parameters are stabilized)	"CLEAR TO DISCONNECT (hand signals on left/right) "	"DISCONNECTING (hand signals on left/right) "

BEFORE TAXI		
EVENT	**CM1**	**CM2**
When NO 2 ENG IN HOTEL MODE, PARAMETERS STABILIZED	"BEFORE PROPELLER ROTATION CHECKLIST"	"BEFORE PROPELLER ROTATION CHECKLIST (refer to EWD C/L) "
Start up clearance received	"BEFORE TAXI PROCEDURE" "BEFORE TAXI CHECKLIST"	"BEFORE TAXI PROCEDURE COMPLETE" "BEFORE TAXI CHECKLIST (refer to EWD C/L) " "BEFORE TAXI PROCEDURE COMPLETE"

BOTH ENGINES FLAME OUT

PL 1 + 2 .... FI

■ **If NH drops below 30 % (no automatic relight)**

CL 1 + 2 .... FTR THEN FUEL SO

ENG 1(2) FLAME OUT AT TAKE OFF

UPTRIM .... CHECK

AUTOFEATHER .... CHECK

■ **If no UPTRIM**

PL 1 + 2 .... ADVANCE TO THE RAMP

● **When airborne**

LDG GEAR .... UP

BLEED 1 + 2 .... OFF, IF NOT FAULT

● **At Acceleration Altitude**

ALT .... SET

● **At VFTO**

PL 1 + 2 .... IN THE NOTCH

PWR MGT .... MCT

IAS .... SET

■ **If normal condition**

SPD TGT .... CHECK VFTO

FLAPS .... 0°

■ **If icing condition**

SPD TGT .... CHECK VFTO ICING FLAPS 15°

FLAPS .... MAINTAIN 15°

PL affected side .... FI

CL affected side .... FTR THEN FUEL SO

BLEED engine alive .... OFF if necessary

SMOKE

CREW OXY MASKS .... ON / 100%

GOGGLES .... SET

CREW COMMUNICATIONS .... ESTABLISH

RECIRC FANS 1 + 2 .... OFF

AP .... ON

UNRELIABLE AIRSPEED INDICATION

AP/YD/FD .... OFF/OFF/STBY
PITCH AND TQ .... MAINTAIN

- **If at take off or GA below 1500 ft:**
  PITCH IMMEDIATELY .... 8°

ICING / VOLCANIC ASHES CONDITIONS .... ESCAPE

25.2.2 FOLLOWING FAILURE

ABNORMAL PARAMETERS DURING START

- **If ITT tends to exceed 900°C, or no ITT, or no NH**
  CL affected side .... FUEL SO
  ENG START ROTARY SELECTOR .... OFF / START ABORT

FIRE LOOP 1A (1B) (2A) (2B) FAULT

LOOP affected .... OFF

ENG 1 (2) FLAME OUT IN FLIGHT

PL affected side .... FI

- **If NH drops below 30 % (no immediate relight)**
  CL affected side .... FTR THEN FUEL SO

PEC 1(2) FAULT

- **If below 400 ft**
  GO AROUND procedure .... APPLY

LO PITCH IN FLIGHT

PL affected side .... FI
CL affected side .... FTR THEN FUEL SO

25.3.5 Approach to stall and stall recovery

PF	PM
CONTROL COLUMN.. .... NOSE DOWN UNTIL OUT OF STALL (1) **"FLAPS 15"**(2) CONTROL WHEEL.........ROLL TO WINGS LEVEL(3) PL...INCREASE AS NEEDED	FLAPS .... 15°
APPLY GENTLE ACTION FOR RECOVERY(4)	
RETURN TO THE DESIRED FLIGHT PROFILE(5)	

(1) The priority is to reduce the angle of attack.
Crew members must accept to lose altitude. To recover from a stall or approach to stall and maintaining the altitude at the same time is not possible.

(2) If the aircraft is in flaps 0° configuration, extend flaps to 15° during the recovery.
In all other configuration and for any flight phase maintain the current configuration for the recovery.

(3) To correctly orientate the lift vector for recovery.

(4) To avoid secondary stall.

(5) Fly the aircraft first and then when it is under control, fly the trajectory.

NOTE: *Use of rudder is not recommended during stall recovery as it can worsen the situation.*

Stick pusher procedure

If angle of attack continues increasing up to the stick pusher angle of attack threshold, the control column is suddenly and abruptly pushed forward. This initiates the stall recovery.

Apply the stall procedure previously described.

Never counteract the stick pusher action.

Procedure at lift-off

Incursion in stick shaker range during lift-off can be generated by:

- Excessive pitch up during rotation
- Excessive rate of pitch rotation
- Turbulences
- Windshear situation

In this case, maintain 10° pitch and when out of the stall warning, follow FD bars.

26. ABNORMAL & EMERGENCY PROCEDURES

26.1 GENERAL

Flight crewmembers shall cope with abnormalities/emergencies by adapting the following principle:

- Prioritization: Aviate-Navigate-Communicate
- Task Sharing
- Division of PF/PM Duties
- Crew Coordination

IMPORTANT: *Never rush up, take all necessary time to analyze situation before acting. No actions (except memo items), no checklists to be performed before acceleration altitude is reached.*

Continuing to fly the airplane is the single most important consideration in almost every situation.

28.1 CREW COORDINATION

Whenever irregularities occur during flight that have effects on aircraft operation or result in serious failure, the Captain shall immediately take over the control from FOs and serve as PF.

PF is responsible for:

- power lever
- flight path and airspeed control
- aircraft configuration
- navigation
- communications

PM is responsible for:

- Monitoring and check list reading
- execution of required actions
- actions on overhead panel
- condition lever

28.2 RULES

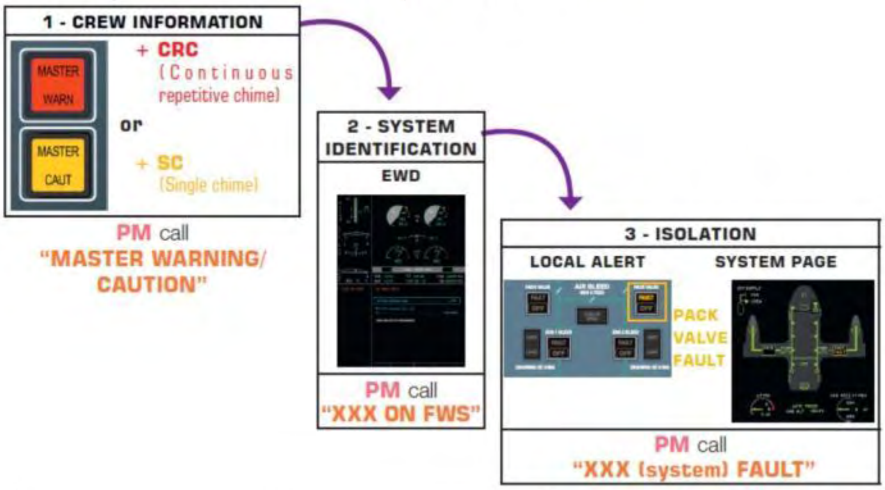
When an emergency or abnormal situation occurs:

1. FLY THE AIRPLANE.

One pilot will devote his/her attention to flying the airplane. When a non-normal situation occurs, the pilot flying (PF) will continue to fly the airplane until properly relieved of that responsibility. It is the captain's (PIC) responsibility to determine who will be the PF for the purposes of situation stabilization and clean-up, and will ensure that both pilots understand who is flying the airplane at all times. The PF will also handle ATC communications as aircraft control permits. Unless the emergency or abnormal procedure directs the pilot to disconnect the auto flight system, It is recommended that it be used as much as possible during these situations.

2. Failure identification

In case of system failure, information is provided to the crew:



PF	PM
	Checks involved flasher and label flashing on EWD **"MASTER WARNING/CAUTION"** **"XXX ON FWS"**
"CHECK" Acknowledges failure or event identification and when able **"SYSTEM CHECK"**	Cancels flashing warning/caution, then checks relevant SD page and lit local alert **"XXX FAULT(OR TYPE OF EVENT)"**

3. Failure analysis: system check

Six checks must be performed for failure confirmation. They are triggered by PF, calling "SYSTEM CHECK" and executed by PM:

<u>**Control**</u>

Is the system control in a relevant position?

<u>**Indicator**</u>

Is the indication relevant? Is the indication in compliance with the corresponding SD page and with the control?

<u>**Supply**</u>

Are the supply source(s) available?

TransAsia	ATR72-600 NORMAL CHECKLIST	REV 04 17 NOV 2014

TAKE OFF BRIEFING	APPROACH BRIEFING
• Aircraft Technical Status • Conditions at departure airport (NOTAM, weather, runway condition, ground movement, obstacle info.) • Rwy excursion risk assessment • Normal departure procedure • Check "ATPCS OFF(INOP)" Take Off Weight • Emergency procedure – Red warning before V1: * On ground emergency EVAC PROC. – Red warning after V1 * Acceleration altitude * Single engine operation proc. • Checklist sequence if emergency exit **Emergency** **Normal** **Abnormal**	• Aircraft Technical Status and NAV status • Conditions at destination airport (NOTAM, weather, runway data (length, surface condition, braking action, landing taxi route, lighting)) • Landing performance (landing distance, Go-around climb gradient)) **Note**: *add 15% to the In-flight LDG Dist. except in emergency.* • Rwy excursion risk assessment • Sudden occurrence handling proc. • Approach chart (date, no. , App. Type) • Transition Level, MSA • Primary App. NAV freq. and course • Approach route course • FAF (or FAP) altitude • DH or MDA and missed approach point – Missed approach procedure * Alternate * Extra & Divert fuel – Go around procedure
TAILWIND LIMITATION: *(Based on AFM 2.03.02 REV16)*	**15 kts**
CARGO DOOR LIMITATION: *(Based on AFM 2.05.07 REV16)*	Do not operate cargo door with a crosswind component ≥ 45 kts

Note: *When entering icing conditions (TAT ≤ 7°C with visible moisture), apply the adequate icing procedures and speeds must be complied and carefully monitored.*

1.18.1.3 ATR72-600 Flight Crew Operations Manual

The current ATR72-600 Flight Crew Operations Manual (FCOM) (Attachment 1-5) is revision 3, published on January 19, 2015 and accepted by CAA, the contents of FCOM are similar to SOP but more detailed. In addition, this SOP also contains the features of flight operation in TNA. If there is any conflict between the FCOM and the SOP, operators should follow the SOP that plays as the primary indicator of TNA policies. The related paragraphs are shown as below:

ENGINE FAILURE

AT TAKE OFF BELOW V1

Abort is mandatory: both PLs are retarded to GI and full braking applied if needed. Reverse is available even on single engine down to full stop: again, control column is transferred to the co-pilot when captain takes nose wheel steering and, in case of single reverse operation roll control must be applied (possibly to full travel) in order to minimize the tendency to bank on the side of the operating engine.

AT TAKE OFF ABOVE V1

Take off must be continued. Directional control must be maintained with rudder and, as soon as aircraft becomes airborne, aileron input to stabilize heading with about 2° of bank toward the operating engine is highly recommended in order to decrease rudder deflection thence improve climb performance.
Both rudder and aileron forces may be completely trimmed out, even at minimum scheduled V2. Once both yaw and roll axis are trimmed out, autopilot may be engaged.

IN APPROACH

Directional control must be maintained with rudder, (which disengages automatically YD and AP if previously engaged) and aileron, in a manner similar to what was described for the continued take off case.

The ATPCS functioning is different between approach and take-off.
Even if TO position is selected:
- Uptrim function is never available
- Auto feather function may be available depending on PL position at the time of the failure.

If autofeather has not operated (windmilling), the drag depends on the engine failed PL position. For this reason :
- In approach, do not reduce the affected PL below 45° PLA before manually feathering the engine.
- If a go around is performed, advance both PLs to the ramp. When appropriate, manually feather the failed engine.

STALLS

STALL WITHOUT ICE ACCRETION

In all configurations, when approaching the stall, the aircraft does not exhibit any noticeable change in flight characteristics: control effectiveness and stability remains good and there is no significant buffet down to CL max ; this is the reason why both the stall alert (audio "cricket" and shaker) and stall identification (stick pusher) are "artificial" devices based on angle of attack measurement.
Recovery of stall approaches should normally be started as soon as stall alert is perceived : a gentle pilot push (together with power increase if applicable) will then allow instantaneous recovery. If the stall penetration attempt is maintained after stall alert has been activated, the STICK PUSHER may be activated : this is clearly unmistakable as the control column is suddenly and abruptly pushed forward, which in itself initiates recovery.

Note : *The "pushing action" is equivalent to 40daN/88 lbs applied in 0.1 second and it lasts as long as angle of attack exceeds the critical value.*

R **WARNING** : Stall training excercises without stick pusher are prohibited.

STALL WITH ICE ACCRETION

Even with airframe de-icers used according to procedure (i.e. as soon as and as long as ice accretion develops on airframe), the leading edges cannot be completely cleared of ice accretion because of existence of "unprotected" elements on the leading edges and continued accretion between two consecutive boots cycles.

This residual ice on leading edges changes noticeably the characteristics of flight BELOW the minimum operating speeds defined for ice accretion, as follows :

- Control effectiveness remains good, but forces to manoeuver in roll and to a lesser degree in pitch, may increase somewhat.
- Above the reduced angle of attack :
  . An aerodynamic buffeting may be felt which will increase with the amount of ice accumulated and angle of attack increase.
  . Stability may be slightly affected in roll, but stick pusher should prevent angle of attack increase before wing rocking tend to develop (Refer to FCOM 1.02.30 for stall alarm threshold definition).

Recovery of stall in such conditions must be started as soon as stall warning is activated or buffeting and/or beginning of lateral instability and/or sudden roll off is perceived.
Recovery will be best accomplished by :
- A pilot push on the wheel as necessary to regain control.
- Selection of flaps 15.
- Increase in power, up to MCT if needed.

AA

STICK PUSHER / SHAKER TEST (once a day)

-Release gust lock
-Push control column in nose down position
-Select WARN rotary selector (LH maintenance panel) to STICK PUSHER YES
-Depress and maintain PTT
  -Monitor stall cricket and stick shaker.
  -After ten seconds, monitor:
    CHAN 1 and CHAN2 illuminate green on LH maintenance panel.
    STICK PUSHER lights illuminate green on both pilots FMA.
    Stick pusher actuator operates.
-Select WARN rotary selector to NORM FLT
-Reengage the gust lock

ATPCS TEST (dynamic test: once a day) (autofeather and uptrim while engines running)

Conditions: - PL 1 + 2 in GI - CL 1 + 2 in AUTO.
- ATPCS P/B depressed in, OFF light extinguished
- PWR MGT on TO position

Check the following results on EWD:

- Turn the ATPCS knob to the left to the arm position and check
  - ARM light .... ILLUMINATES
  - TQ INDICATION .... INCREASE
  - NP & NH INDICATION .... DECREASE
- Turn the ATPCS knob to ENG 1 position and check :
  - ENG 2 UPTRIM LIGHT .... ILLUMINATES
  - TQ 2 .... NO CHANGE
  - NP, NH .... INCREASE SLIGHTLY
  - TQ 1 needles indication .... DECREASE BELOW 18 %
  - After 2.15 s : associated propeller is automatically feathered
    - ARM light .... EXTINGUISHED
    - PROP 1 AUTO FTR LABEL .... DISPLAYS
- Turn the ATPCS knob to the right to the arm position and check :
  - ARM light .... ILLUMINATES
  - TQ INDICATION .... INCREASE
  - NP & NH INDICATION .... DECREASE
- Turn the ATPCS knob to ENG 2 position and check :
  - ENG 1 UPTRIM LIGHT .... ILLUMINATES
  - TQ 1 .... NO CHANGE
  - NP, NH .... INCREASE SLIGHTLY
  - TQ 2 needles indication .... DECREASE BELOW 18 %
  - After 2.15 s : associated propeller is automatically feathered
    - ARM light .... EXTINGUISHED
    - PROP 2 AUTO FTR LABEL .... DISPLAYS

R **CAUTION** : Do not perform ENG TEST while taxiing as ACW is temporarily lost and consequently, both HYD pumps are temporarlily lost as well.

Note : If ENG TEST must be repeated, wait 10 minutes before setting ATPCS selector in ENG position in order not to damage feathering pumps. (Winding heating).

AA **BOTH ENGINES FLAME OUT**

ALERT

CONDITION	VISUAL	AURAL
Both engines flame-out	- MW light flashing red - Associated ENG 1+2 OUT red message on EWD	CRC

PROCEDURE

BOTH ENGINES FLAME OUT

PL 1 + 2 . . . . FI

■ **If NH drops below 30 % (no automatic relight)**

CL 1 + 2 . . . . FTR THEN FUEL SO

FUEL SUPPLY . . . . CHECK

OPTIMUM SPEED . . . . Vm HB

COMMUNICATIONS . . . . VHF 1

ENG START ROTARY SELECTOR . . . . START A & B

ENG 2 RELIGHT

ENG 2 START pb . . . . ON

● **When NH above 10%**

CL 2 . . . . FTR

ENG 2 RELIGHT . . . . MONITOR

CL 2 then PL 2 . . . . AS RQD

ENG 1 RELIGHT

ENG 1 START pb . . . . ON

● **When NH above 10%**

CL 1 . . . . FTR

ENG 1 RELIGHT . . . . MONITOR

CL 1 then PL 1 . . . . AS RQD

■ **If neither engine starts**

CL 1 + 2 . . . . FTR THEN FUEL SO

ENG START ROTARY SELECTOR . . . . OFF/START ABORT

FUEL PUMPS 1 + 2 . . . . OFF

FORCED LANDING or DITCHING procedure(2.04.05) . . . . APPLY

CAUTION : Do not select AVIONICS VENT EXHAUST MODE to OVBD.

R ■ **If at least one engine recovered**

CL / PL engine(s) recovered . . . . AS RQD

■ **If one engine not recovered**

CL engine NON recovered . . . . FTR THEN FUEL SO

R LAND ASAP

SINGLE ENG OPERATION procedure(2.05.02) . . . . APPLY

R SYSTEMS affected . . . . RESTORE

APM . . . . OFF

AA

ENG 1 (2) FLAME OUT AT TAKE OFF

ALERT

An engine flame out may be recognized by :
- Sudden dissymetry
- TQ decrease
- Rapid ITT decrease

CONDITION	VISUAL	AURAL
engine flame out or ATPCS sequence	- MW light flashing red - Associated ENG 1 (2) OUT red message on EWD + AUTO FTR and UPTRIM labels on EWD	CRC

PROCEDURE

R

ENG 1(2) FLAME OUT AT TAKE OFF

UPTRIM .... CHECK
AUTOFEATHER .... CHECK

■ **If no uptrim**

PL 1 + 2 .... ADVANCE TO THE RAMP

● **When airborne**

LDG GEAR .... UP
BLEED 1 + 2 .... OFF, IF NOT FAULT

● **At acceleration altitude**

ALT .... SET

● **At VFTO**

PL 1 + 2 .... IN THE NOTCH
PWR MGT .... MCT
IAS .... SET

■ **If normal conditions**

SPD DGT .... CHECK VFTO
FLAPS .... 0°

■ **If icing conditions**

SPD DGT .... CHECK VFTO ICING FLAPS 15°
FLAPS .... MAINTAIN 15°

PL affected side .... FI
CL affected side .... FTR THEN FUEL SO
BLEED engine alive .... OFF if necessary

■ **If damage suspected**

FIRE HANDLE affected side .... PULL
LAND ASAP
SINGLE ENG OPERATION procedure(2.05.02) .... APPLY

■ **If no damage suspected**

ENG RESTART IN FLIGHT procedure(2.05.02) .... APPLY

■ **If unsuccessful** :

LAND ASAP
SINGLE ENG OPERATION procedure(2.05.02) .... APPLY

GENERAL

The procedures following failures represent the actions applicable after a failure to ensure adequate dafety and to ease the further conduct of the flight. They are applied according to the "Read and Do" principle except for the memory items.

PRESENTATION

The procedures are presented in the basic check list format with an adjacent expanded section which provides:

- indication of the particular failure, alert condition
- explanation for actions where the reason is not self evident
- additional background information

The abbreviations used are identical with the nomenclature on the cockpit panels. All actions are printed in CAPITAL letters.

■ : a preceding black square is used to identify a pre-condition (in bold) for given action(s).

● : a preceding black dot is used to indicate the moment (in bold) when given action(s) have to be applied.

TASK SHARING

For all procedures, the general task sharing stated below is applicable.

The pilot flying remains pilot flying throughout the procedure.

PF, Pilot Flying, responsible for:

- PL
- flight path and airspeed control
- aircraft configuration
- navigation

PM, Pilot Monitoring, responsible for:

- check list reading
- execution of required actions
- actions on overhead panel
- CL
- communications

The AFCS is always coupled to the PF side (CPL selection).

PROCEDURES INITIATION

- No action will be taken (apart from depressing MW pb):
  . Until flight path is stabilized.
  . Under 400 ft above runway (except for propeller feathering after engine failure during approach at reduced power if go around is considered).

- Before performing a procedure, the crew must assess the situation as a whole, taking into consideration the failures, when fully identified, and the constraints imposed.

ANALYSIS OF CONSEQUENCES OF A FAILURE ON THE FLIGHT

Basic airmanship calls for a management review of the remaining aircraft capabilities under the responsability of CM1.

FWS ALERTING

(see page 3)

ELECTRONIC CHECK- LISTS USE : HUMAN FACTOR RECOMMENDATIONS

Upon completing procedure, PNF need tick each item, i.e. meaning the item was acknowledged and taken care of.

- Importance of procedure pending message:

Pending procedure notice need be carefully considered when displayed, therefore meaning this one needs yet be performed and completed.

- Importance "PROCEDURE COMPLETED" item:

Completed procedure item, is displayed at the end of each started procedure, provided all items have been properly ticked. It is the only way to complete and correctly terminate a started procedure.

- Importance "IF" statements:

Following each procedure's "IF" alternative proposition, PNF must carefully read and understand these different alternatives to meet current depiction and get PF's approval and confirmation to comply with relevant "IF" procedure.
Once an "IF" case has been selected, PNF must carefully read and understand relevant procedure's proposition and it's associated subtitle, obtain PF's confirmation before resuming corresponding associated task.

R - Awareness of STATUS:
R The flight crew must open and review the statuses during recall.

- DU failure:

Neither DU fault procedure exists and no relevant reference is made in FWS, FCOM nor QRH.

SINGLE ENG OPERATION

ALERT

CONDITION	VISUAL	AURAL
Engine flame out	- MC light flashing amber - SINGLE ENG amber message on EWD	SC

PROCEDURE

SINGLE ENG OPERATION

PWR MGT . . . . MCT
ENG BOOST FUNCTION (if installed) . . . . AS RQD
LAND ASAP
FUEL PUMP affected side . . . . OFF
DC GEN affected side . . . . OFF
ACW GEN affected side . . . . OFF
PACK affected side . . . . OFF
BLEED affected side . . . . OFF
APM . . . . OFF
TCAS . . . . TA ONLY
OIL PRESSURE AND NP ON FAILED ENGINE . . . . MONITOR

Note: In icing conditions, FLAPS 15 will be selected to improve drift down performances and single engine ceiling.

Note: Refer to QRH pages (4.61) and (4.62) to determine single engine gross ceiling.

Note: If during the flight, a positive oil pressure has been noted on the failed engine for a noticeable period of time, maintenance must be informed.

Note: monitor fuel balance. Recommended operational maximum fuel unbalance is 200 kg (440 lb).

● **When FUEL CROSS FEED is required**

FUEL PUMP affected side . . . . ON
FUEL X FEED . . . . ON
FUEL PUMP on operating engine . . . . OFF

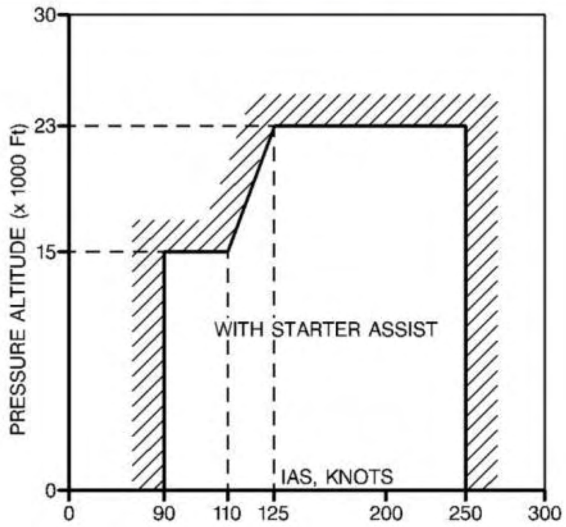
To be continued next page(...\...)

AA

ENG RESTART IN FLIGHT

PROCEDURE

ENG RESTART IN FLIGHT



FUEL SUPPLY .... CHECK
CL .... FUEL SO
PL .... FI

CAUTION: After ATPCS sequence PWR MGT rotary selector must be set to MCT-position before engine restart in order to cancel propeller feathering.

ENG START ROTARY SELECTOR .... START A & B
R START PB .... ON

Note : AP-YD may disconnect during start

R ● **When NH above 10 %**

CL .... FTR
RELIGHT .... MONITOR
CL .... AUTO
PL .... ADJUST TO OTHER ENGINE
R ENG START ROTARY SELECTOR .... OFF/START ABORT
SYSTEMS AFFECTED .... RESTORE
R APM .... OFF

COMMENTS

- Engine relighting in flight is only guaranteed within the envelope and always necessitate starter assistance.
- The power may be restored immediately after relighting provided OIL TEMP > 0°C.
- Should the engine fail to light up within 10 seconds, select fuel to shut off, the ignition OFF and allow engine to be ventilated for 30 seconds minimum prior to making another attempt.

Mod : 5948

AA

ENG 1(2) FLAME OUT IN FLIGHT

ALERT

CONDITION	VISUAL	AURAL
Engine 1(2) flame out	- MW light flashing amber - ENG 1(2) OUT amber message on EWD	SC

PROCEDURE

ENG 1(2) FLAME OUT IN FLIGHT

PL affected side . . . . FI

■ **If NH drops below 30% (no immediate relight)**

CL affected side . . . . FTR THEN FUEL SO

■ **If damage suspected**

FIRE HANDLE affected side . . . . PULL

R LAND ASAP

SINGLE ENG OPERATION procedure (2.05.02 page 1) . . . . APPLY

■ **If no damage suspected**

ENG RESTART IN FLIGHT procedure (2.05.02 page 10) . . . . APPLY

■ **If engine out confirmed**

R LAND ASAP

SINGLE ENG OPERATION procedure (2.05.02 page 1) . . . . APPLY

COMMENTS

- Shut down the engine if no immediate relight.
- The causes of engine flame out can generally be divided into two categories :
  . External causes such as icing, very heavy turbulence, fuel mismanagement. These causes, which may affect both engines can generally be easily determined and an immediate relight can be attempted.
  . Internal causes which as engine stalls or failures usually affect a single engine and are not so easily determined. In these cases, the engine is shut down then the cause of the flame out investigated. If it cannot be positively determined what caused the flame out, the need for engine restart should be evaluated against the risk or further engine damage or fire that may result from a restart attempt.
- If damage is suspected, as precautionary measure, the FIRE handle is pulled.

1.18.1.4 ATR Flight Crew Training Manual

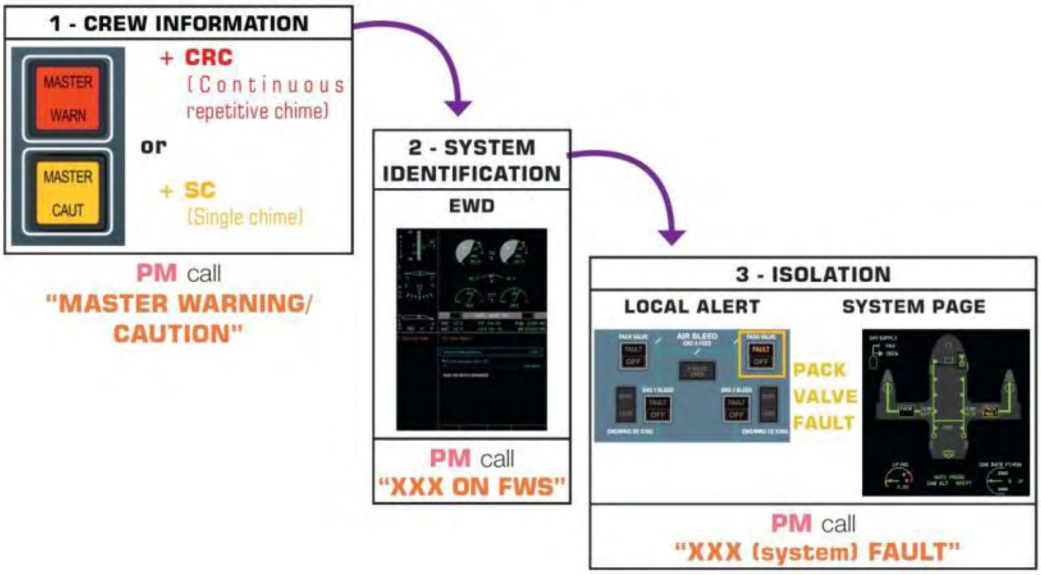
The Flight Crew Training Manual (FCTM) (Attachment 1-6) provided by ATR is an essential tool to learn the ATR standard operating procedures. It has been conceived as the standard baseline for all ATR flight crew training. The manual was published in February 2014. The related paragraphs are shown as below:

4. Abnormal and emergency procedures

IMPORTANT: Never rush up, take all necessary time to analyse situation before acting. No actions (except memo items), no checklists to be performed before acceleration altitude is reached.

4.1. Failure identification

In case of system failure, information is provided to the crew:



PM	PF
PM checks involved flasher and label flashing on EWD. ▶ CALL "MASTER XXX, XXX ON FWS"	
PM cancels flashing **WARNING** and / or **CAUTION**, then checks relevant SD page and lit local alert and: ▶ CALL "XXX FAULT (OR TYPE OF EVENT)"	▶ CALL "CHECK" PF acknowledges failure or event identification and when able: ▶ COMMAND "CHECK SYSTEM"

4.2. Failure analysis: system check

Six checks must be performed for failure confirmation. They are triggered by PF, calling **"SYSTEM CHECK"** and executed by PM:

Control

Is the system control in a relevant position?

Indicator

Is the indication relevant? Is the indication in compliance with the corresponding SD page and with the control?

Supply

Are the supply source(s) available?

Circuit breakers

Flight Crew may reengage a tripped circuit breaker only if he/she judges it necessary for a safe continuation of the flight. In this case only one reengagement should be attempted.

If the failure alert disappears, continue normal operation and record the event in the maintenance log. If not, apply the associated failure procedure.

On the ground, a pilot may re-engage a tripped circuit breaker provided the action is coordinated with the maintenance team.

Lighting

Are the bulb(s), digit(s) working?

Reset

At PF discretion, one reset of a push button of a failed system, associated with an amber caution, may be performed by selecting system related push button OFF for 3 seconds and then ON.

EXCEPTIONS: BLEED LEAKS, LO LEVEL, EEC, PEC, BUS, CAB PRESS MAN.

4.3. Checklist methodology

Before executing checklist crew must **confirm** it is the appropriate one:

PM	PF
▶ CALL "SYSTEM CHECKED, XXX FAILURE CONFIRMED" (OR NOT)	
	▶ CALL "SINGLE PACK VALVE FAULT CHECKLIST"

READ AND DO, CROSSCHECKS

Concept: PM reads out the item loudly and performs the required action AFTER PF confirmation.

PM	PF
PM reading the C/L on EWD. ▶ READ AND CALL "PACK VALVE AFFECTED SIDE....OFF" PM points out the PACK VALVE PB. ▶ CALL "PACK VALVE 2?"	
	▶ CHECK AND CALL "CONFIRMED"
After PF confirmation, PM depresses PACK VALVE 2 PB. ▶ CALL "OFF"	

EXCEPTION: Once **on the ground**, with aircraft stopped and parking brake set, CM1 performs required actions as stated in the emergency procedure. No crosscheck procedure is required. Once all procedures are completed, CM1 calls out checklist. In this case, *Challenge and response* methodology is used (refer to 01.04 p5).

Once checklist is completed, PM calls out:

PM	PF
After checklist completion: ▶ CALL "SINGLE PACK VALVE FAULT C/L COMPLETE "	

4.4. Assessments / decision / information

4.4.1. Assessment

Once checklist is completed, PM reads status on PF request, PF summarizes the situation, taking into account the three following aspects: T-O-C

- Technical assessment: consider consequences of related failure on systems by scanning the overhead panel (fuel, DC/AC, anti-/de-icing, ACW, hydraulic, air) and checking the relevant SD page.
- Operational assessment: consider possibility to land at destination, divert / alternate, depending on failure, operational limitations, weather conditions, fuel status.
- Commercial assessment: consider passengers or crew casualties (e.g.: depressurization) and in case of diversion, possibility to allow passengers to proceed to destination airport (transportation, feeding, lodging accommodations...), in accordance with operator policy.

4.4.2. Decision

Once assessment is performed, PF is able to suggest a decision, endorsed by Captain.

Crew must settle a consensus before making a decision.

4.4.3. Information

PF and PM plan together the consequences of failures encountered. Then PM informs, if necessary:

- ATC
- Flight attendant
- Passengers
- Dispatch

4.5. Example

Follows a PACK VALVE FAULT troubleshooting example:

Flight events	PM	PF	
MC + SC + AIR PACK ON FWS + PACK VALVE FAULT (LOCAL ALERT)	▶ CALL AND DO "MASTER CAUTION, AIR PACK ON FWS" MASTER CAUTION PB......... DEPRESS		Failure Identification
AFTER ASSOCIATED PANEL AND SD PAGE CHECK	▶ CALL "PACK VALVE 2 FAULT"	▶ CALL "CHECK"	
	▶ DO PACK VALVE PB.. CHECK DEPRESSED SUPPLY.................................ENG OK CIRCUIT BREAKER.................. CHECK LIGHTING .... OK	▶ COMMAND "CHECK SYSTEM"	Failure Analysis
IF NO ABNORMAL CONDITION IS NOTED	▶ CALL "PACK VALVE 2 RESET?" ▶ DO AND CALL PACK VALVE 2..................POINTED AT WITH FINGER "PACK VALVE 2?" ▶ DO AND CALL PACK VALVE 2............ OFF (for 3 sec) "OFF" PACK VALVE 2.............................. ON "ON"	▶ COMMAND "RESET PACK VALVE 2" ▶ DO AND REPLY ITEM POINTED AT BY PM......... CHECK "CONFIRMED"	
PACK VALVE 2 FAULT CONFIRMED	▶ CALL "SYSTEMS CHECKED, PACK VALVE 2 FAILURE CONFIRMED"	▶ COMMAND "SINGLE PACK VALVE FAULT CHECKLIST, RADIO RIGHT SIDE"	Failure Confirmation
PM READS AND EXECUTES C/L DISPLAYED ON EWD UNDER PF CONTROL	▶ READ, DO AND CALL "PACK VALVE AFFECTED SIDE OFF" PACK VALVE 2..................POINTED AT WITH FINGER "PACK VALVE 2?" ▶ DO AND CALL PACK VALVE 2............................ OFF "OFF" ▶ CALL "AVOID LARGE QUICK POWER CHANGES AT HIGH ALTITUDES"	▶ DO AND REPLY ITEM POINTED AT BY PM......... CHECK "CONFIRMED" ▶ REPLY "CHECK"	Checklist Completion

Flight events	PM	PF	
PM READS AND EXECUTES C/L DISPLAYED ON EWD UNDER PF CONTROL (CONT'D)	▶ CALL **"MAXIMUM FLIGHT LEVEL 200/MEA"** ▶ CALL **"SINGLE PACK VALVE FAULT C/L COMPLETED PENDING STATUS"**	▶ REPLY **"CHECK"**	**Checklist Completion**
PM READS STATUS DISPLAYED ON EWD	▶ CALL **"STATUS PACK FAULT PENDING ACTIONS: AVOID LARGE QUICK POWER CHANGES AT HIGH ALTITUDES LIMITATION: MAX FL 200/MEA STATUS PACK FAULT COMPLETED"**	▶ CALL **"STATUS PACK FAULT"**	**Reading of status**
WHEN ABLE, PF ASSESSES THE SITUATION	▶ CALL **"GO AHEAD"**	▶ CALL **"READY FOR ASSESSMENT?"** ▶ CALL **TECHNICAL** **"WE HAVE A PACK VALVE 2 FAILURE. FUEL OK, DC/AC OK, HYD OK, AIR: REMAINING ONLY LEFT SIDE CIRCUIT.** **OPERATIONAL** **"FL LEVEL IS LIMITED, LARGE & QUICK POWER CHANGES AVOIDED. DESTINATION AIRPORT IS MAINTAINED".** **COMMERCIAL** **"TEMPERATURE CABIN MAY INCREASE"**	**Assessments**
PF SUGGESTS A DECISION TO CM1		▶ CALL **"I SUGGEST THAT WE CONTINUE TO DESTINATION AND WRITE IT DOWN IN MAINTENANCE LOG."**	**Decision**
		"NOBODY NEEDS TO BE INFORMED EXCEPT COMPANY, IF YOU AGREE. CONTACT DISPATCH TO INFORM ABOUT MALFUNCTION."	**Information**
	CAPTAIN ▶ CALL **"I AGREE"**		
		▶ CALL **"CLEAR FWS, RADIO LEFT SIDE"**	
	▶ DO AND CALL CLR PB .... DEPRESS **"FWS CLEARED"**		

5. Flows

During their mission, crew members have several sequences of tasks to perform. These sequences are defined by the manufacturer to:

- Fit the design of the aircraft,
- Prioritize the tasks,
- Organize the workload on board.

When a sequence of tasks is necessary to complete the requirements of a flight phase, they are organized in Standard Operational Procedures (SOPs).

Example: Before Take-Off Procedure

In order to achieve the procedures, the SOPs tasks are organized in an ergonomic and logical order with regard to the instruments and the systems the pilots have to use. The physical progression to achieve this procedure is called "Flow".

The completion of these flows facilitates the pilot activity and the memorization of the procedures.

Example: Please refer to the Preliminary Cockpit Preparation flow described in 02.02.04.

9. Briefings

9.1. Departure briefing

1 All departure settings must be ready before PF performs the briefing.

2 General Conditions
- Actual and expected weather for departure, cruise and arrival. Hazardous phenomena (Icing, thunderstorm, turbulence…)
- NOTAMs
- Aircraft status: daily check, documentation, MEL items…

3 Taxi
- Taxi out description
- Restrictions: contamination, closed Taxiway…
- Runway in use and expected holding point
- Anticipate de-icing holdover times.

4 Take-off Performance
- Limitations, bleeds ON or OFF, power setting (Boost, RTO).

Departure chart

5 Jeppesen chart n° and date

6 Departure procedure name

7 MSA

8 Flight path description: routing, 1st altitude or FL, climb gradient

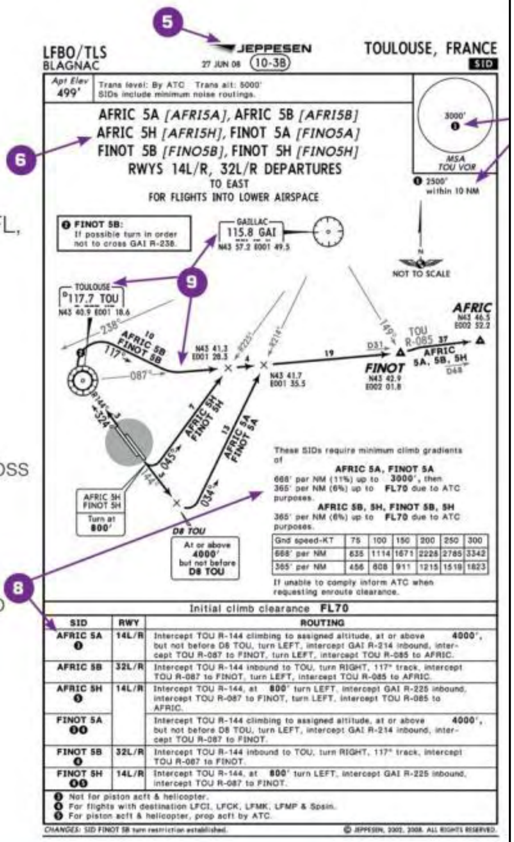
9 NAVAIDS settings:
Active frequencies & associated courses
Standby frequencies (if necessary)
DME hold (if necessary)
BRG 1 & 2 setting: VOR or ADF

10 FMS setting: Check SID inserted in FPL for cross check operation

11 Single engine flight path description: routing, acceleration altitude, return to departure airport and expected approach, or diversion to take-off alternate.

12 Review potential specific threats

13 Open questions



Example: CM2 is PF.

1 "ARE YOU READY FOR THE DEPARTURE BRIEFING?"

2 "VISIBILITY IS 2000M, CEILING AT 1500FT, WIND FROM 320/15 KT, QNH 1012, NORMAL CONDITIONS. NO MEL, NO NOTAM."

3 "WE'LL TAXI OUT VIA PAPA, HOLDING POINT N1, FOR RUNWAY 32R."

4 "TAKE-OFF WITH BLEEDS ON, ANTI-ICING OFF."

5 "CHART 10-3B, VALID FROM JUNE 27TH."

6 "EXPECTED DEPARTURE IS AFRIC5B."

7 "MSA IS 3000 FT, 2500 FT WITHIN 10NM." (Set ALT SEL or Set SID or MSA constraint)

8 "324 INBOUND TO TOU THEN RIGHT TURN TO HEADING 117 TO INTERCEPT 087 OUTBOUND RADIAL FROM TOU TO FINOT. THEN INTERCEPT 085 OUTBOUND RADIAL TO TOU TO AFRIC. CLIMB GRADIENT IS 11% UP TO 3000FT, WHICH WE CAN COMPLY ON BOTH ENGINES."

9 "NAV 2: TOU, CRS 324, STBY ILS
NAV 1: TOU, CRS 087, STBY GAI
ADF1 & 2: TOE
BRG1 ON VOR, BRG2 ON ADF."

10 "FINOT SID IS SET IN THE FMS..." (PF CHECK on FPLN page / PM CHECK with SID Jeppesen chart)

11 "IN CASE OF ENGINE FAILURE, PROCEED STRAIGHT AHEAD CLIMBING 3000 AND REPORT ATC."

12 "NO SPECIFIC THREAT"

13 "ANY QUESTIONS? DEPARTURE BRIEFING COMPLETE."

9.2. Departure clearance

When departure clearance is obtained from ATC, you must check its consistence and compliance with expected SID:

- Is cleared SID in compliance with prepared one?
- Altitude clearance selected and crosschecked on PFD(s).
- Set transponder code.

If no clearance amendment is received, PF calls: "NO CHANGE"

If clearance is amended, modify FMS FPLN, reorganize NAVAIDS and perform new briefing.

9.3. Take-off briefing

1 PF calls: "ARE YOU READY FOR TAKE-OFF BRIEFING?"

2 Take-off parameters: runway QFU reminder, TOW, V1

3 Procedure in case of failure: take-off abort & continuation description

4 Open questions

ATR	**NORMAL PROCEDURES** GENERAL PROCEDURES & POLICIES	02.01.09 Page 3 FEB 14 42-600 / 72-600

Example: CM2 is PF.

1. "ARE YOU READY FOR TAKE-OFF BRIEFING?"
2. "TAKE-OFF RUNWAY 32R, WEIGHT 22 TONS, V1 111 KT, NORMAL CONDITIONS."
3. "ANY FAILURE BEFORE V1, YOU CALL "STOP" AND STOP AIRCRAFT

IF FAILURE AT OR AFTER V1, WE CONTINUE TAKE-OFF, RUNWAY HEADING TO 3000 FT, THEN RIGHT TURN TRACKING TOE CLIMBING TO 4000 FT, ACCELERATION ALTITUDE IS 1000 FT, MSA IS 3000 FT."

4. "ANY QUESTIONS? TAKE-OFF BRIEFING COMPLETE."

9.4. Arrival briefing

1 All settings must be performed before PF's arrival briefing.

2 **Top Of Descent (TOD)**

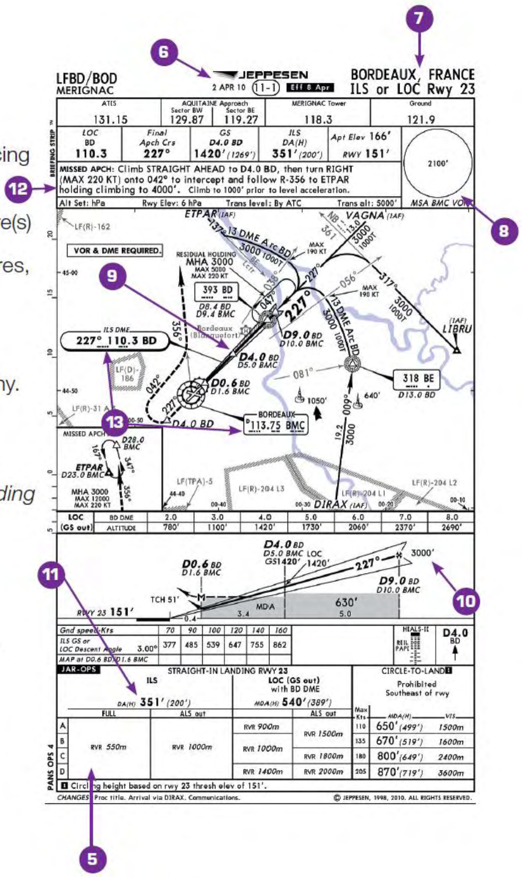
- Expected remaining distance and MSA
- Expected point of deceleration

3 **Approach conditions**

- Actual and forecast weather, normal or icing atmospheric conditions
- Aircraft status: MEL items, En-route failure(s)
- NOTAMs / ATIS: airport equipments failures, anticipate runway assignments changes & unexpected closure.
- Landing weight, runway in use: landing limitation and approach climb limitation if any.

4 **Alternate & Holding time**

- Quote holding time before diversion. For computation details refer to 2.01.09 p5 *Holding Time*.



Approach chart

5 Actual and forecast weather at destination: visibility / RVR compared to minima

6 Jeppesen chart n° and date

7 Type of approach procedure

FOR TRAINING ONLY

1.18.1.5 TNA Flight Training Management Manual

The current ATR72-600 Flight Training Management Manual

(FTMM) (Attachment 1-7) is revision 33, published on January 8, 2015 and approved by CAA. The purpose of the FTMM is to establish a unified training system, procedures and standards for each fleet.

1.18.1.6 TNA FOD Operations Manual

The current Flight Operations Department Operations Manual (FOD OM) (Attachment 1-8) is revision 33, published on October 01, 2014. The related paragraphs are shown as below:

5-3 副駕駛昇訓正駕駛程序(FO to Captain Upgrade Training)

5-3-1 甄選程序Selection Procedures

基本甄選程序Basic Selection Procedures：

1. 航務處平時即根據本手冊第10章相關資格列出合格人員送交所屬 機隊教師(IP)會議評估合乎基本甄選資格人員之平時飛航表現，獲 得推薦者，得參加日後航務處不定期辦理之昇訓甄選。未能獲得推 薦者，由IP會訂定加強職能計劃與時程，完成加強後，重新送交IP 會評估成效，直到獲得推薦.(FOD will list the FOs who meet the basic qualification for upgrade in accordance with the relevant qualifications specified in Chapter 10 of the Manual from time to time and present to relevant IP meetings for recommendation. Those who are recommended by the IP meetings are qualified candidates for the future upgrade training selection. Those who are not recommended by the IP meetings shall complete the reinforcement measures provided by the IP meetings until being acknowledged and recommended)

2. 航務處依人力需求不定期呈報昇訓需求人數，經 總經理核准後實施以下甄選程序。(FOD shall submit report on the number of persons required for upgrade training before the implementation of the following procedure to the President for approval prior to implementation)

3. 由機隊管理部宣佈昇訓額度，獲得IP會推薦者，需於指定期間內參加學科考試，且成績達90分以上。 由標訓部安排於特定期間內舉行學科考試，逾期不得要求測試。(Qualified candidates must take written tests within specified time and reach 90 points or higher. The STD shall schedule for holding the written test within specified period and candidates must take the test within the time frame and may not request for test taking past this period.

4. 由航務處將入選名單填入本章附表二「副駕駛昇訓正駕駛評分表」(如附表二)，並逐項給分。(Qualified candidates will be listed by the FOD and filled into the Appendix 2 of the Chapter with scores given accordingly).

5. 由航務處該機隊至少三分之二以上人員出席之IP聯席會議，舉行口試/面試後，並依最終排名擇定昇訓人員。(FOD will call at least two thirds of the fleet IP/CPs to carry out a review and oral test. The result will *be filled into the Appendix 2 to produce the final scores and ranking of the selected candidates.*

Remark: Candidates falling below 60 points given by one third of the interviewers can not be recommended (see Appendix 5 of this Chapter)

6. 由航務處簽報甄選結果，呈總經理核准。(The FOD shall report the selection results to the President for approval.

……

口試/面試評分表

Oral/Written Tests Evaluation Sheet

項目 Item / 姓名 Name	口試分數 Oral Score (50%)	線上綜合表現評估 Comprehensive Online Performance Evaluation (50%)	總分 Total Score

說明 Instructions:：

一、 本表由擔任面試官填寫。

二、 「口試分數」以受試者回答口試題目正確性與完整性給分。

三、 「線上綜合表現評估」由面試官根據受試者在線上表現之實際案例綜合評估後給分。

四、 總分若有三分之一出席之考試官評定低於 60 分者，則不予推薦。

1. The sheet is filled out by interviewer.
2. The “oral test score” is based on the correctness and comprehension of the respondent’s reply to oral test questions.
3. The “Online Comprehensive Performance Evaluation” is scored by the interviewer according to the real cases of respondent’s online performance in comprehensive evaluation.
4. If there is score falling below 60 points from one third of the interviewers, the applicant will not be recommended.

填表人 Filled by：

11-9 記錄與資料控管方式(The management and control of flight operations records and data)

各項記錄或資料依達到其規定之保存期限後，由各記錄或資料保存者適時銷毀，包括但不限於：飛時記錄（保存一年）、飛航文件（保存3個月）、飛航駕駛員班表（保存

兩年）、個人資料與訓練記錄（聘雇期間）。
附註：駕駛員訓練/考核(包括檢定不及格之記錄)與資格記錄應於駕駛員聘用期間持續保存。
(Flight Operations related records and data shall be preserved accordingly: Flight Time/Duty Time Related Records (at least one year); flight documents (at least 3 months); Rosters (at least 2 years); Personal data and training records, including successful and unsuccessful flight crew evaluations (employment period). After the required retention periods, the records may be disposed.)
以上記錄(包括電子形式，若有)於保存時，應有適當之識別方式、清楚可讀、專檔或專櫃維護、鎖妥，並僅供權責人員存取。存檔設備需能具備基本防火、防盜功能。
(The above records (including in an electronic form) shall be identifiable with proper naming or filing system. They shall be legible, maintained and locked in proper storage devices (such as metal cabinets) with protection/security functions, and are accessible to authorized personnel only.

1.18.1.7 ATR72-600 Minimum Equipment List and Configuration Difference List

The current ATR72-600 Minimum Equipment List and Configuration Difference List (MEL/CDL) is revision 1 and was published on February 10, 2015. It is developed from the ATR Master MEL revision 05 and ATR72-212A AFM revision 15, and then be tailored to TNA specific operational requirements. It was approved by CAA. The MEL paragraphs related to propellers are shown in Appendix 1-3

1.18.1.8 ATR72-600 Runway Analysis Manual

The current ATR72-600 Runway Analysis Manual (RAM) published on September 30, 2013, and was approved by CAA. It provides flight crewmembers and other operational personnel the aircraft takeoff and landing performance data, including Regulatory Take-Off Weight (RTOW) chart and Regulatory Landing Weight (RLW) chart, and computation of the takeoff and landing performance assuming the case of a critical engine failure at any point during takeoff and landing. The information of engine out standard instrument departure of Songshan airport runway 10 is shown in Appendix 1-4.

1.18.1.9 RCSS Departure Aeronautical Chart

The Aeronautical Information Publication (AIP) Taipei FIR is published by CAA. In accordance with the AIP, the RCSS MUCHA TWO departure chart is shown in Figure 1.18-1. The KEELUNG ONE departure chart is shown in Figure 1.18-2.

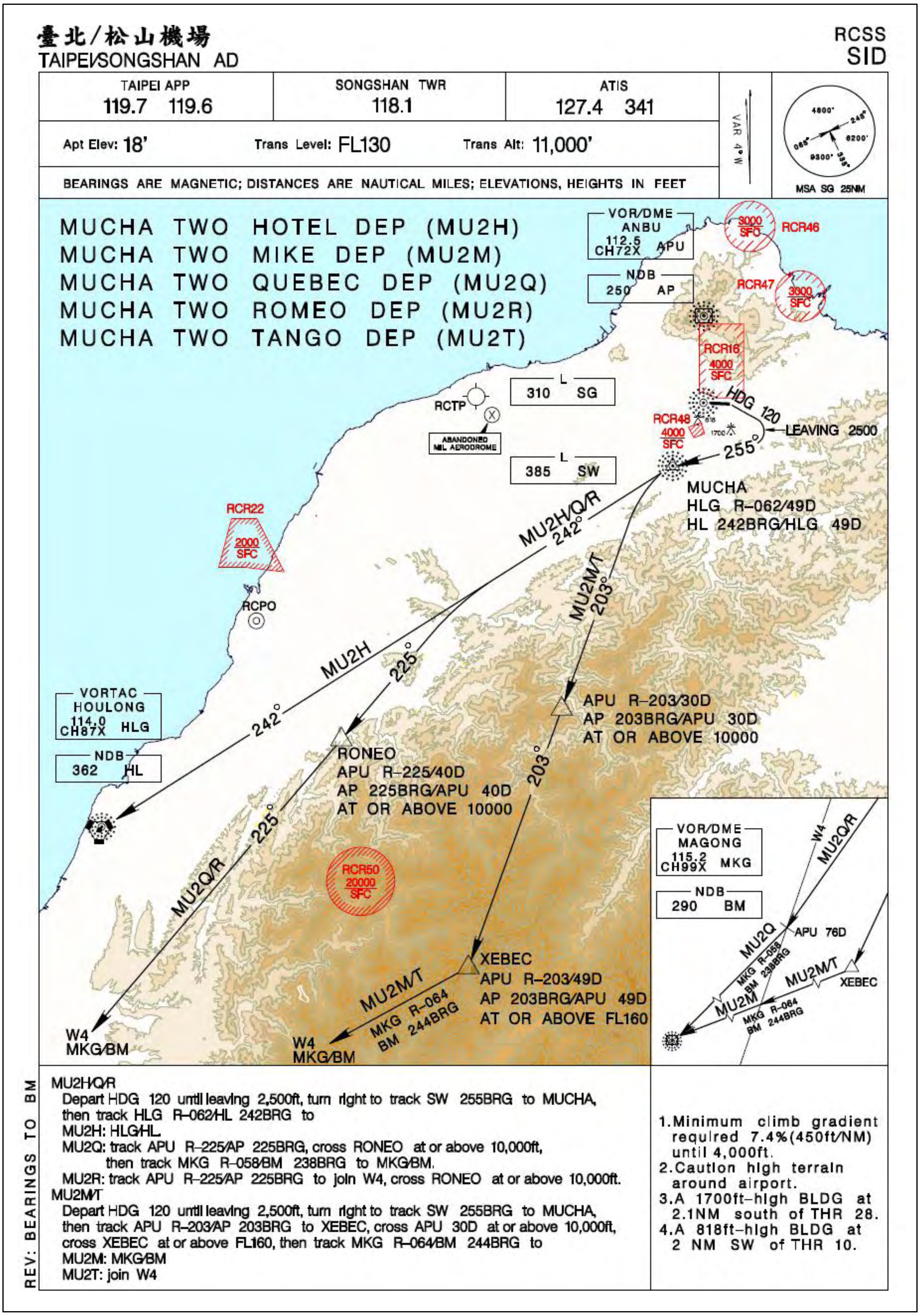


Figure 1.18-1 RCSS MUCHA TWO departure chart

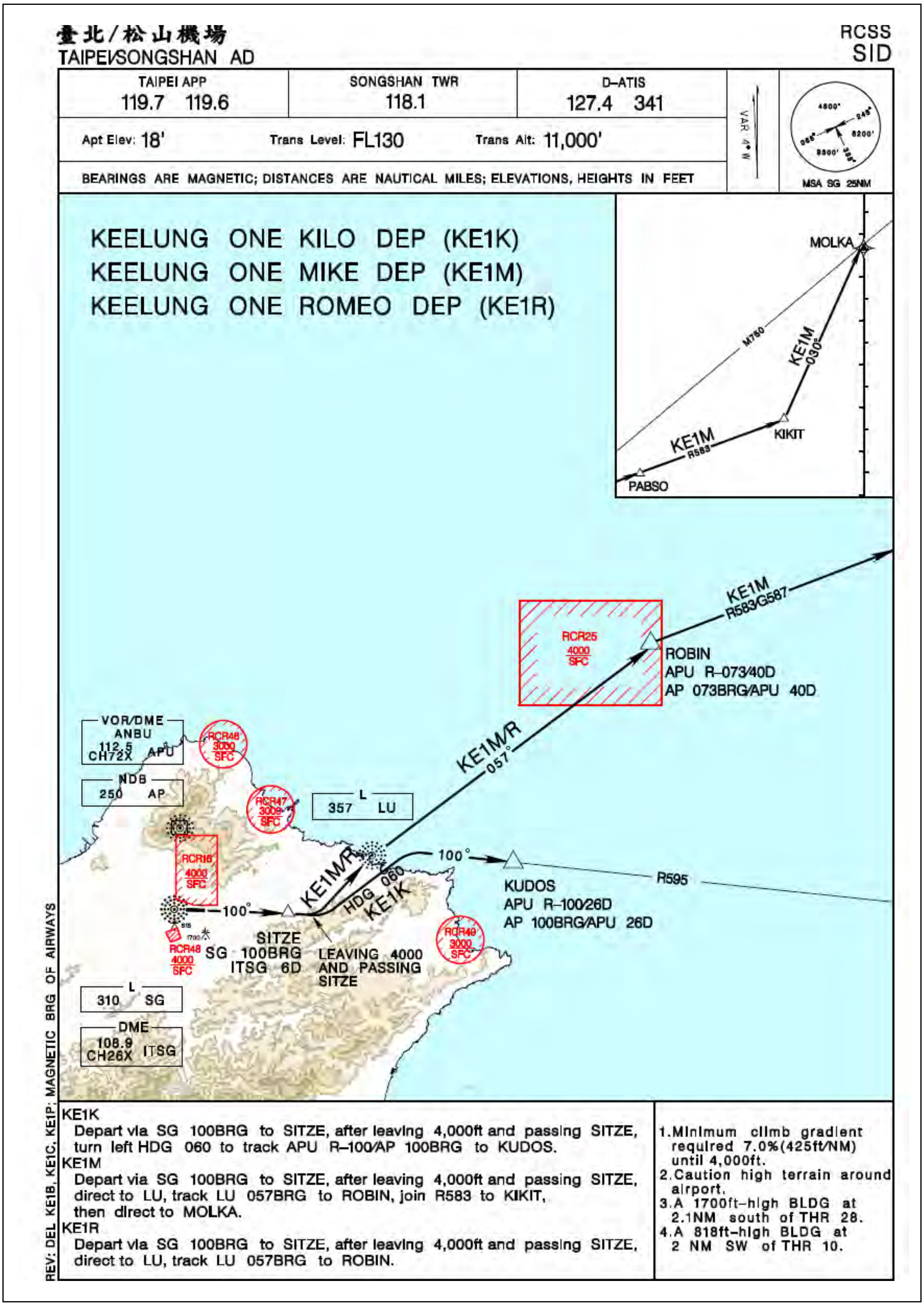


Figure 1.18-2 KEELUNG ONE departure chart

1.18.2 TNA Flight Crew Interview

The flight operations group interviewed 12 TNA ATR flight crews after the GE235 occurrence. The interviewees include:

- Four ATR72-500 IPs/CPs;
- Two ATR72-600 IPs/CPs;
- Two ATR72-600 Captains;
- Four ATR72-600 First Officers.

The interview notes were integrated into 9 topics and summarized as following:

- Abort take-off policy while ATPCS not armed during rolling

  Most of the interviewees stated that the ATR72-600 flight crew should abort take-off if the ATPCS is not armed during take-off rolling. While encountering the same condition, the ATR72-500 flight crew can continue the take off if the ATPCS off weight had been calculated and below the RTOW limitation. However, some ATR72-500 interviewees prefer to disregard the above company policy and abort take-off regardless of take-off weight.

- ATPCS dynamic test

  Only few interviewees can correctly indicated that ATPCS dynamic test should be conducted at the end of the last flight of a day. Some ATR72-500 interviewees stated that ATPCS dynamic test is unnecessary for an ATR72-500 aircraft. Most interviewees agreed that the dynamic test was rarely conducted by flight crew. One interviewee stated that he learned the ATPCS dynamic test from ATR72-600 differences training and tried to conduct it in line operations. However, some captains refused to do it because they would like to get off duty early.

- Crew coordination for controls of power levers and condition levers

  With regard to ATR72-600 operations, most interviewees stated that they follow the instructions from ATR72-600 differences training. The PF is responsible for power levers and PM is responsible for condition levers in abnormal or emergency condition. One ATR72-600 interviewee stated that both of power and condition levers should be controlled by CM1 in line operations.

  With regard to ATR72-500 operations, there are several different statements for this issue.

- Crew resource management

  Most of the interviewees were unable to share what they learned from the CRM training. There were some introductory cases in CRM recurrent training but the instructor did not design scenarios to lead the trainees discussing the specific situation.

  Few senior captains do not consider that using a standard call-out is important and prefer to apply gestures instead of call-outs. Some first officers would try to challenge a captain’s SOP non-compliance behavior but would not insist in correcting it. In addition, several interviewees do not want to report a SOP non-compliance behavior to the safety reporting system of the company because they do not trust the system.

- ATR72-600 differences training

  A few ATR72-600 interviewees who had flown a glass cockpit aircraft stated that the 5-days difference training was adequate. The others stated that it was not adequate, especially for FMS and electronic displays familiarization. Most ATR72-600 interviewees stated that longer lead time periods prior to the differences training would be helpful for learning, such as conduct the ATR72-600 observation flights, more full time self-study courses (at least one week) , and counseling program from experiences and current ATR72-600 pilots. Interviewees also indicated that there were about 7 days for self-study arranged by the TNA prior to the differences training. However, most of the self-study time was shortened to 2-3 days due to support flight duties.

- One engine flameout at take-off

  Most of the interviewees stated that the scenario of one engine flameout at take-off in simulator training was set at the aircraft just lifted off the ground and auto pilot was not engaged condition. In simulator, The IP required trainees to carry out the procedures step by step and not rush to complete the procedures.

- Autopilot engagement issue

  Most of the ATR72-500 interviewees stated the autopilot will disengaged automatically while one engine flameout occurred under AP engaged condition due to its abrupt yawing moments. However, the ATR72-600 interviewees stated that the autopilot will not disengaged automatically while one engine flameout occurred under AP engaged condition, further more they also indicated that the ATR72-600 aircraft has more powerful auto-trim function and applying too much rudder pedal to correct direction is not necessary, it could caused yaw damper disengaged if you do so. One ATR72-600 interviewee stated that he may manually disengage autopilot while one engine flameout occurred even if the autopilot did not disengage automatically. Some interviewees stated that ATR instructors taught them not to disengage the autopilot because it could reduce the workload.

- Comments on GE235 flight crew

  Most of the interviewees made positive comments on the GE235 flight crew. Pilots flew with Captain A or Captain B within one week prior to the occurrence stated that their behaviors and conditions were normal in flight.

  One IP who was conducted the upgrade training to the captain A indicated that his comments to captain A was “a little nervous during line operations and had a tendency of rush to perform the procedures without coordination with the PM.”

- ATR fleet manpower problem

  A few interviewees stated that the TNA should increase training requirements and standards for flight safety. In recent years, several senior ATR first officers were transferred to Airbus fleet. Salaries paid by TNA also cannot attract high qualities pilots from outsources. This resulted in TNA have the limited choice to select the first officers who have less experiences and upgrade them promote to captain.

IV. Appendices

Appendix 1-1 TNA ATR72-600 Differences Training Syllabus

ATR 600 Difference Course
One week

Publication date: 08/11/13

DAY1	DAY2	DAY3	DAY4	DAY5
NAS presentation Planning Interactive tools (2H00)	■ -FLIGHT NSTRUMENTS -INTEGRATED SYSTEMS	■ -FWS -AFCS		
VHP1 Briefing (0H30)	VHP2 Briefing (0H30)	VHP3 Briefing (0H30)	VHP4 Briefing (0H30)	FFS Briefing (1H00)
VHP (3H00)	VHP (3H00)	VHP (3H00)	VHP (3H00)	FFS (4H00)
NAS presentation --- FMS initialization Lateral/Vertical revision pages presentation Debriefing (0H30) ■ - GLASS COCKPIT FAMILIARISATION -VCP	full cockpit preparation (SOP) Complete System pages description --- FMS practice (speed configurations) Debriefing (0H30) CRM (2h00)	Failures treatment Flaps Unlock DC Gen fault IOM failures FMS failures DU failures Engine Flame Out FWS failure FMS msg (INTEG, Unable RNP, D-R) Emergency Evacuation Debriefing (0H30)	NAVIGATION (LFBO → LFMT) FMS practice Non Precision Approach Debriefing (0H30) ■ -NAVIGATION SYSTEM -COMMUNICATION	Severe Icing Stall EFATO Go-Around twin ENG Go-Around Single ENG Debriefing (1H00)

All ■ modules are flexible therefore, they must be studied by the end of the week under trainee responsibility.

AFCS= Automatic Flight Control System EFATO=engine flameout at take-off FFS=full flight simulator FWS= Flight Warning System LMS=Learning Management Software MFSTD= Maintenance & Flight Synthetic Training Device NAS=New Avionic Suite NPA=Non Precision Approach VHP=Virtual Hardware Platform VCP= Virtual Control Panel CRM= Crew Resource Management

Appendix 1-2 PT/PC training syllabus

復興航空
TransAsia Airways

ATR FLEET PROFICIENCY TRAINING
YEAR 2015 (1ST)

Trainee:	Crew Member:	Day Month Year 2015
☐ CAPT ☐ F/O	**SIMULATOR TIME** PF: PM:	**Instructor :**

RCSS	RCQC

5: Proficient **4:** Satisfactory **3:** Acceptable **2:** Improvement required **1:** Unsatisfactory

NO	ITEM	5	4	3	2	1
1	TRANSIT COCKPIT PREPARATION					
2	ENG START					
3	CROSS WIND TAKE OFF(RWY 10)					
4	TCAS					
5	EXCESS CAB ALT EMER DESCENT					
6	HYD BLUE OVHT					
7	VOR RWY 20 APP (CDFA)					
8	FLAP UNLK					
9	GO AROUND WITH TWO ENGINE					
10	RWY 20 VISUAL approach / Landing					
11	TAKE OFF (RWY 02)					
12	ENG FLAME OUT AFTER V1					
13	RWY 02 ILS APP and Manual Landing					
14	TAKE OFF (RWY 02)					
15	ENG FIRE BEFORE V1					
16	RTO					
17	EMER EVACUATION					

If the grade will be marked on "3" or below, please add comment as clear as possible on the back for additional training reference.

復興航空
TransAsia Airways

ATR FLEET PROFICIENCY CHECK YEAR 2015 (1ST)

Examinee:	Crew Member:	Day Month Year 2015
☐ CAPT ☐ F/O	**SIMULATOR TIME** PF: PM:	**Examiner :**

S: Satisfactory **U**: Unsatisfactory SB: Satisfactory With Briefing

NO	ITEM	S	U	SB
1	TRANSIT COCKPIT PREPARATION			
2	ENG START			
3	CROSS WIND TAKE OFF(RWY 10)			
4	TCAS			
5	EXCESS CAB ALT EMER DESCENT			
6	HYD GREEN OVHT			
7	TLU FAULT			
8	VOR RWY 20 APP (CDFA)			
9	GO AROUND WITH TWO ENGINE			
10	RWY 20 VISUAL approach / Landing			
11	TAKE OFF (RWY 02)			
12	ENG FLAME OUT AFTER V1			
13	RWY 02 ILS APP and Manual Landing			
14	TAKE OFF (RWY 02)			
15	ENG FIRE BEFORE V1			
16	RTO			
17	EMER EVACUATION			

Appendix 1-3 MEL Paragraphs Related to Propellers

61 PROPELLERS

1. ITEM		2. RECTIFICATION INTERVAL	3. NUMBER INSTALLED	4. NUMBER REQUIRED FOR DISPATCH	5. REMARKS OR EXCEPTIONS	
21-4	**PIU And Associated Propeller Speed Selection**	C	2	0	(o)	May be inoperative provided both CL are set to 100% OVRD. **Note:** *If affected side cannot be identified, both PIU should be considered as inoperative.*

OPERATING PROCEDURES

a) Engine not running – PL on GI – CL on FUEL SO
- *RH Maintenance Panel, set WOW on FLT position*
- *Advance CL to AUTO*
- *Check PEC FAULT illuminates after 30 seconds*
- *Retard CL to FUEL SO*
- *Check PEC FAULT extinguishes after 30 seconds*
- *Reset PEC to make sure that SGL CH extinguishes*
- *RH Maintenance Panel, set WOW on NORM position*

b) Confirm SGL CH light illumination and extinction during unfeathering.

22-1	**Autofeather System (and Associated Test)** OD	C	2	0	* (o)	May be inoperative provided operations are conducted in compliance with AFM

OPERATING PROCEDURES

–Refer to AFM Supplement 7_02.06: Dispatch with Autofeather system inoperative.

*–For MTOW and takeoff speeds, refer to the RTOW chart titled "**AUTOFEATHER INOP**".*

Note: In case of engine failure after V1, do not reduce PL below 45° of PLA before feathering.

22-2	**ATPCS (and Associated Test)** OD	C	1	0	* (o)	May be inoperative provided operations are conducted in compliance with the AFM

OPERATING PROCEDURES

– Refer to AFM Supplement 7_02.10: Dispatch with ATPCS OFF.

*– For MTOW and takeoff speeds, refer to the RTOW chart titled "**ATPCS OFF**".*

22-3	**ATPCS ARM Light**	C	1	0	*	May be inoperative provided ATPCS is considered inoperative.

All

DISPATCH WITH AUTOFEATHER SYSTEM INOPERATIVE

R **Uptrim and AFU are considered operative. If not, refer to the connected procedure.**

– Increase V1 limited by VMCG by 5 kt

– Increase VR by 2 kt

– Increase VMCA by 3 kt, check VR, V2

– Increase VMCL by 3 kt

– Check effect on TOR, TOD, 2nd segment climb

NOTE :In case of engine failure after V1, do not reduce PL below 45º of PLA before feathering.

DISPATCH WITH ATPCS OFF

R **AFU is considered operative. If not, refer to the connected procedure.**

- Select ATPCS OFF and BLEED VALVES OFF
- Increase V1 limited by VMCG by 5 kt
- Increase VR by 2 kt
- Increase VMCA by 3 kt. Check VR and V2
- Increase VMCL by 3 kt
- Check ATPCS inoperative effect on TOR, TOD and 2nd segment
- Apply RTO power by pushing both PLs up to the ramp
- After take off set both PLs into the notches, then apply CLIMB SEQUENCE
- BLEED VALVES . . . . ON

NOTE :In case of engine failure after V1 do not reduce PL below 45º of PLA before feathering

Appendix 1-4 RAM of Songshan Runway 10

Runway DRY
Anti-Icing OFF
QNH 1013

SONGSHAN 10

MTOW=50,265 LBS

Rwy Length: *8547 FT* Elevation: *13 FT* Slope: *0.01 %* *RCSS / TSA*

EOSID:

- *Climb runway heading to O locator ;*
- *Turn LEFT bearing 066 to LU and hold.*

ACC. HEIGHT (ALT): ***1100 FT (1113 FT)***

MAX. ACC. HEIGHT (ALT): 2255 FT (2268 FT)

OAT	A/C ON					ATPCS OFF (MEL 61-22-2)				
DC	-15 KT	-10 KT	-5 KT	0 KT	10 KT	-15 KT	-10 KT	-5 KT	0 KT	10 KT
10	**48535** 4-6 94/113/118 -227 lb /-10 hPa	**50209** 4-4 104/118/122 -230 lb /-10 hPa	**50264** 1-1 104/111/115 +0 lb /-10 hPa	NL	NL	**42722** 4-4 108/109/112 -194 lb /-10 hPa	**43960** 4-4 117/117/119 -187 lb /-10 hPa	**44885** 4-4 118/118/121 -188 lb /-10 hPa	**45742** 4-4 119/119/122 -189 lb /-10 hPa	**46298** 4-4 120/120/122 -190 lb /-10 hPa
12	**48369** 4-6 94/113/117 -234 lb /-10 hPa	**50041** 4-4 104/118/122 -229 lb /-10 hPa	**50264** 1-1 106/111/115 +0 lb /-10 hPa	NL	NL	**42581** 4-4 107/109/112 -193 lb /-10 hPa	**43821** 4-4 116/116/119 -187 lb /-10 hPa	**44745** 4-4 118/118/120 -188 lb /-10 hPa	**45601** 4-4 119/119/122 -189 lb /-10 hPa	**46156** 4-4 120/120/122 -190 lb /-10 hPa
14	**48201** 4-6 94/113/117 -233 lb /-10 hPa	**49873** 4-4 103/118/122 -229 lb /-10 hPa	**50264** 1-1 107/111/115 +0 lb /-10 hPa	NL	NL	**42439** 4-4 107/109/112 -193 lb /-10 hPa	**43682** 4-4 116/116/119 -186 lb /-10 hPa	**44605** 4-4 118/118/120 -188 lb /-10 hPa	**45461** 4-4 119/119/121 -189 lb /-10 hPa	**46015** 4-4 120/120/122 -190 lb /-10 hPa
16	**48036** 4-6 94/112/117 -232 lb /-10 hPa	**49708** 4-4 103/118/122 -228 lb /-10 hPa	**50264** 1-1 108/111/115 +0 lb /-10 hPa	NL	NL	**42300** 4-4 107/109/112 -192 lb /-10 hPa	**43547** 4-4 116/116/119 -186 lb /-10 hPa	**44469** 4-4 117/117/120 -187 lb /-10 hPa	**45323** 4-4 119/119/121 -188 lb /-10 hPa	**45876** 4-4 120/120/122 -189 lb /-10 hPa
18	**47866** 4-6 93/112/116 -227 lb /-10 hPa	**49545** 4-4 103/117/121 -227 lb /-10 hPa	**50264** 1-1 109/111/115 +0 lb /-10 hPa	NL	NL	**42162** 4-4 107/108/112 -192 lb /-10 hPa	**43414** 4-4 116/116/118 -186 lb /-10 hPa	**44335** 4-4 117/117/120 -187 lb /-10 hPa	**45189** 4-4 119/119/121 -188 lb /-10 hPa	**45741** 4-4 119/119/122 -189 lb /-10 hPa
20	**47705** 4-6 93/112/116 -232 lb /-10 hPa	**49384** 4-4 102/117/121 -228 lb /-10 hPa	**50264** 1-1 110/111/115 +0 lb /-10 hPa	NL	NL	**42025** 4-4 106/108/111 -193 lb /-10 hPa	**43283** 4-4 116/116/118 -187 lb /-10 hPa	**44203** 4-4 117/117/120 -189 lb /-10 hPa	**45056** 4-4 118/118/121 -190 lb /-10 hPa	**45608** 4-4 119/119/122 -191 lb /-10 hPa
22	**47539** 4-6 93/111/116 -226 lb /-10 hPa	**49222** 4-4 102/117/121 -228 lb /-10 hPa	**50264** 4-1 111/111/115 +0 lb /-10 hPa	NL	NL	**41888** 4-4 106/108/111 -193 lb /-10 hPa	**43152** 4-4 116/116/118 -187 lb /-10 hPa	**44071** 4-4 117/117/119 -189 lb /-10 hPa	**44923** 4-4 118/118/121 -190 lb /-10 hPa	**45474** 4-4 119/119/121 -191 lb /-10 hPa
24	**47377** 4-6 92/111/115 -232 lb /-10 hPa	**49062** 4-4 101/117/121 -229 lb /-10 hPa	**50264** 4-1 111/113/116 +0 lb /-10 hPa	NL	NL	**41751** 4-4 106/108/111 -193 lb /-10 hPa	**43021** 4-4 115/115/118 -188 lb /-10 hPa	**43938** 4-4 117/117/119 -190 lb /-10 hPa	**44790** 4-4 118/118/120 -191 lb /-10 hPa	**45340** 4-4 119/119/121 -192 lb /-10 hPa
26	**47213** 4-6 92/111/115 -228 lb /-10 hPa	**48900** 4-4 101/117/121 -228 lb /-10 hPa	**50264** 4-1 110/115/118 -88 lb /-10 hPa	NL	NL	**41613** 4-4 105/108/111 -193 lb /-10 hPa	**42891** 4-4 115/115/118 -187 lb /-10 hPa	**43806** 4-4 117/117/119 -189 lb /-10 hPa	**44657** 4-4 118/118/120 -190 lb /-10 hPa	**45206** 4-4 119/119/121 -191 lb /-10 hPa
28	**47050** 4-6 92/110/114 -227 lb /-10 hPa	**48740** 4-4 101/117/120 -231 lb /-10 hPa	**50246** 4-4 110/119/122 -239 lb /-10 hPa	NL	NL	**41477** 4-4 105/108/111 -193 lb /-10 hPa	**42762** 4-4 115/115/118 -188 lb /-10 hPa	**43676** 4-4 117/117/119 -190 lb /-10 hPa	**44526** 4-4 118/118/120 -191 lb /-10 hPa	**45075** 4-4 119/119/121 -193 lb /-10 hPa
30	**46888** 4-6 92/110/114 -227 lb /-10 hPa	**48580** 4-4 100/116/120 -235 lb /-10 hPa	**50078** 4-4 109/118/122 -237 lb /-10 hPa	NL	NL	**41340** 4-4 105/107/110 -192 lb /-10 hPa	**42633** 4-4 115/115/117 -188 lb /-10 hPa	**43546** 4-4 116/116/119 -190 lb /-10 hPa	**44395** 4-4 118/118/120 -192 lb /-10 hPa	**44942** 4-4 118/118/121 -193 lb /-10 hPa
32	**46727** 4-6 91/109/114 -227 lb /-10 hPa	**48418** 4-4 100/116/120 -243 lb /-10 hPa	**49913** 4-4 109/118/122 -247 lb /-10 hPa	**50264** 1-1 110/111/115 +0 lb /-10 hPa	NL	**41206** 4-4 104/107/110 -198 lb /-10 hPa	**42504** 4-4 115/115/117 -206 lb /-10 hPa	**43416** 4-4 116/116/118 -209 lb /-10 hPa	**44264** 4-4 117/117/120 -211 lb /-10 hPa	**44811** 4-4 118/118/120 -213 lb /-10 hPa
34	**46583** 4-6 91/109/114 -278 lb /-10 hPa	**48264** 4-4 100/116/119 -303 lb /-10 hPa	**49757** 4-4 108/118/122 -316 lb /-10 hPa	**50264** 1-1 111/111/115 +0 lb /-10 hPa	NL	**41081** 4-4 104/107/110 -249 lb /-10 hPa	**42373** 4-4 115/115/117 -281 lb /-10 hPa	**43283** 4-4 116/116/118 -286 lb /-10 hPa	**44130** 4-4 117/117/120 -291 lb /-10 hPa	**44676** 4-4 118/118/120 -294 lb /-10 hPa
36	**46323** 4-6 91/109/114 -415 lb /-10 hPa	**47967** 4-4 100/116/119 -477 lb /-10 hPa	**49439** 4-4 109/118/121 -494 lb /-10 hPa	**50264** 4-1 113/113/117 +0 lb /-10 hPa	**50264** 1-1 109/111/115 +0 lb /-10 hPa	**40836** 4-4 105/107/110 -382 lb /-10 hPa	**42065** 4-4 114/114/117 -467 lb /-10 hPa	**42968** 4-4 116/116/118 -477 lb /-10 hPa	**43806** 4-4 117/117/119 -486 lb /-10 hPa	**44348** 4-4 118/118/120 -492 lb /-10 hPa
38	**45793** 4-6 92/110/115 -440 lb /-10 hPa	**47344** 4-4 101/115/119 -466 lb /-10 hPa	**48794** 4-4 109/117/120 -483 lb /-10 hPa	**50196** 4-4 118/119/122 -507 lb /-10 hPa	**50264** 4-1 114/114/118 +0 lb /-10 hPa	**40348** 4-4 106/106/109 -391 lb /-10 hPa	**41418** 4-4 113/113/116 -456 lb /-10 hPa	**42304** 4-4 115/115/117 -466 lb /-10 hPa	**43128** 4-4 116/116/118 -475 lb /-10 hPa	**43660** 4-4 117/117/119 -481 lb /-10 hPa
40	**45221** 4-4 93/111/115 -432 lb /-10 hPa	**46724** 4-4 101/114/118 -458 lb /-10 hPa	**48153** 4-4 110/116/120 -474 lb /-10 hPa	**49509** 4-4 119/119/122 -507 lb /-10 hPa	**50200** 4-4 124/124/127 -541 lb /-10 hPa	**39813** 4-4 107/107/110 -402 lb /-10 hPa	**40774** 4-4 112/112/115 -446 lb /-10 hPa	**41644** 4-4 114/114/116 -457 lb /-10 hPa	**42453** 4-4 115/115/117 -466 lb /-10 hPa	**42975** 4-4 116/116/118 -472 lb /-10 hPa
42	**44655** 4-4 94/111/115 -439 lb /-10 hPa	**46107** 4-4 102/113/117 -451 lb /-10 hPa	**47515** 4-4 111/115/119 -465 lb /-10 hPa	**48804** 4-4 120/120/123 -513 lb /-10 hPa	**49414** 4-4 123/123/127 -534 lb /-10 hPa	**39231** 4-4 109/109/111 -420 lb /-10 hPa	**40132** 4-4 111/111/114 -439 lb /-10 hPa	**40986** 4-4 113/113/115 -449 lb /-10 hPa	**41778** 4-4 114/114/116 -458 lb /-10 hPa	**42291** 4-4 115/115/117 -464 lb /-10 hPa
44	**44057** 4-4 95/110/114 -432 lb /-10 hPa	**45493** 4-4 103/112/116 -442 lb /-10 hPa	**46880** 4-4 112/115/118 -455 lb /-10 hPa	**48053** 4-4 121/121/124 -513 lb /-10 hPa	**48626** 4-4 122/122/126 -527 lb /-10 hPa	**38616** 4-4 109/109/111 -420 lb /-10 hPa	**39494** 4-4 110/110/113 -431 lb /-10 hPa	**40330** 4-4 112/112/114 -441 lb /-10 hPa	**41106** 4-4 113/113/115 -450 lb /-10 hPa	**41609** 4-4 114/114/116 -456 lb /-10 hPa
46	**43450** 4-4 96/109/113 -428 lb /-10 hPa	**44873** 4-4 104/112/115 -437 lb /-10 hPa	**46244** 4-4 113/114/117 -450 lb /-10 hPa	**47279** 4-4 121/121/124 -516 lb /-10 hPa	**47832** 4-4 121/121/124 -522 lb /-10 hPa	**37988** 4-4 108/108/110 -415 lb /-10 hPa	**38850** 4-4 109/109/112 -426 lb /-10 hPa	**39669** 4-4 111/111/113 -436 lb /-10 hPa	**40430** 4-4 112/112/114 -444 lb /-10 hPa	**40923** 4-4 113/113/115 -450 lb /-10 hPa
48	**42839** 4-4 97/109/113 -419 lb /-10 hPa	**44254** 4-4 106/111/114 -426 lb /-10 hPa	**45579** 4-4 114/114/118 -459 lb /-10 hPa	**46491** 4-4 120/120/123 -507 lb /-10 hPa	**47035** 4-4 120/120/123 -513 lb /-10 hPa	**37359** 4-4 107/107/109 -406 lb /-10 hPa	**38204** 4-4 108/108/111 -416 lb /-10 hPa	**39007** 4-4 110/110/112 -426 lb /-10 hPa	**39753** 4-4 111/111/113 -435 lb /-10 hPa	**40236** 4-4 112/112/114 -441 lb /-10 hPa
50	**42236** 4-4 98/108/112 -410 lb /-10 hPa	**43643** 4-4 107/110/114 -418 lb /-10 hPa	**44873** 4-4 116/116/119 -480 lb /-10 hPa	**45706** 4-4 119/119/122 -499 lb /-10 hPa	**46240** 4-4 119/119/122 -505 lb /-10 hPa	**36735** 4-4 106/106/108 -397 lb /-10 hPa	**37564** 4-4 107/107/110 -408 lb /-10 hPa	**38351** 4-4 109/109/111 -418 lb /-10 hPa	**39080** 4-4 110/110/112 -427 lb /-10 hPa	**39554** 4-4 111/111/113 -432 lb /-10 hPa

TOW (LB) Codes
V1 / VR / V2 (IAS KT)
DTOW / -10 hPa

Limitation Codes:
0=Dry check, 1=Structure, 2=2nd segment, 3=Runway, 4=Obstacle
5=Tire speed, 6=Brake energy, 7=Rwy 2 engines, 8=Final T.O., 9=VMC

Date: 30 SEP, 2013 ***REV 00***

V. Attachment List

No	Item
1-1	Captain A training records in previous airlines
1-2	PT/PC Observation Report
1-3	TNA Flight Operations Manual (FOM)
1-4	TNA ATR Standard Operation Procedure (SOP)
1-5	ATR72 Flight Crew Operating Manual (FCOM)
1-6	ATR Flight Crew Training Manual (FCTM)
1-7	TNA Flight Training Management Manual (FTMM)
1-8	TNA Flight Operations Department Operations Manual (FODOM)
1-9	ATR 42/72 Flight Crew Qualifications (European Aviation Safety Agency Operational Evaluation Board Report)
1-10	TNA Operations Specification
1-11	TNA Staff Interview Records
1-12	TNA flight schedules (January 2015)
1-13	TNA ATR fleet recurrent training schedules(May 2015)

Aviation Safety Council

Taipei, Taiwan

GE235 Occurrence Investigation
Factual Data Collection
Group Report

Airworthiness Group

July 2, 2015

ASC-FRP-15-07-003

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Contents

I. Team Organization

Chairman: David Lee, Aviation Safety Investigator, ASC	
Members:	
1	Yanni Lee, Aviation Safety Investigator, ASC
2	Carol Horgan, Sr. Air Safety Investigator (Powerplants) NTSB, USA
3	Henri Denis, Investigator, BEA, France
4	Jérome Pfeiffer, Safety Investigator, ATR, France
5	Fabien Darsonval, Powerplant Specialist, ATR, France
6	Chng Seng Piang, Director, Technical Service, ATR, Singapore
7	Nora Vallée, Civil Aviation Safety Investigator, TC, Canada
8	Thomas Berthe, Investigator, P&WC
9	David Barnard, Accessories Investigator, P&WC
10	Mike Huang, Aviation Safety Inspector, CAA
11	Nicolas Liaw, Aviation Safety Inspector, CAA
12	William Lin, Aviation Safety Inspector, CAA
13	Nicolas Hung, Assistant Manager, TNA
14	Wilson Ling, Engineer, TNA
15	Jimm Wang, Engineer, TNA

II. History of Major Activities

Date	Activities
02/04/2015	1. Go team launched. 2. Secured latest 3 months aircraft Technical Log Book, No. 1, 2 Engine Log Books and No. 1, 2 Reduction Gearbox Log Books. 3. Recovered FDR, CVR and QAR. 4. Monitored the recovery of aircraft wreckage. Recovered aircraft wreckage including: fuselage, cockpit and broken debris.
02/05/2015	1. Requested Songshan Air Force Base to provide space for the temporary storage of aircraft wreckage. 2. New Taipei City and Taipei City Emergency Response Center helped to transport all recovered wreckage to Songshan Air Force Base. Those aircraft wreckage was recovered including cockpit, part of front fuselage, aft and part of center fuselage, tail section, left wing and part of right wing, No. 1 and No. 2 engines, chairs and debris.
02/06/2015	1. Removed No. 1 and No. 2 Multi-function computers, flushed and submerged in clean water. 2. Checked No. 1 and No. 2 engine placards. The serial numbers showed on the placards were exactly the same as records. 3. Checked feathering mechanism status of No. 1 propeller. Blades of No. 1 propeller were at feathering positions.
02/07/2015	1. Visited wreckage storage site with specialists from TSB, BEA and PWC representative. 2. Removed No. 1 and No. 2 Propeller Electronic Controls (PECs), Multi-Purpose Computer (MPC), Captain and FO’s EDU (Electronic Display Unit), flushed and submerged in clean water. 3. Recovered left wing from downstream of Keelung River and transferred it to Songshan Air Force Base storage site.

02/08/2015	1. Removed Captain and FO's PFD, ND and center DU, ATPCS control panel, 2 CMS computers, flushed and submerged in clean water. 2. Checked No. 1, 2 engines with bore scope, all engine turbine sections showed normal conditions. 3. Checked No. 1 engine torque sensors of No. 1, 2 engines, resistance of sensor connectors were all within specs. AFU electrical harness continuity checks were all passed.
02/09/2015	1. Witnessed by BEA, ATR, TC, TSB and CAA personnel to remove parts from No. 1, 2 engines for further testing/inspection: a. 2 Engine Electronic Controls (EEC) b. 2 Data Collection Units (DCU) c. 2 Auto Feather Units (AFU) d. 2 Propeller Interface Units (PIU) e. 2 Core Avionic Cabinets (CAC) f. 2 AFU electrical harnesses g. 4 torque sensors h. 8 speed sensors (4 Nh, 2 Nl, 2 Np) i. 2 fire handles 2. Measure stick pusher actuator length; the actuator was at retracted position.
02/10/2015	Examined 7 pieces of aircraft wreckage structures. All broken structures were due to overload and post impact damages.
02/13/2015	Sent 22/25 recovered components to TSB/BEA for inspection and / or test. TSB/BEA received those items on Feb. 19, 2015.
02/25/2015	Removed 2 Propeller Valve Modules (PVM) from No. 1, 2 engines and stored in ASC laboratory.

04/08/2015 ~ 04/14/2015	1. Monitored the AFUs (S/N: RT 3077, RT2362, RT2354) tests at Rosemount Aerospace Inc. Participants included representatives from NTSB, TC, BEA, P&WC, ATR, TNA and ASC. 2. Test results showed that the AFU (RT 3077) removed from No. 1 engine of the occurrence aircraft passed all the tests. 3. The continuity failures detected on Pin J and Pin H of the AFU (RT2362) which removed from No. 2 engine of the occurrence aircraft were located inside the 90°connector and the continuity failure might from time to time disappear. 4. The continuity failures detected on Pin J of the AFU (RT2354) which removed from the other aircraft was located inside the 90°connector.
04/20/2015 ~ 04/22/2015	1. Two PECs and 2 EECs NVM data were downloaded at UTAS Windsor Locks, Connecticut, participants included representative from NTSB, TC and P&WC. 2. The PECs and EECs NVM data have been successfully downloaded. No significant faults were found.

III. Factual Description

1.3 Damage to aircraft

The aircraft was destroyed.

1.6 Aircraft information

1.6.1 Aircraft and engine basic information

Basic information of the occurrence aircraft is shown in Table 1.6-1

Table 1.6-1 Aircraft basic information

Aircraft basic information (statistics date: February 04, 2015)	
Nationality	Taiwan, R.O.C.
Aircraft registration number	B-22816
Manufacturer	Avions de Transport Régional
Aircraft model	ATR72-212A
Aircraft serial number	1141
Manufactured date	April 14, 2014
Delivery date	April 14, 2014
Owner	TransAsia Airways
Operator	TransAsia Airways
Number of certificate of registration	103-1271
Certificate of airworthiness, validity date	March 31, 2015
Total time (hours)	1627:05
Total cycles	2356
Last check, date	A4 CHECK / January 26, 2015
Time / cycles since last check	44:50 / 64

Basic information of the two Pratt & Whitney Canada engines is shown in Table 1.6-2

Table 1.6-2 Engine basic information

Engine basic information (statistics date: February 04, 2015)		
Number/position	No. 1/ Left	No. 2/ Right
Manufacturer	PWC	PWC
Model	PW127M	PW127M
Serial number	ED0913	ED0814
Manufacture date	May 09, 2014	November 19, 2013
Installation date	August 16, 2014	February 07, 2014
Time since installation (hours)	829:31	1627:05
Cycle since installation	1240	2356
Last check, date	A4 CHECK / January 26, 2015	A4 CHECK / January 26, 2015
Time / cycles since last check	44:50 / 64	44:50 / 64

1.6.2 Maintenance related information

A review of maintenance record before the occurrence flight showed that there was no defects report or Minimum Equipment List (MEL) item of the occurrence flight when the aircraft was dispatched from Songshan airport to Kinmen airport. The Technical Log Books (TLBs) from aircraft delivery date to the occurrence date, the pre-flight check, daily check, transit check records of the last 6 months and the last periodic check (A4 check) records before the occurrence were reviewed. There was no defect report related to autofeather of the No.2 engine.

The Deferred Defect (DD) records, status of Airworthiness Directive (AD) and Service Bulletin (SB) of the occurrence aircraft were also reviewed. The control of DD records of the occurrence aircraft were in compliance with CAA regulation and no DD item related to autofeather of the No.2 engine was found. The review showed that the occurrence aircraft was in compliance with all applicable AD and SB.

1.6.3 Propellers system

The occurrence aircraft was equipped with HAMILTON STANDARD 568F-1 propellers. The propeller is of the variable pitch type, hydromechanically controlled, and can be placed in reverse or feathering configurations. According to the Aircraft Maintenance Manual, Description / Operation (AMM D/O) (Revision number = 38, Revision date = Dec 01/14), the propeller's operating modes include propeller in a governing speed mode, synchrophasing, propeller in a governing pitch mode and feathering / unfeathering modes.

Feathering can be performed:

- Manually, by the condition lever in case of engine failure
- Automatically, in case of torque decrease at take-off on one engine
- Manually, by the fire handle in case of engine fire
- Manually, during maintenance operations

When the condition lever is moved past the safety trigger of FTR position, micro switch 5KF (6KF) and 54KF (55KF) are activated which enables the activation of the feather pump, energization of the feather solenoid and indication to the Propeller Electronic Control (PEC) to command pitch increase toward feather.

The Automatic Takeoff Power Control System (ATPCS) is operational if it is armed prior to take-off. Arming of the system is performed when all the following conditions are simultaneously met:

- Power Management (PWR MGT) selector switch is placed in TO (Take-Off) (Figure 1.6-1) position
- ATPCS (pushbutton(Figure 1.6-1) switch is pressed in
- Torques of engines 1 and 2 are higher than 46.2% which corresponds to 5,558 ft.lb
- both power levers are above 55 degrees MFCU (Mechanical Fuel Control Unit) (equivalent to 49 degrees of power lever angle)

When the ATPCS is armed, ARM legend of ATPCS comes on. When the system is armed, a torque lower than 18.5% on one engine causes uptrim of the other engine. The uptrim causes the valid engine increasing its power from TO to RTO (Reserve Take-Off), and 2.15 second later, the propeller of the faulty engine is automatically feathered by activation of the Propeller Valve Module (PVM) solenoid and increase of the pitch by the PEC. From then automatic feathering of the valid engine is prohibited to ensure both engines are not feathered at the same time.

According to the BEA provided GE235 Answer to Action Log Revision #4 (Attachment 1), once the ATPCS sequence has been triggered, autofeathering of the failed engine can be aborted during the 2.15 seconds if at least one of the following conditions is true:

- PWR MGT selector switch is moved out of TO position
- ATPCS push button is released off
- At least one of the power levers is retarded below 55 degrees MFCU (equivalent to 49 degrees of power lever angle)
- Torque of the engine detected failed increases above 2,229 ft. lb threshold
- Torque of the sane engine drops below 5,558 ft. lb threshold.

The autofeathering and UPTRIM system is disarmed after 2.15 seconds delay when any of the arming conditions is cancelled. The cancellation can only result from one of the following conditions:

- PWR MGT selector other than TO
- ATPCS push button set to OFF
- Both power lever retarded below 55 degrees MFCU (equivalent to 49 degrees of power lever angle).

When the ATPCS is not selected at take-off, an aural warning is triggered and warning lights come on if the autofeathering is not selected during TO CONFIG test.

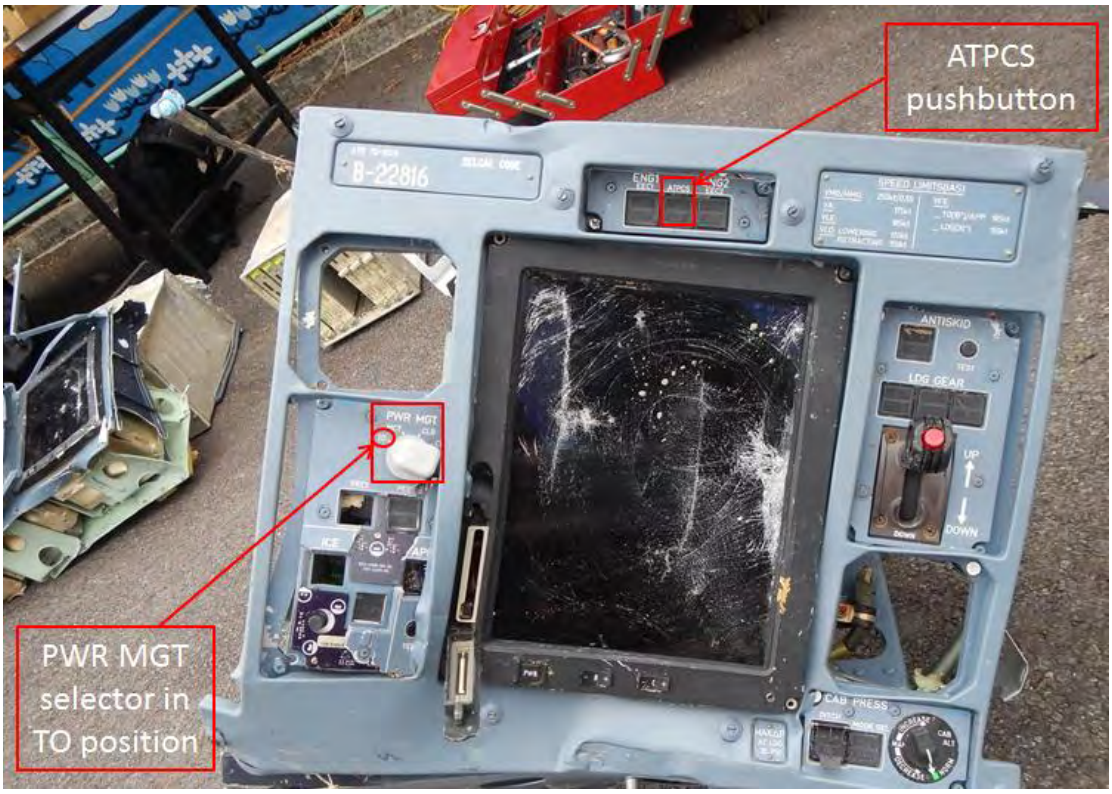

Figure 1.6-1 PWR MGT selector and ATPCS pushbutton

According to Attachment 1, simultaneous autofeathering of both propellers can be prevented by two protections:

- One relay inhibitor per side, installed between MFC1(2) output and PVM1(2) feather solenoid, which prevent autofeathering command propagation to PVM1(2), when propeller 2(1) autofeathering signal is already active (Figure 1.6-2);
- One software protection inside the MFC which prevents an autofeathering signal sent to the propeller when autofeathering signal is active on opposite propeller.

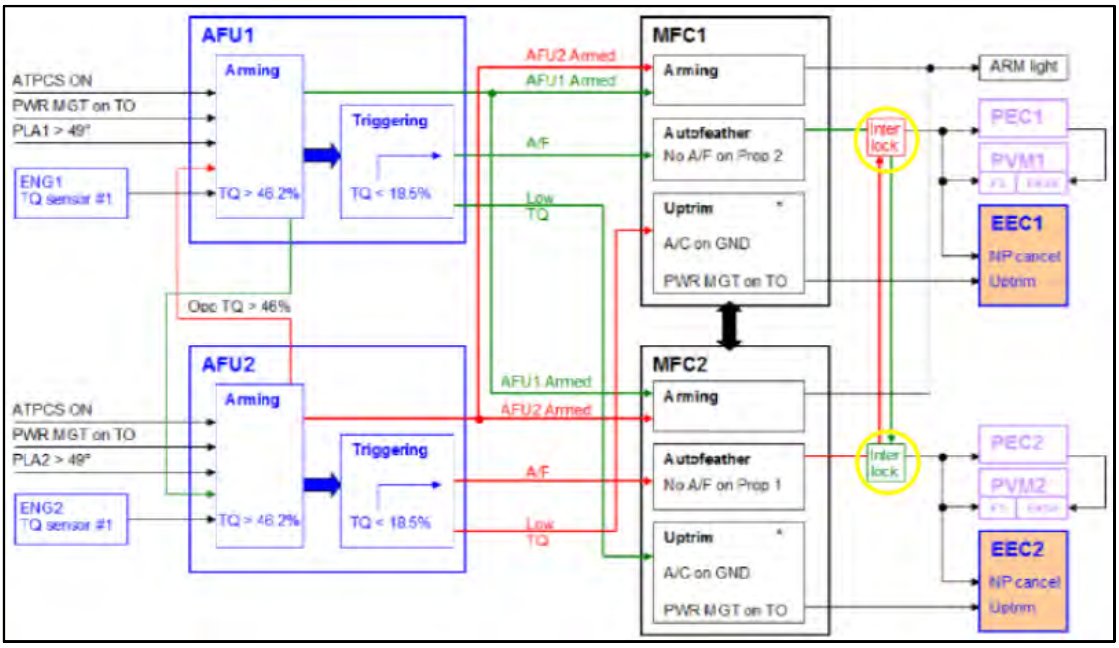

Figure 1.6-2 Functions of the ATPCS system

When the fire handle is pulled, feathering is performed identical to that of the automatic feathering system. Upper two photos of Figure 1.6-3 show that both safety wires of No. 1 and No. 2 fire handles are secured in place. Lower two photos of Figure 1.6-3 show the pointers of two fire bottle pressure gages are in the green ranges.

Figure 1.6-3 No. 1, 2 fire handles and fire bottles

1.6.4 Engine torque sensing and indication

According to the AMM D/O, torque is one of engine parameters associated with power. Each engine contains two torque sensors which located on the reduction gearbox casing at 4 (No. 2) and 8 (No. 1) o'clock approximately when looking forward. Torque sensors are used to measure the torque produced by the engine.

As shown in Figure 1.6-4, the signal sensed by the No. 1 and No. 2 sensors is transmitted to the Auto Feather Unit (AFU) and the Electronic Engine Control (EEC) respectively, where it is converted into engine torque indications. The AFU and EEC transmit the data to the Core Avionic Cabinet 1 (CAC1) and CAC2. The CAC is provided with the 5VDC reference voltage and the signal from the AFU, which are then routed to Display Unit (DU) through ARINC 429 and displays the TORQUE value in analog form. The indication in the digital form is provided in ARINC 429 message from the EEC to DU. The torque value in digital form is also transmitted to the Multi-Purpose Computer (MPC), which is then stored in the Solid State Flight Data Recorder (SSFDR) through ARINC 429.

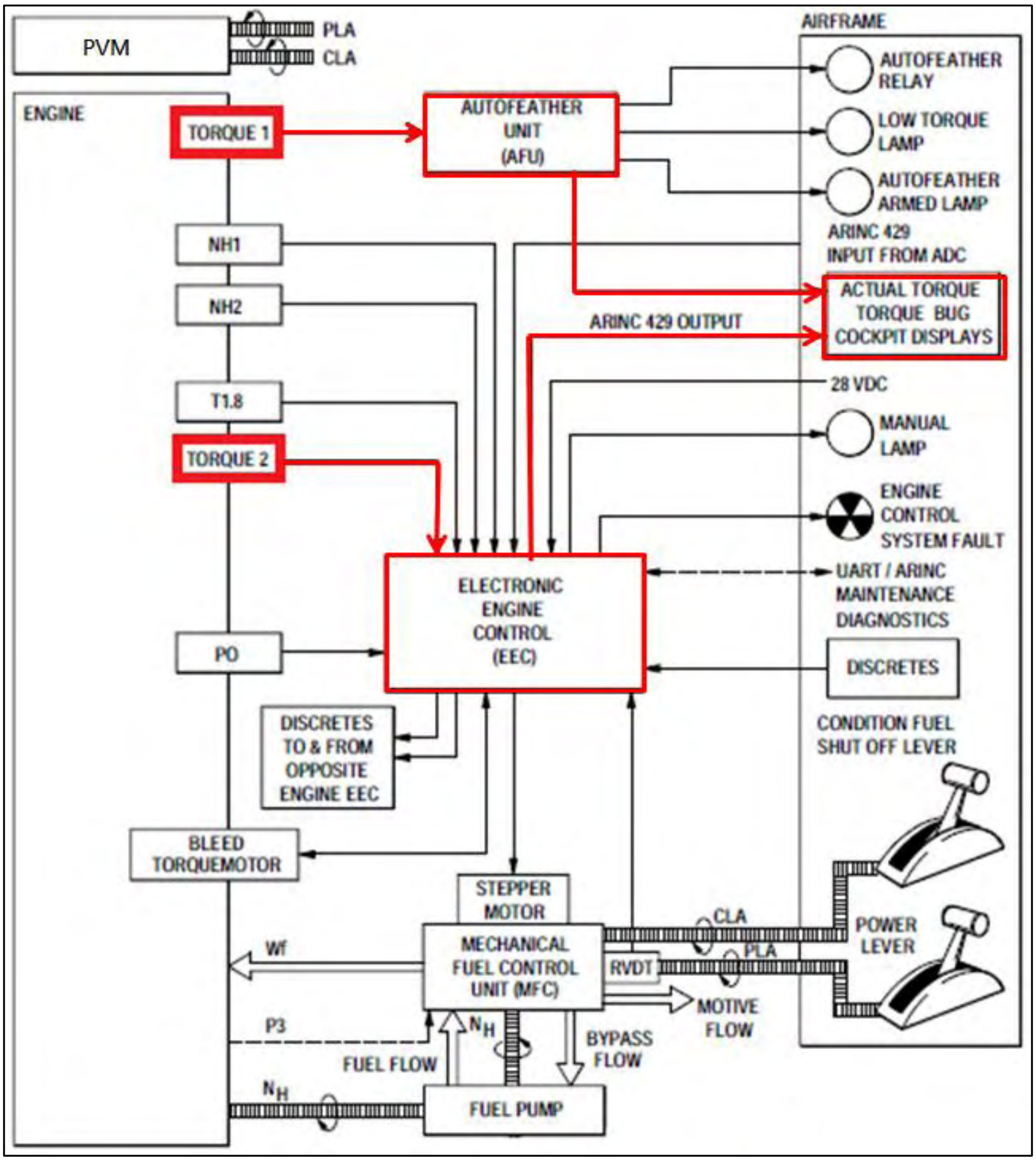

Figure 1.6-4 Engine torque sensing and indication

1.12 Wreckage and impact information

On February 04, 2015, TransAsia Airways (TNA) passenger flight GE235, an ATR72-212A aircraft, crashed into Keelung River of Nankang section at 1054 Taipei time. The Central Aircraft Accident Response Center (CAARC) was setup by the Ministry of Transportation and Communications immediately after the crash. ASC was informed by the CAA, and also established an occurrence investigation command post center in ASC office immediately. With the assistances of New Taipei City and Taipei City Emergency Response Centers, the wreckage salvage and transportation to storage site operations were finished in one and a half days. This section states recovery of aircraft wreckage, wreckage transfer and wreckage temporary storage (Attachment 2).

1.12.1 Recovery of aircraft wreckage

Upon receiving the occurrence notification, ASC launched go team to the occurrence site right after a pre-investigation meeting. The members of go team included Investigator-in-charge (IIC) and investigators in flight operation, maintenance, flight recorders, survival factors and wreckage recovery.

The aircraft wreckage was broken into the cockpit and middle/aft fuselage two major portions with its nose immersed in the mud of riverbed. A floating bridge and three heavy lift vehicles were deployed by the Army Engineering Corps to facilitate the rescue of the victims and recovery of the aircraft wreckage. While the search and rescue operations were continuously going, the salvage operation of aircraft wreckage was commenced in the late afternoon of the occurrence day. The FDR and CVR of the aircraft were found at 1605 local time and had been delivered to ASC. Figure 1.12-1 showed that those two major portions of the wreckage were lifting up and moved to offshore ground of the river. By the late afternoon of day two salvage operation, the aforementioned two major portions and both engines were all successfully recovered.

Figure 1.12-1 Wreckage recovery operations

Figure 1.12-2 and 1.12-3 show the mappings of recovered aircraft wreckage during salvage operations. Total wreckage recovered is approximately 85% of the whole aircraft. The remaining unrecovered 15% of the whole wreckage is mainly between the after cargo area and forward of the ice shield area as shown in Figure 1.12-2. Larger pieces of aircraft wreckage are listed as follows.

Cockpit and forward fuselage

Radome, left and right sides cockpit skin, FR (frame) 11~16 cargo door surround, cargo door entry structure, fuselage lower skin, left side emergency exit, right side emergency exit and surround, right side fuselage

Middle and aft fuselage and landing gears

FR24-27 lower part with lower faring, center wing box, middle and aft fuselage broken at FR24~25, left and right hand side fuselages, left hand side main landing gear

Tail

Horizontal stabilizer and right hand side elevator, right hand side elevator tip, rudder and rudder tip, right hand side rudder antenna, dorsal fin and vertical stabilizer

Left wing

Outer wing box, aileron, outboard wing skins and panels, outboard and inboard flaps

Right wing

Outer wing box, aileron tab, flap fairing

Engines

No.1 (left) and No.2 (Right) engines

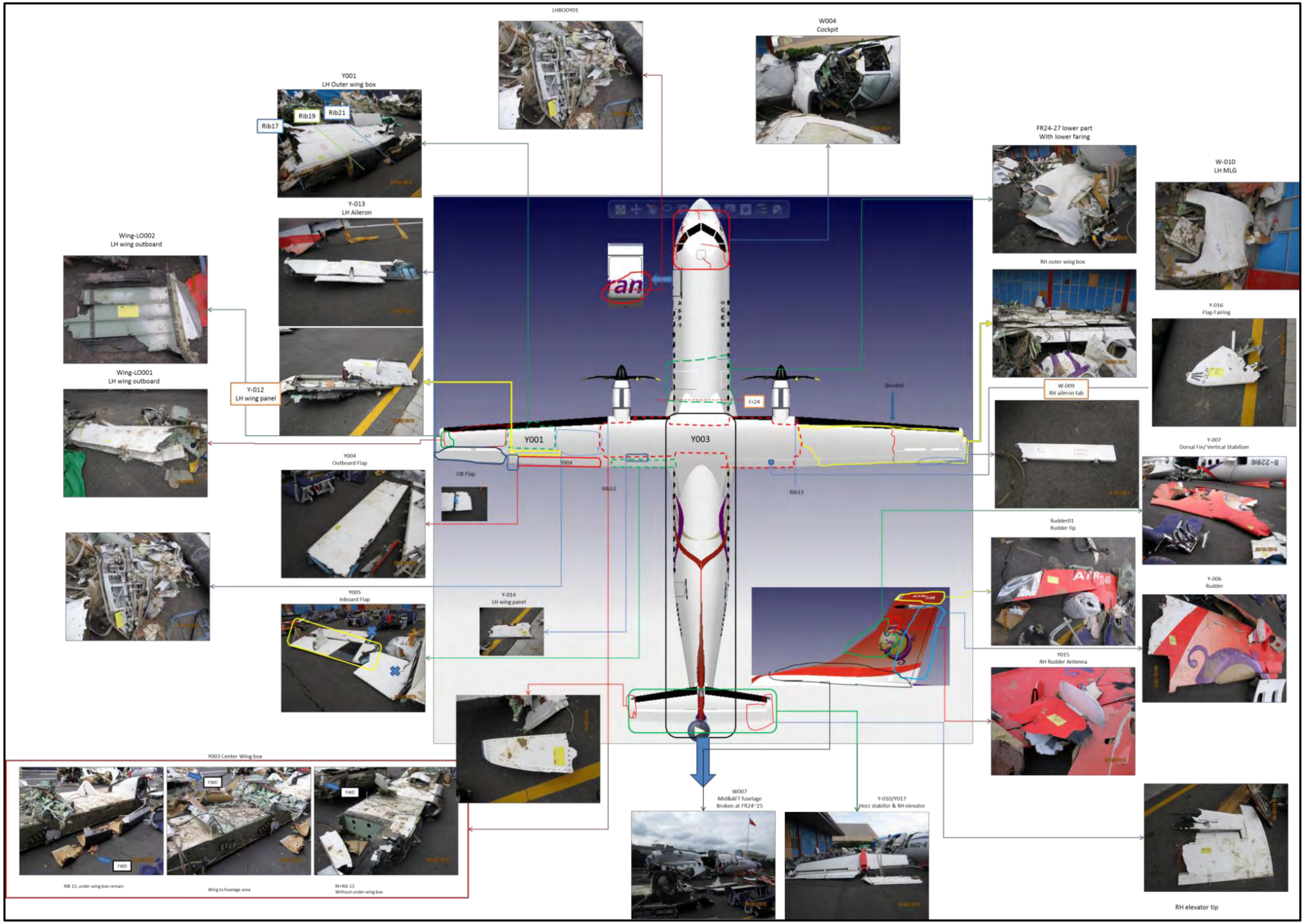

Figure 1.12-2 Recovered aircraft wreckages (1)

Figure 1.12-3 Recovered aircraft wreckages (2)

1.12.2 Wreckage transfer and temporary storage

With the support of the Ministry of National Defense (MND), the recovered aircraft wreckage was transported to the Songshan Air Force Base (SAFB) for temporary storage and subsequent inspections. With the assistances of New Taipei City and Taipei City Emergency Response Centers, all the aircraft wreckages were loaded into five trucks and transported to the SAFB as shown in Figure 1.12-4. The operation of aircraft wreckage transfer was finished in the late night of February 05, the second day after the occurrence.

Figure 1.12-4 Wreckage transferring to storage site by trucks

Figure 1.12-5 shows the aircraft cockpit portion was lifted and moved to the wreckage storage site. The locations of wreckage were arranged as two dimensions reconstruction of whole fuselage. The aircraft emergency locator transmitter (ELT) was deactivated on February 06 after being notified by Songshan airport.

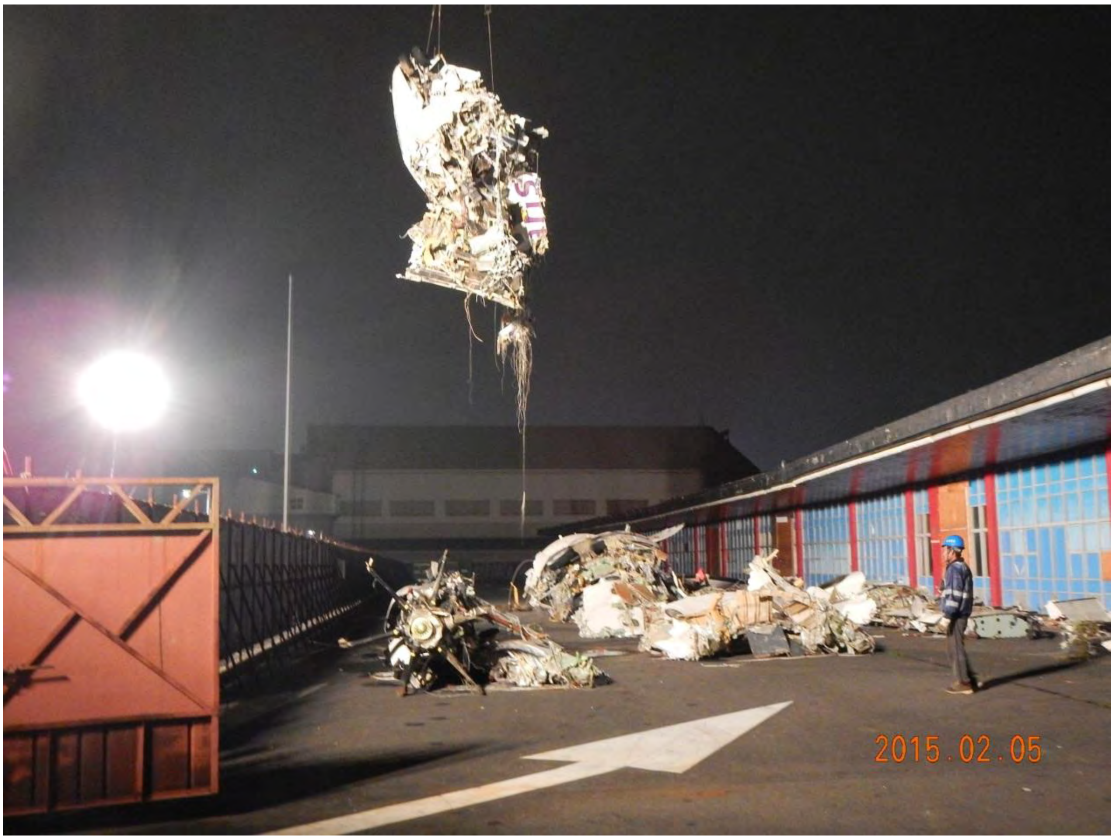

Figure 1.12-5 Temporary wreckage storage site

1.16 Test and research

1.16.1 Aircraft structure examination

The examination of aircraft structure was conducted on February 10, 2015 at the wreckage storage site in SAFB. The examination was finished with joint efforts of ASC, CAA, and TNA structure engineers. Totally 7 aircraft structural pieces were examined. Those fractured surfaces of structural pieces all showed overload and post impact damages. The results of examination were fed into the wreckage structure database which was compiled by ASC during wreckage recovery operation.

1.16.2 Engines examination

The examination of engines was conducted on February 7-9, 2015 at the wreckage storage site in SAFB. Representatives from the following organizations participated in the examination: Transportation Safety Board (TSB) Canada, Transport Canada (TC), ATR, P&WC, CAA, TNA and ASC. After the examination, the P&WC service investigation provided the factual notes (Appendix 1).

1.16.2.1 No.1 engine

The No. 1 engine is a P&WC Model PW127M, serial number ED0913, total hours 829:31 and total cycles 1240. The engine was installed on the occurrence aircraft following aircraft delivery due to a low oil pressure event with the original installed engine. Review of the engine logbook and reduction gearbox logbook showed no unusual maintenance.

The No. 1 engine was examined in the airframe nacelle as recovered. The external case inspection showed all quick engine change items and airframe nacelle to engine connections appeared to be intact, with water immersion damage. The propeller blade remained attached to the hub with the blade outer spans separated.

The engine turbo machine was borescope inspected in accordance with the PW127 engine maintenance manual. The turbine section components, combustion section components, compressor section components and reduction gearbox components all displayed no indications of any anomalies affecting normal operation, and all components observed showed normal running wear. All components showed immersion damage.

Some control and accessory components of No. 1 engine were removed and shipped to TSB Canada for routing to their respective vendors for investigation and analysis under the oversight of National Transportation Safety Board (NTSB), Transport Canada (TC), BEA, P&WC, ATR, UTAS and ASC. The removed components are as following: Propeller Electronic Control (PEC), Engine Electronic Control (EEC), Auto Feather Unit (AFU), Data Collection Unit (DCU), Torque Sensor No. 1 and No. 2, upper and lower Nh Sensors, Nl sensor and Np sensor.

1.16.2.2 No.2 engine

The No. 2 engine is a P&WC Model PW127M, serial number ED0814, total hours 1627:05 and total cycles 2356. The engine was an original installation on the occurrence aircraft. Review of the engine logbook and reduction gearbox logbook showed no unusual maintenance.

The No. 2 engine was examined in the airframe nacelle as recovered. The external case inspection showed all quick engine change items and airframe nacelle to engine connections appeared to be intact, with water immersion damage. The propeller blade remained attached to the hub with the blade outer spans separated. The nacelle aft section and exhaust duct were separated.

The engine turbo machine was borescope inspected in accordance with the PW127 engine maintenance manual. The turbine section components, combustion section components, compressor section components and reduction gearbox components all displayed no indications of any anomalies affecting normal operation, and all components observed showed normal running wear. All components showed immersion damage.

To troubleshoot the fault of uncommanded autofeather, the continuity check was done on the AFU harness which connecting the AFU and No.1 torque sensor. According to the PW127 engine maintenance manual, all the results are within limits (see Table 1.16-1 and Figure 1.16-1). Upon removal of the harness plugs for the continuity check, both the torque probe and AFU plugs showed slight water ingress to plug retaining collar. The connector pin seats appeared to be dry.

Table 1.16-1 Continuity check of No. 2 AFU electrical circuit

Point-A	**Point-B**	**expected**	**result**
J6 pin A	J6 pin B	553-589 ohms	575 ohms
P16 pin H	P6 pin A	0-0.5 ohms	0 ohm
P16 pin J	P6 pin B	0-0.5 ohms	0 ohm
Insulation resistance (with reference to ground) of torque sensor No. 1 > 2 Mohms			

P16 pin H to P6 pin A J6 pin A to J6 pin B

Figure 1.16-1 Continuity check of No. 2 AFU electrical circuit

Some control and accessory components of No. 2 engine were removed and shipped to TSB Canada for routing to their respective vendors for investigation and analysis under the oversight of NTSB, TC, BEA, P&WC, ATR, UTAS and ASC. The removed components are as following: PEC, EEC, AFU, DCU, Torque Sensor No. 1 and No. 2, upper and lower Nh Sensors, Nl sensor and Np sensor.

1.16.3 Components test and examination[1]

1.16.3.1 AFUs tests

Two AFUs removed from the occurrence aircraft, and another AFU removed from an ATR72 aircraft that experienced an uncommanded autofeather event after the GE235 occurrence were sent to the manufacturer, UTAS Rosemount Aerospace, in Minnesota, USA for test and examination.

The test was performed at UTAS facility in Eagan/Burnsville, Minnesota USA, during April 8-11, 2015. The attendees of this test included representatives from safety boards (NTSB, BEA and ASC), regulator (Transport Canada), Advisors (UTAS, PWC and ATR) and observer (TransAsia Airways). The test was based on shop test for functional testing and extended to laboratory examination. During the shop test, a field notes (referred to Appendix 2) was made by NTSB which documented key findings and group decisions. BEA also prepared a Meeting Report of this AFUs tests, document no. BEA2015-0039_tec10,

[1] All the tests are conducted on post-impact components.

referred to Attachment 3. The Meeting Report provided more detailed test process and results, but not including laboratory examination. After all necessary tests including laboratory examination finished, NTSB provided ASC a full AFU Investigation Report prepared by UTAS on June 11, 2015, document number D06429311, Non Technical Rev A (referred to Attachment 4). Following paragraphs are excerpts that relevant to occurrence AFUs from the UTAS document and the BEA Meeting Report.

<u>Basic information</u>: Basic information of these 2 AFUs is shown in Table 1.16-2.

Table 1.16-2 AFUs basic information

	AFU #1	AFU #2
		
Manufacturer	UTAS	UTAS
Part Number	30048-0000-28	30048-0000-28
Serial Number	RT3077	RT2362
J2 Connector Reference *	1301	1315
Position	Engine 1	Engine 2
Aircraft ID	B-22816	B-22816
Flight ID	GE 235	GE 235

* Format is year week (YYWW)

<u>Work performed</u>

The following testing protocol for each AFU was agreed for all the units before the meeting:

- Visual inspection

- Perform a continuity check ([Ref 1][2]– page 125 and 126)
- Perform the functional tests manually ([Ref 1] – page 101 and 123)
- Perform the functional tests automatically [Ref 2][3]
- Perform the thermal cycle tests ([Ref 1] – page 124)
- Perform the vibrations tests ([Ref 1] – page 129)

If a device failed a test, then the testing protocol would be adapted.

AFU No. 1

AFU No. 1 passed continuity test, manual functional tests, automatic functional tests, thermal tests and vibration tests.

Findings for AFU No. 1

- AFU No. 1 passed all the tests in accordance with CMM [Ref 1]

AFU No. 2

AFU No. 2 failed to pass continuity test. The measured resistances values for the Pins J and H were fluctuated from 1 to 20 ohms when the ribbon was moved by hand. The resistance was higher than the CMM (Component Maintenance Manual with Illustrated Parts List, 73-20-03, Rev. 11, Oct 01, 2014) values threshold of 0.35 ohms for the Pins J and H. These two pins are the pins connected with the torque sensor. An X-ray examination was performed and no defect was found of this unit. In order to find where the increased resistance occurred between Pin J/H of J2 connector and the A2 board strip contact (contact points No. 34/33), a new test procedure was proposed and agreed by all attendees for this unit.

To perform the new test, three test points were defined to facilitate the isolation of the high resistance.

- X1 – The insulation was removed at the end of the flex to create a testing point
- X2 – The flange on the pin that is soldered between the flex circuit and the circuit card
- X3 – A testing point on the circuit card, instead of the strip contact point defined in the CMM

Detail test results by applying the new test procedure for AFU No. 2 are as follows.

---

[2] 73-20-03 Rev11, Component Maintenance Manual, Part Number 30048-0000-* Part Testing and Fault Isolation

[3] D06409502 Rev C, Acceptance Test Procedure

- The resistance (R_{X1}) measured between pin J and point X1 provided a value consistent with the maximum resistance value provided by the CMM. Moving the ribbon did not affect this value.
- The resistance (R_{X2}) measured between pin J and point X2 provided a value greater than R_{X1}, which was unstable and changed while the ribbon was moved.
- The resistance (R_{X3}) measured between pin J and point X3 provided a value greater than R_{X1}, which was unstable and changed while the ribbon was moved.

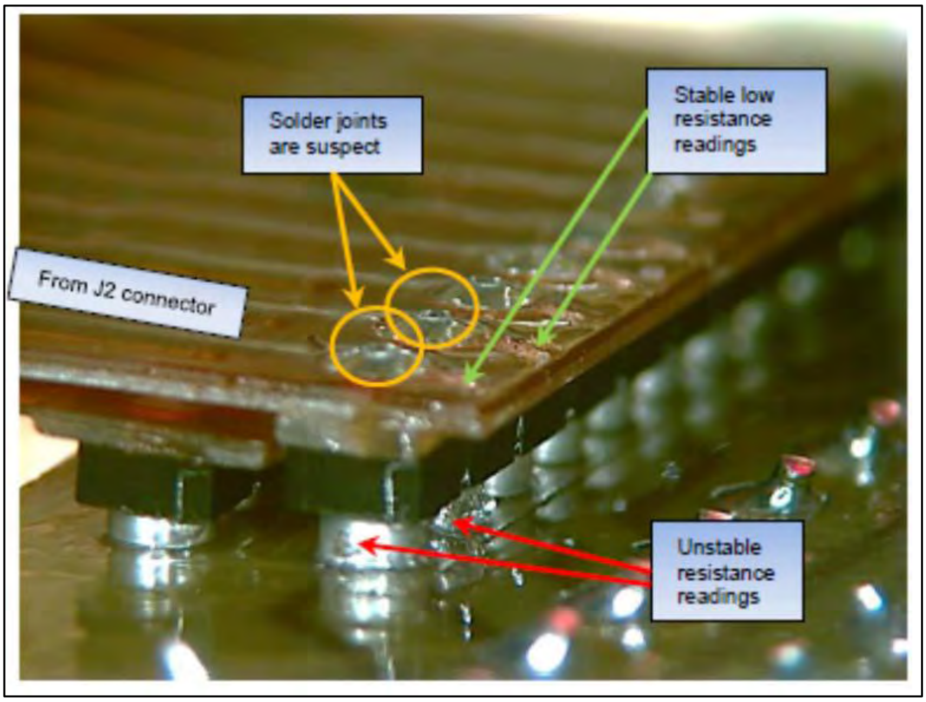

Figure 1.16-2 Continuity check of pin J and A2 board

It was noted that the first time R_{J2} and R_{H2} were measured, both were unstable. As the tests were repeated, from time to time, R_{J2} and/or R_{H2} were stable during one test. The continuity failures detected on pin H and pin J were located inside the header strip connector (end of the ribbon, opposite to the J2 socket). The discontinuity was observed to be intermittent. The test results are summarized in Table 1.16-3.

Table 1.16-3 Test results of AFU No. 2 by applying new test procedure

AFU No. 2			
	X1	X2	X3
Pin J	Stable	Unstable	Unstable
Pin H	Stable	Unstable	Unstable

The functional test of AFU No. 2 was not completed due to a short circuit was detected during the gain tests. An X-ray examination was performed and a possible cause was found on the bounding No. 16 of component U5 of A2 board. As the component replacement could be seen as a destructive choice, it was decided to stop the test with this unit.

A CT-Scan (Computed Tomography) of J2 solder joints was performed and potential solder cracking was identified. A destructive test was performed to find the possible root cause of continuity failures inside the 90°connector of J2 flex circuit. The J2 flex circuit was cut out of the CCA (Circuit Card Assembly) and housing. Pins 33-42 of J2 flex circuit was examined using optical microscope and with the SEM (Scanning Electron Microscope). Figure 1.16-3 shows the photos of Pins 33 and 34 with 40X magnifications and with SEM examination. The Pins 33-42 of J2 flex circuit was cross sectioned to the component centerline and examined. Figure 1.16-4 and 1.16-5 show the photos of cross sectioned pin to flex solder joints of Pins 33 and 34. The Pin-Flex solder joints displayed a coursing of the solder micro structure near the pin on each of the 10 pins in the strip. The condition was most advanced on pins near the end of the strip. In the optical cross-section images the Lead-rich phase are the grey particles dispersed within the white Tin-rich phase. In the SEM images the Lead phase is white and Tin is grey. The solder microstructure is enlarging, coarsening and cracking in a stress zone adjacent to the Pin / Solder interface. Away from this “crack zone” the solder microstructure is very fine.

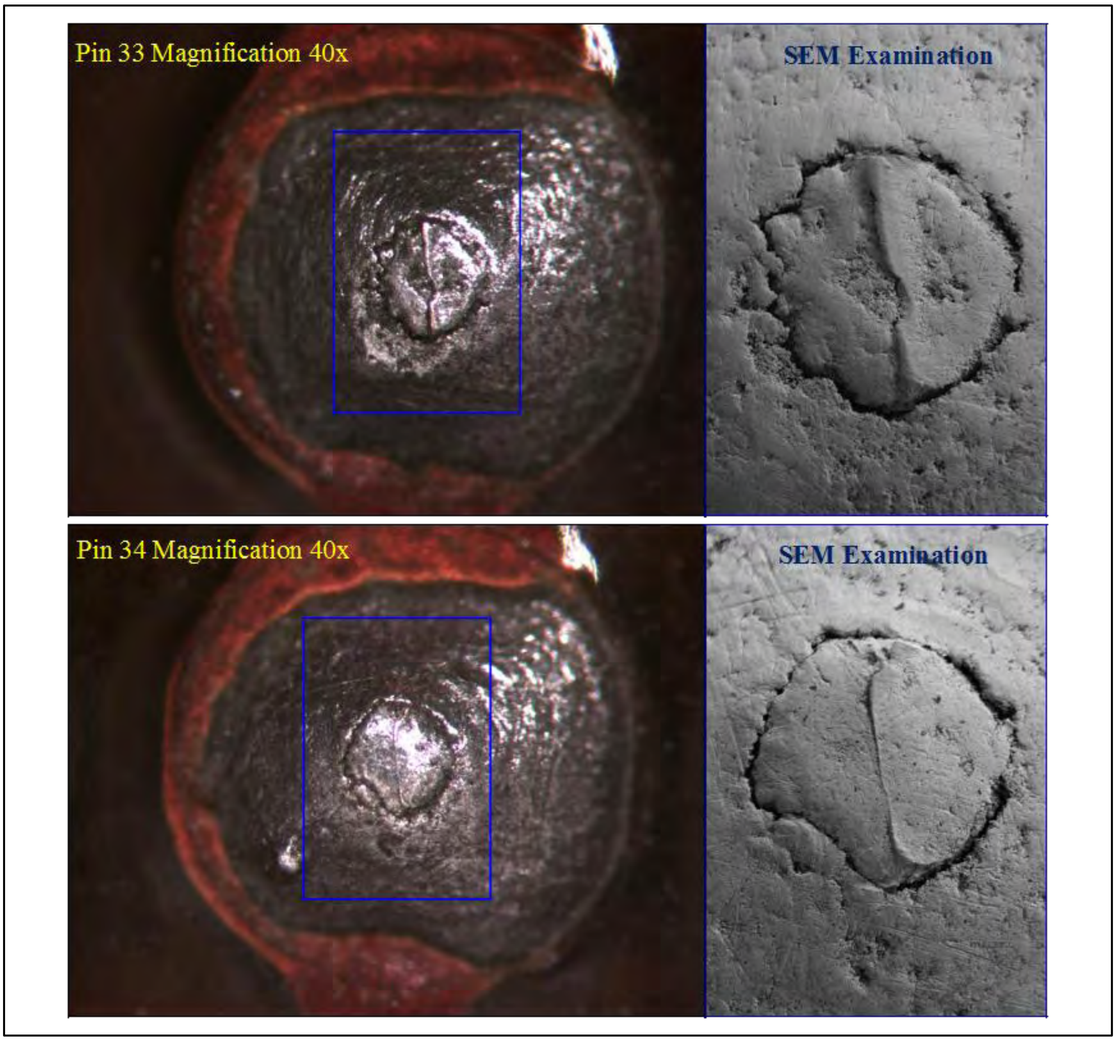

Figure 1.16-3 Pins 33 and 34 with 40X magnifications and with SEM

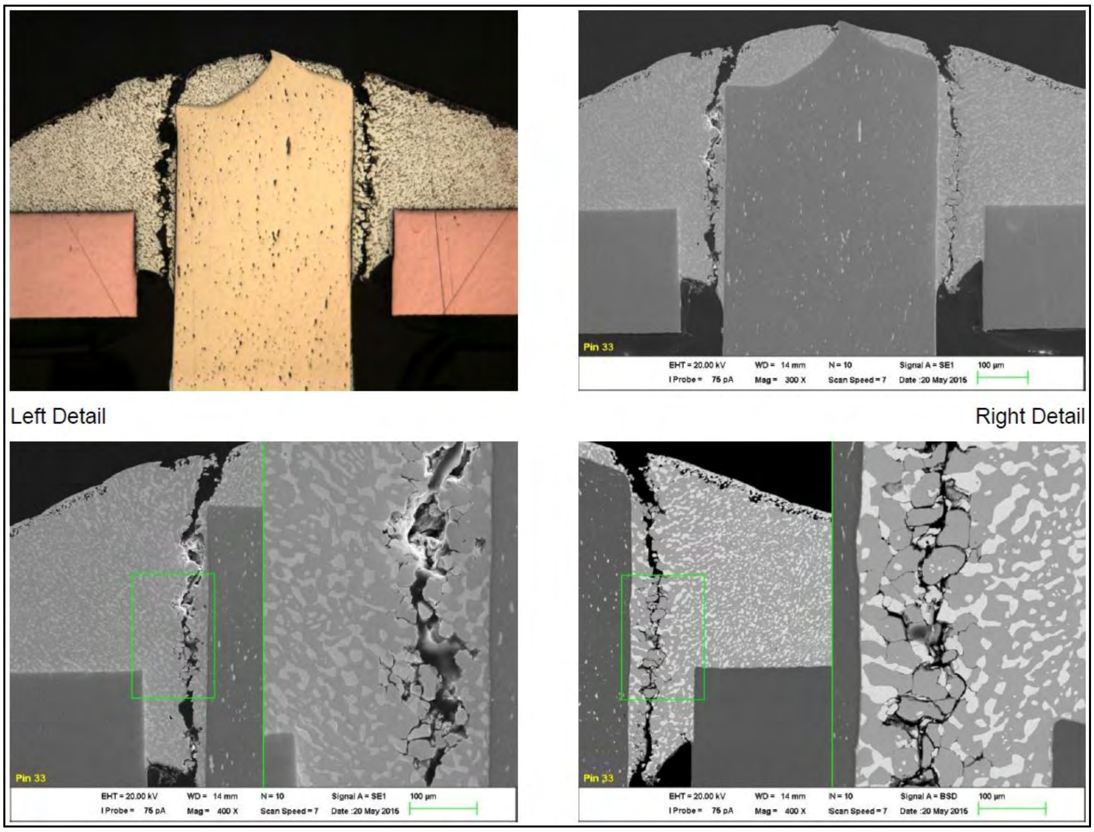

Figure 1.16-4 Cross sectioned pin to flex solder joints of Pins 33

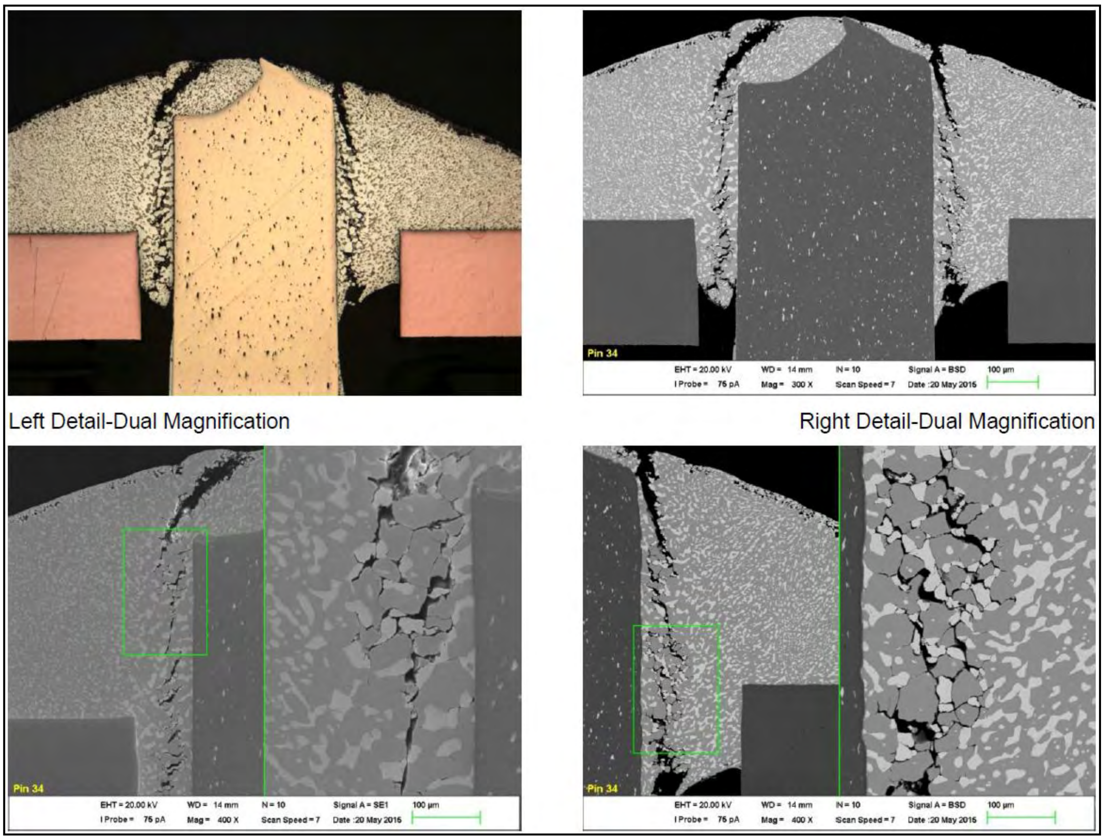

Figure 1.16-5 Cross sectioned pin to flex solder joints of Pins 34

Findings for AFU No. 2

- Continuity failures (resistance values above the CMM threshold) exist between pin H and the circuit board, and between pin J and the circuit board
- Continuity failures (resistance values above the CMM threshold) are located at the solder joint interface between the flex circuit and the header pin
- Continuity failures (resistance values above the CMM threshold) were inconstant
- The solder microstructure is enlarging, coarsening and cracking in a stress zone adjacent to the solder joint interface between the flex circuit and the header pin

1.16.3.2 MFCs NVM data download

Twenty two boards of two Multi Function Computers (MFC 1, 2) were removed from the occurrence aircraft and shipped to BEA for NVM data readout. BEA provided the Final report of the Computer MFC 1 and computer MFC 2 Memories readout, document no. BEA2015-0039_tec11, date of issue 16/04/2015, referred to Attachment 5. Following paragraphs are excerpts of the document.

Four memory chips extracted from boards CPU1 and CPU2 of MFC 1 and MFC 2 were dried and electrically checked before the readout processes. The memories were readout twice to check the correctness of the downloaded binary files. The binary file of each memory was then decoded by BEA and Airbus and the same results were found. Information stored in the memory chips included 3 groups of readout, Basic BITE, Advanced BITE and Super advanced BITE.

The only information provided by the basic BITE memories is that from the CPU2 of MFC 1. The only recorded failure is the code 02 of the system “flight control”, no other failure had been detected since the last MFC maintenance action[4], with an erase of the memory.

Advanced BITE and Super Advanced BITE provided following information,

[4] TNA information: TNA checks MFC memory every Wednesday night during weekly check. If only WOW (Weight On Wheel) failure code existed, the memory will be erased. If there were failure code other than WOW, the associated correction will be documented in the TLB. From the maintenance records, the last weekly check of the occurrence aircraft was performed on January 28, 2015 with no fault found.

During the 6 of the 8 previous flights (no event for flight N-1 and N-2), the code 02 appeared in the group “flight control” (advanced BITE). The meaning of this code and the associated action are the following:

- TORQUE 2 FAULT (confirmation delay: 30 s)
- This code appears with the following conditions:
  - right power lever in TO position AND torque below 25%
  - OR right power lever not in TO position AND torque upper 50%
  - AND right ECU not fault
  - AND right engine oil not in low pressure
  - AND MFC1B or 2B valid.
- Action:
  - Check AFU, Torque indicator, microswitch on right power lever and associated wiring.

When this failure occurs, it shall be underlined that:

- the failure concerns a chain composed of {TQ sensor #1 of engine #2, harness, AFU #2}
- it is impossible to know what element of the chain failed.
- the exit of the system is the needle TQ indication displayed on the EPD. This failure has then an impact on the information displayed to the crew.
- the digital TQ indication displayed on the EPD uses another chain and another sensor (TQ sensor #2 of the engine). It is this information, which is recorded by the DFDR.

All those flights were performed the day before the flight of the event (2015/02/04).

The flights N-1 and N-2 were performed the same day than the flight of the event (2015/02/04). It is impossible to know if the crew faced or not the same failure during these two flights:

- no indication of ATPCS sequence exists on the FDR recorded data (no feathering request recorded inside the FDR and the super advanced BITE)
- after the take off, it is impossible to know if the needle TQ indication of the engine #2 was invalid as the information of the torque values recorded by the FDR is provided by

another chain using the TQ sensor #2

- as the confirmation delay for the MFC to record this failure is 30 seconds, this failure might have happened intermittently, for durations lower than 30 seconds.

During the flight of the event, MFC #2 recorded an autofeather request inside the super-advanced BITE, with a signal coming from the AFU No. 2. Both module 2A and 2B recorded the same context:

- A single record
- Code E1: Activation signal for feathering pump 2 status
- Code E3: Auto feathering signal from AFU No. 2

This recording is consistent with the record of the code 02 of the group “flight controls”, recorded inside the advanced BITE during the flight of the event (all the MFC modules). As the right power lever was recorded in the take off position by the FDR, the torque indication value was then detected below 25%.

During the flight N-1, the Super Advanced BITE information seems not consistent for the propeller brake recorded context. Both MFC 2A and 2B modules performed the same first record, but the module 2B performed 2 additional records. This has no impact on the investigation of the event. Nevertheless, ATR is investigating these differences.

FINDINGS

- No error other than the invalid needle TQ indication was detected by the MFC since the last erase of the MFC memory (maintenance action)
- AFU #2 reported TQ values of the engine #2 lower than 25% to the MFC during more than 30 s.
- The auto feathering triggered during the flight of the event.

1.16.3.3 PECs and EECs data download

Two EECs and 2 PECs removed from the occurrence aircraft were sent to manufacturer, Hamilton Sundstrand at Windsor Locks, Connecticut, USA, for NVM data download. The work was performed by Hamilton Sundstrand and overseen by the representatives from NTSB, TC and P&WC during the time period April 20-22, 2015. The Shop Findings Report of EECs and PECs, referred to Attachment 6, was provided to ASC on May 20, 2015. Following is the basic information of the EECs and the PECs,

Table 1.16-4: Basic information of EEC and PEC

	P/N	S/N	Position
EEC	1012974-4-002	14040035	No.1 / left
EEC	1012974-4-002	13100020	No.2 / right
PEC	816332-5-401	13070018	No.1 / left
PEC	816332-5-401	13080013	No.2 / right

The shop finding and data download indicated that both PECs had no induced failures and no fault codes stored during the occurrence flight. Both EEC passed power up test with some stored fault codes. Each of the fault codes occurred on a flight prior to the event and was most probably caused by the power-up sequence of the EEC, DCU, AFU, Air Data Computer.

1.16.3.4 Harnesses

The harnesses connecting No. 1 torque sensors to AFU of both engines were removed from the occurrence aircraft and shipped to BEA for further lab examination. A non-destructive means was performed by using an X-ray and a macroscopic examination (Appendix 3). The connection between the torque sensor and the AFU is made through (Figure 1.16-6):

- Pin No. 1 and pin No. 2 on the torque sensor connector
- Pin H and pin J on the AFU connector

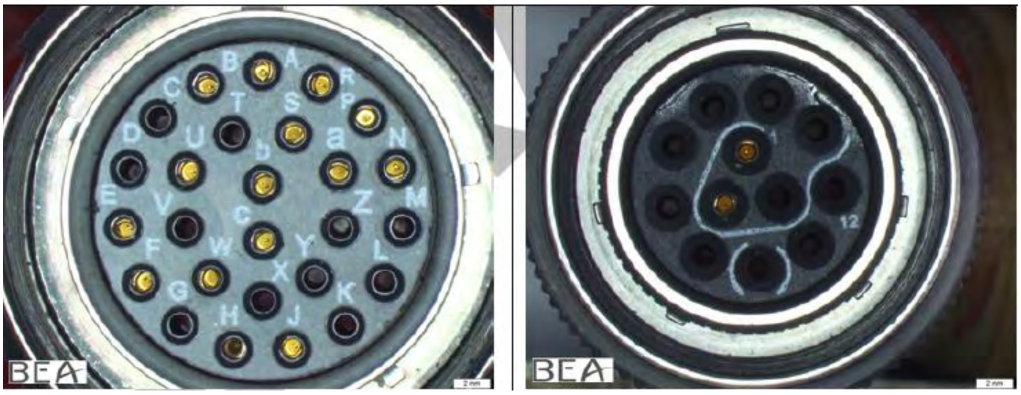

Figure 1.16-6 Torque sensor and AFU connectors

The X-ray examination of both harnesses showed no anomaly. The X-ray pictures of the connectors which connect AFU and the torque sensor of No. 2 engine are shown in Figure 1.16-7.

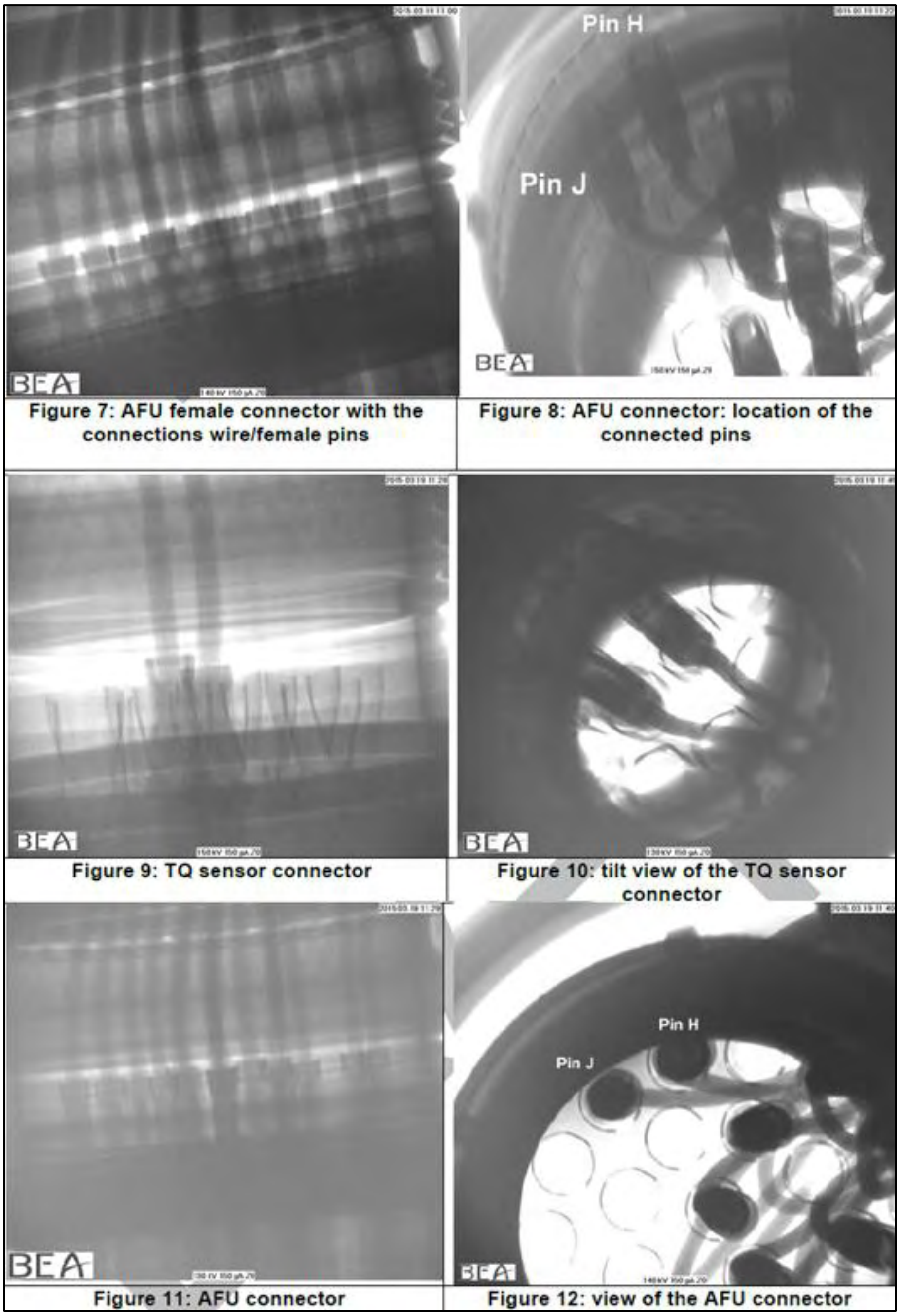

Figure 1.16-7 X-ray examination of AFU and torque sensor connectors

The macroscopic examination showed a difference between the pin H of AFU connector of No.2 engine and the other pins on this connector. A picture of pins H, J of No. 2 AFU connector is shown in Figure 1.16-8.

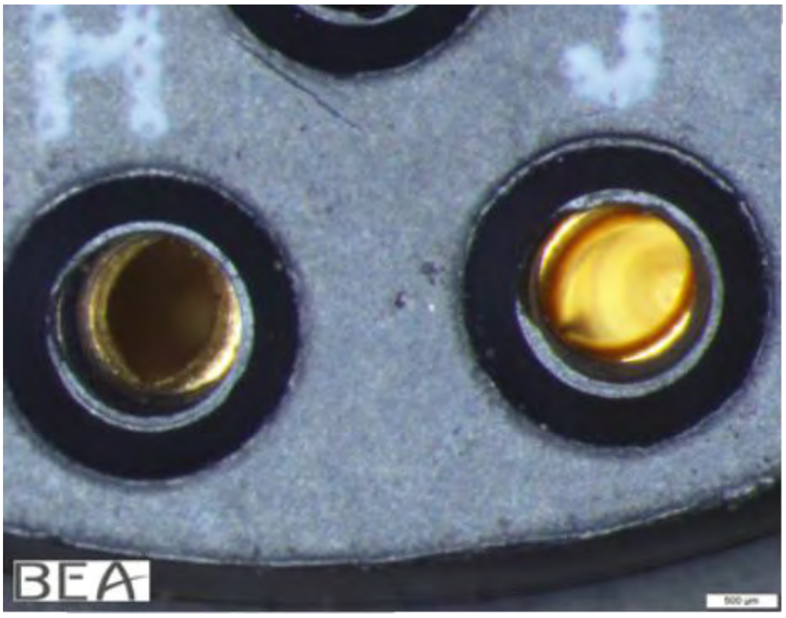

Figure 1.16-8 Pins H and J of No. 2 AFU connector

The harness was brought to UTAS Rosemount Aerospace to combine with the AFU test if situation required. Because of the discontinuity was found in AFU No.2, ASC requested just to perform the continuity check of harness. A continuity check then was done on the pin J and H of harness. The resistances were 0.20 ohms and 0.21 ohms respectively.

1.16.3.5 Accessories tests

Twelve engine sensors including right torque, left torque, Np speed, lower Nh speed, upper Nh speed and Nl speed sensors of No. 1 and No. 2 engines which removed from the occurrence aircraft were sent to P&WC via TSB for testing. After all necessary tests finished, P&WC provided ASC a report on June 22, 2015, document number RFA No 15ECN00082 SI File No: 15-006 (referred to Attachment 7). According to the report, observations recorded from testing of the speed and torque sensors were indicative of immersion in water and impact. Test results are summarized in Appendix 4.

Two Data Collection Units (DCUs) which removed from No. 1 and No. 2 engines of the occurrence aircraft after the crash were sent to the manufacturer, Safran Electronics, via TSB for memory data readout. According to Attachment 7, the readout data from the DCU of both engines did identified engine cycle count and engine run-time data.

1.18 Additional information

1.18.1 Interview summaries

1.18.1.1 Assistant manager of maintenance division

The interviewee first introduced TNA's maintenance difficulty reporting procedures and how the difficulty was reported. TNA's Maintenance Control Center (MCC) collects reported aircraft defects from all stations and compiles them into a daily report each day. These defects might be from pilot report, safety department or maintenance personnel etc. A printed out daily report was prepared and used for reference during TNA's directors meeting. MCC assists directors of each division to review the daily report as necessary. If there were service difficulty item, MCC would report this item to Quality Control Center (QCC). QCC also compulsorily needed to make Service Difficulty Report (SDR) and reporting the difficulty to the Civil Aeronautics Administration (CAA). After the SDR was reported to the CAA, TNA's Reliability Control Board (RCB) would discuss with CAA personnel for solution of the service difficulty case.

Regarding the issues of aircraft diversion resulted from engine problems during B-22816 ferry flight from Bangkok to Taiwan, the interviewee expressed how those engine problems were reported to Taiwan CAA. While the aircraft B-22816 was in cruise from Toulouse to Taipei, a low oil pressure warning on the No. 1 engine occurred. The flight crew shut down the No. 1 engine and diverted to Macau airport. TNA replaced of the No. 1 engine to resume the aircraft delivery flight. During the flight from Macau to Taipei, the No. 1 engine low oil pressure warning appeared again and the flight crew shut down the No. 1 engine. The investigation confirmed that the missing drive shaft / spur gear woodruff key of the No. 1 engine reduction gearbox oil scavenge pump was the cause of the engine low oil pressure warning. When the aircraft B-22816 was diverted to land at Macau airport, TNA on board aircraft personnel with the ferry flight called TNA Flight Control Center (FCC) about the diversion. TNA FCC then reported the event to CAA. Due to the repeated No. 1 engine low oil pressure warning and commanded in flight shut down events, CAA sent Principal Maintenance Inspector (PMI) to Kaohsiung airport to assist TNA after the aircraft B-22816 landed at Kaohsiung airport.

While being asked what TNA's actions taken and response to those in flight shut down events in the latest 5 years were, the interviewee replied that 2 of those in flight shut down events occurred during aircraft delivery were mentioned earlier. One engine in flight shut down event occurred in May 2, 2012 was resulted from manufacturing defect of engine turbine blades which had been investigated and closed by the ASC. The incident occurred on August 16, 2011 was resulted from defective J1 and J2 connectors of the Auto Feather Unit (AFU). TNA revised ATR Continuous Airworthiness Maintenance Program (CAMP) task number 771362-RAI-10000-TNA to change the inspection of AFU to hard time interval. The last one occurred in October 6, 2010 was due to engine torque fluctuation after take-off. To reduce loss of engine torque signal or torque fluctuations related event, TNA issued Engineering Circular EC-1106-04 requesting the compliance of related documents and procedures to perform electrical connector care.

1.18.1.2 Maintenance personnel stationed in Kinmen airport

The interviewee has worked for TNA since 1995. He has CAA's A/E/AV licenses and stationed in Kinmen airport as a senior mechanics now. The interviewee received ATR72-500 type training and configuration differences course training between the ATR72-500 and -600 aircrafts. The interviewee also received aviation maintenance related recurrent training each year. The interviewee then described how to follow the procedures to authorize and dispatch aircraft after completion of required check and maintenance.

While being asked what work had been done before the aircraft B-22816 was dispatched to service the previous flight of the occurrence flight from Kinmen to Songshan, the interviewee replied that there were two mechanics stationed in Kinmen airport, since the other one had no CAA license, the mechanics with no CAA license performed fueling work and the interviewee did the transit check alone. The interviewee finished the transit check in 20 minutes with no fault found. Usually, if no fault was found, transit check could be done in about 20 to 25 minutes. The interviewee also checked maintenance records; there was no deferred defect of the aircraft B-22816. The interviewee then signed the Technical Log Book and the aircraft was airworthiness released for service. After the other mechanics finished fueling job, the interviewee walked to the cockpit and gave the fueling form to the Captain. The flight crew did not mention any problem about the engines.

If there were fault found before the aircraft departure, the interviewee never discussed with the flight crew to apply MEL for delay maintenance. Delay of aircraft scheduled departure time would not bring any pressure on him. The interviewee said keeping aircraft airworthiness was the first priority.

1.18.1.3 Maintenance personnel stationed in Songshan airport

The interviewee has worked for TNA since 2005. Before that he had been in the Dragon Air for 2.5 years. He has CAA’s A/E/AV licenses, and is stationed in Songshan airport as a mechanic now. The interviewee had received ATR72-500 type training and configuration differences course training between the ATR72-500 and -600 aircrafts. The interviewee also received aviation maintenance related recurrent training each year. The interviewee then described how to follow the maintenance procedures to dispatch aircraft after completion of required check and maintenance.

The transit check before the occurrence flight was done by the interviewee. The transit check was finished in 20 minutes with no fault found. The interviewee expressed that if no fault was found, transit check usually could be done in about 20 minutes. The interviewee also checked maintenance records and no deferred defect record of the aircraft B-22816 was found. The interviewee then signed the Technical Log Book and the aircraft was airworthiness released to service.

The interviewer asked whether or not the flight crew mentioned about engine problem before the occurrence flight from Songshan to Kinmen. The interviewee replied that the first leg of that day was flight

GE231. The interviewee did a pre-flight check while the Captain performed a 360 degree check. The pre-flight check result was normal. Before the leg of flight GE235, the interviewee did the transit check himself. The flight crew did not mention anything about the engine. If there were fault found before the aircraft departure, the interviewee never bargained with the flight crew to apply MEL for delay maintenance. Delay of aircraft scheduled departure time would not bring any pressure on him. The interviewee said keeping aircraft airworthiness was the first priority.

1.18.2 Abnormal engine torque related events/information

1.18.2.1 Chronology of TNA ATR72 aircraft abnormal engine torque related events/information

A review of Taiwan CAA's aviation incident reports revealed that 2 TNA ATR72 abnormal engine torque related events were investigated between October 2010 and the day of GE235 occurrence. One was reted to the connection of the torque sensor to the EEC and the other one event related to the AFU. There was also a TNA ATR72 autofeathering event occurred after the GE235 occurrence. A chronology of these events and information is shown in Table 1.18-1.

Table 1.18-1 TNA ATR72 abnormal engine torque related events

Date	**Type of aircraft or Info issued by**	**Description of event/information**
Nov. 17, 2008	P&WC	P&WC issued Service Information Letter SIL No. PW100-125 to operators on proper electrical connector protection and wrapping.
Oct. 06, 2010	ATR72-500	After aircraft takeoff, No. 2 engine torque vibrated between 20% and 100%, the aircraft in flight turned back and landed safely. Or connection between No. 2

		torque sensor and EEC was suspected.
Jun. 28, 2011	TNA	1. TNA issued Engineering Circular EC-1106-04 to Line/Base Maintenance and Training Section iterate the importance of practice appropriate connector care during any engine connector installation. 2. The Flight Operations Division added Abnormal Engine Parameters in Flight procedure into teh ATR FLEET Training Program.
Aug. 16, 2011	ATR72-500	1. During cruise, No. 1 engine torque dropped to zero causing the pilot shut down No. 1 engine. The No. 1 engine was then restarted and aircrft landed safely. 2. P&WC report confirmed that the defects found on AFU causing the uncommanded autofeathering of engine No. 1.
Mar. 15, 2012	TNA	TNA issued Engineering Circular EC-1203-03 to inform related department for the information in the report with the associated symptom.
Feb. 21, 2015[5]	ATR72-500	After aircraft takeoff, No. 1 engine torque dropped causing No. 1 propeller autofeathering. The aircraft turned back and landed safely.

1.18.2.2 Related Service Information issued by P&WC

On August 15, 2007, P&WC issued SB21742 to do a one-time inspection of AFU. The reason to issue SB21742 was that aging of the AFU electrical connectors and interconnect ribbon solder joints can lead to loss of torque signal. On August 2007, P&WC issued SB21742R1 to recommend sending AFU to an authorized accessory shop that can do the one-time inspection per the latest CMM instructions. On December 2009,

[5] Incident date of this event was after the date of GE235 occurrence (Feb. 04, 2015).

P&WC moved the intend of SB21742R1 in Table 4 of section 05-20-00 of the Engine Maintenance Manual (P/N 3037332, rev. 42) to change this inspection to a repeat inspection. P&WC then cancelled the SB21742 in April 2011 because it is now covered in the Engine Maintenance Manual.

On December 14, 2010, P&WC issued Service Information Letter (SIL) No. PW100-138 (see attachment 9) for AFU inspection / repair at shop visits. The document indicated that some of the AFUs involved in those autofeather events exhibited cracks in the soldering of the U3 voltage converter mounted on the AFU board. Those cracks are believed to have caused momentary electrical disruptions leading to the autofeath events. The manufacturer of the AFU then revised instructions regarding the U3 converter inspection, installation and soldering to its mounting board. In addition, testing requirements for the AFU have been improved via testing at low, high and ambient temperatures.

On September 26, 2011, P&WC issued Service Information Letter No. PW100-147 (see attachment 10) for AFU related autofeather events. The document indicated that several of the reported autofeather events are associated to 28 Volts DC power interruptions at the AFU. On the ATR aircraft, those power interruptions will generate large magnitude torque bug fluctuations. The AFU manufacturer has incorporated related contents to its CMM which include:

- Revised instructions for U3 converter inspection, installation and soldering on the mounting board.
- Inspections related to the J1 and J2 flex conductors and boards interconnect flexible ribbons.
- Functionality testing of the AFU at different temperature (low, high and ambient).

1.18.3 Wreckage and LRU database

Two wreckage databases (structure database and LRUs database, as shown in Attachment 11, 12) were developed using an Excel spread sheet for records keeping and information sharing. The structure database containing 38 pieces of larger wreckage recovered from the aircraft crash site. Data fields of the structure database contain parts nomenclature, location, results of structure examination and related photos. The LRU database containing 68 line replacement units removed from cockpit and No. 1, 2 engines. Data fields of the LRU database contain item nomenclature, part number, serial number, wet or dry status, shipping information (TSB/BEA/ASC) and related photos.

IV. Appendix

1. ATR-72 Reg. B-22816 Accident Investigation, Engine Inspection Factual Notes
2. Field Notes, Examination of Autofeathering Units at UTAS Rosemount Aerospace, Burnsville, Minnesota, April 8-11, 2015
3. Technical document, Cable TQ sensor – AFU engine 1 & 2, X-Ray and macroscopic examination report, BEA2015-0039-tec08, 20/03/2015
4. Test results of torque and speed sensors

Appendix 1. ATR-72 Reg. B-22816 Accident Investigation, Engine Inspection Factual Notes

Service Investigation
Factual Notes

Pratt & Whitney Canada
Une société de United Technologies / A United Technologies Company

Page: 1 of 41

12 February 2015

Aviation Safety Council
Republic of China

Attn:
Director, Occurrence Investigation Division

Subject: ATR-72 Reg. B-22816 Accident Investigation, Engine Inspection Factual Notes.

Please find attached the subject factual notes for your review.

In brief summary of our observations, the nacelle fault isolation for uncommanded autofeather in accordance with the PW127 engine maintenance manual showed the trim plug characterization, the No. 1 torque sensor continuity, and the autofeather unit to torque sensor continuity to be correct. The next action stated in the fault isolation flow is replacement of the autofeather unit.

Boroscope inspection of the turbomachine showed no pre-impact anomalies affecting normal operation.

We will remain in close coordination for the on-going investigation of the engine controls and accessories.

Please regard that these observations are of a preliminary nature and may be altered or corrected on the basis of further information or analysis. A final report will be issued for the investigation.

If you have any questions or require any further information please do not hesitate to contact me at Tel:

Regards,

PRATT &WHITNEY CANADA

CC:

Service Investigation

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	ECCN or USML (ITAR) #	9E991
	P-ECCN or P-USML (Non US Origin)	

FACTUAL NOTES, POWERPLANT INSPECTION IN SUPPORT OF ACCIDENT INVESTIGATION OF ATR-72 REG. B-22816 PERFORMED FOR THE AVIATION SAFETY COUNCIL, REPUBLIC OF CHINA.

P&WC Ref. No.: 15-006

1. INVESTIGATION PARTICIPANTS

The powerplant inspection was conducted on 7-9 February 2015 at the facilities of Songshan Air Force Base, Taipei, Taiwan. The following individuals participated in the investigation as representatives of their respective organizations:

Aviation Safety Investigator
Occurrence Investigation Division
Aviation Safety Council, Republic of China

Investigator
Aviation Safety Division
Aviation Safety Council, Republic of China

Senior Technical Analyst
Operations Service Branch
Transportation Safety Board Canada

Civil Aviation Inspector
Transport Canada

Propulsion & Air Systems Director
Alenia Aeronautica EADS ATR

Field Service Representative
Pratt & Whitney Canada

Service Investigation
Pratt & Whitney Canada

2. LEFT HAND ENGINE HISTORY

PW127M S/N ED0913

Total Hours: 826

Total Cycles: 1236

The engine was installed on the subject aircraft following aircraft delivery due to a low oil pressure event with the original installed engine. Review of the engine logbooks showed no unusual maintenance.

3. LEFT HAND ENGINE EXAMINATION

All positional references in relation to view from aft looking forward. Upstream and downstream references are in relation to gas path flow from compressor inlet to exhaust.

3.1 External Condition

The engine was examined in the airframe nacelle as recovered. All quick engine change items and airframe nacelle to engine connections appeared to be intact, with water immersion damage. The propeller hub remained attached to the hub with the blade outer spans separated.

3.1.1 External Cases

Reduction Gearbox: The housing was intact. The propeller shaft was intact. The reduction gearbox mounted controls and accessories were intact.

Front Inlet Case: Displayed no apparent impact damage. The front inlet case mounted controls and accessories were in place and intact.

Rear Inlet Case/Accessory Gearbox: Displayed no apparent impact damage. The accessory gearbox mounted controls and accessories were in place and intact.

Low Pressure Diffuser Case: Displayed no apparent impact damage.

Intercompressor Case: Displayed no apparent impact damage.

Gas Generator Case: Displayed no apparent impact damage.

Turbine Support Case: Displayed no apparent impact damage. The fuel nozzle manifold was intact.

Please refer to photos No. 1 through 5.

Photo No. 1
Engine left hand view.

Photo No. 2
Engine right hand view.

Photo No. 3
Engine forward view.

Photo No. 4
Engine rear view.

Photo No. 5
Compressor inlet case, autofeather unit and engine electronic control, in-situ.

3.1.2 **Chip Detectors and Filters:**

Due to the flight data recorder information and post impact engine boroscope inspection showing no indications of any mechanical anomalies, the chip detectors and filters were not examined.

3.2 **Disassembly Observations:**

Due to the flight data recorder information showing no indications of any mechanical anomalies, the engine turbo machine was boroscope inspected in accordance with the PW127 engine maintenance manual by a technician from P&WC (S.E.A.) Ltd.

3.2.1 **Turbine Section:**

The turbine section components displayed no indications of any anomalies affecting normal operation, and all components observed showed normal running wear. All components showed water immersion damage. Please refer to photos No. 6 through 11.

Photo No. 6
Second stage power turbine.

Photo No. 7
First stage power turbine.

Photo No. 8
First stage power turbine vane ring.

Photo No. 9
Low pressure turbine.

Photo No. 10
High pressure turbine.

Photo No. 11
High pressure turbine vane ring.

3.2.2 **Combustion Section:**

The combustion section components displayed no indications of any anomalies affecting normal operation, and all components observed showed normal running wear. All components showed water immersion damage. Please refer to photo No. 12.

Photo No. 12
Combustion chamber liner.

3.2.3 **Compressor Section:**

The compressor section components displayed no indications of any anomalies affecting normal operation, and all components observed showed normal running wear. All components showed water immersion damage. Please refer to photos No. 13 and 14.

Photo No. 13
Low pressure impeller and shroud

Photo No. 14
High pressure impeller.

3.2.4 **Reduction Gearbox:**

The reduction gearbox components displayed no indications of any anomalies affecting normal operation, and all components observed showed normal running wear. All components showed water immersion damage. Please refer to photos No. 15 through 17.

Photo No. 15
Reduction gearbox second stage spur gears, detail.

Photo No. 16
Reduction gearbox helical input gearshaft and helical gear.

Photo No. 17
Reduction gearbox helical input gearshaft and helical gear.

3.2.5 **Accessory Gearbox:**

The accessory gearbox was not examined.

3.3 **Controls and Accessories Evaluation:**

The following listed components were removed and forwarded to Transportation Safety Board Canada for routing to their respective vendors for investigation and analysis under the oversight of Transportation Safety Board Canada or the United States National Transportation Safety Board as appropriate.

3.3.1 **Hydromechanical Control System**

Due to the flight data recorder information showing no indications of any anomalies the hydromechanical control system, these components were not removed.

3.3.2 **Electronic Control System**

Propeller Electronic Control: Hamilton Sundstrand Model EPC100-1, P/N 816332-5-401, S/N 13070018. The unit was re-immersed in fresh water and packed sealed in water for shipping. Please refer to photos No. 18 and 19.

Photo No. 18
Propeller Electronic Control.

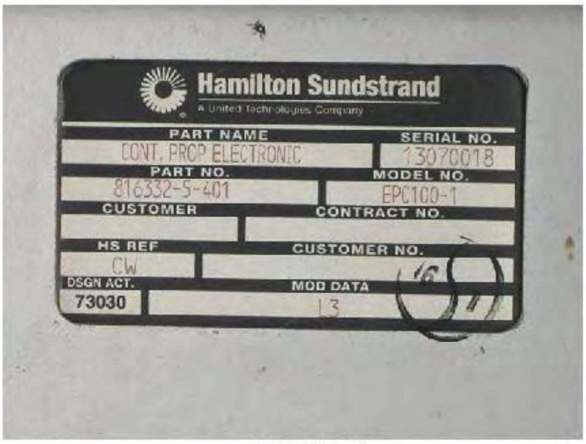

Photo No. 19
Propeller electronic control data plate.

Engine Electronic Control: Hamilton Sundstrand Model EEC132-190, P/N 1012974-002, P&WC P/N 3373309-4, S/N 14040035. Please refer to photos No. 20 and 21.

Photo No. 20
Engine electronic control.

Photo No. 21
Engine electronic control data plate.

Autofeather Unit: Rosemont P/N 30048-0000-28 Rev D, P&WC P/N 30048-0000 Rev. A RE55, S/N RT3077. Please refer to photos No. 22 and 23.

Photo No. 22
Autofeather unit and torque sensor No. 1.

Photo No. 23
Autofeather unit data plate.

Data Collection Unit: Safran P/N 62133, P&WC P/N 3075879-0, S/N 14019276. Please refer to photos No. 24 and 25.

Photo No. 24
Data collection unit.

Photo No. 25
Data collection unit data plate.

3.3.3 **Inlet Temperature and Torque Sensing Systems**

Torque Sensor No. 1: P/N 3073471-02, S/N CH1282. Please refer to photo No. 22.

Torque Sensor No. 2: P/N 3073471-02,S/N CH1734. Please refer to photo No. 23.

Photo No. 26
Torque sensor No. 2.

3.3.4 **Performance Indicating System**

Nh Sensor (upper): P/N 3077761-01,S/N CH2610. Please refer to photo No. 27.

Nh Sensor (lower): P/N 3077761-01,S/N CH2595. Please refer to photo No. 28.

Photo No. 27
Nh sensor upper.

Photo No. 28
Nh sensor lower.

NL Sensor: P/N 3033509, S/N CH21092. Please refer to photo No. 29.

Photo No. 29
Nl sensor.

NP Sensor: P/N3077761-01, S/N CH2615. Please refer to photo No. 30.

Photo No. 30
Np sensor.

3.3.5 **Ignition System**

No ignition system components were removed.

3.3.6 **Air System**

No air system components were removed.

4. RIGHT HAND ENGINE HISTORY

PW127M S/N ED0814

Total Hours: 1624

Total Cycles: 2352

The engine was original installation on the subject aircraft. Review of the engine logbooks showed no unusual maintenance.

5. RIGHT HAND ENGINE EXAMINATION

All positional references in relation to view from aft looking forward. Upstream and downstream references are in relation to gas path flow from compressor inlet to exhaust.

5.1 External Condition

The engine was examined in the airframe nacelle as recovered. All quick engine change items and airframe nacelle to engine connections appeared to be intact, with water immersion damage. The propeller hub remained attached to the hub with the blade outer spans separated. The nacelle aft section and exhaust duct was separated.

5.1.1 External Cases

Reduction Gearbox: The housing was intact. The propeller shaft was intact. The reduction gearbox mounted controls and accessories were intact.

Front Inlet Case: The front inlet case was crushed and the reduction gearbox was forced aft and upward into the engine mount structure. The torque sensor No. 1 probe was deformed due to impact fracture of the inlet housing mounting boss. The autofeather unit lower canon plug boss was deformed by impact. The rest of the front inlet case mounted controls and accessories were in place and intact

Rear Inlet Case/Accessory Gearbox: Displayed no apparent impact damage. The accessory gearbox mounted controls and accessories were in place and intact.

Low Pressure Diffuser Case: Displayed no apparent impact damage.

Intercompressor Case: Displayed no apparent impact damage.

Gas Generator Case: Displayed no apparent impact damage.

Turbine Support Case: Displayed no apparent impact damage. The fuel nozzle manifold was intact.

Please refer to photos No. 31 through 37, 55 and 58.

Photo No. 31
Engine left hand view.

Photo No. 32
Engine right hand view.

Photo No. 33
Engine forward view.

Photo No. 34
Engine rear view.

Photo No. 35
Compressor inlet case. Autofeather unit and engine electronic control, in-situ.

Photo No. 36
Compressor inlet case, right hand side.

Photo No. 37
Exhaust duct and power turbines.

5.1.2 **Chip Detectors and Filters:**

Due to the flight data recorder information and post impact engine boroscope inspection showing no indications of any mechanical anomalies, the chip detectors and filters were not examined.

5.2 **Disassembly Observations:**

Due to the flight data recorder information showing no indications of any mechanical anomalies, the engine turbo machine was boroscope inspected in accordance with the P&WC engine maintenance manual by a technician from P&WC (S.E.A.) Ltd.

5.2.1 **Turbine Section:**

The turbine section components displayed no indications of any anomalies affecting normal operation, and all components observed showed normal running wear. All components showed water immersion damage. Please refer to photos No. 38 through 43.

Photo No. 38
Second stage power turbine.

Photo No. 39
First stage power turbine.

Photo No. 40
First stage power turbine vane ring.

Photo No. 41
Low pressure turbine.

Photo No. 42
High pressure turbine.

Photo No. 43
High pressure turbine vane ring.

5.2.2 **Combustion Section:**

The combustion section components displayed no indications of any anomalies affecting normal operation, and all components observed showed normal running wear. All components showed water immersion damage. Please refer to photo No. 44.

Photo No. 44
Combustion chamber liner.

5.2.3 **Compressor Section:**

The compressor section components displayed no indications of any anomalies affecting normal operation, and all components observed showed normal running wear. All components showed water immersion damage. Please refer to photos No. 45 and 46.

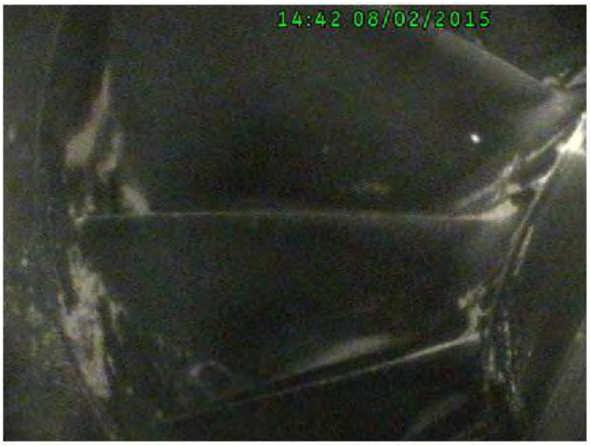

Photo No. 45
Low pressure impeller and shroud.

Photo No. 46
High pressure impeller.

5.2.4 **Reduction Gearbox:**

The reduction gearbox components displayed no indications of any anomalies affecting normal operation, and all components observed showed normal running wear. All components showed water immersion damage. Impact damage to the front inlet case prevented examination of the second stage spur gears. Please refer to photos No. 47 and 48.

Photo No. 47
Reduction gearbox helical input gearshaft and helical gear.

Photo No. 48
Reduction gearbox helical gear, detail.

5.2.5 **Accessory Gearbox:**

The accessory gearbox was not examined.

5.3 **Controls and Accessories Evaluation:**

On nacelle fault isolation for uncommanded autofeather in accordance with the PW127 engine maintenance manual showed the trim plug characterization, the No. 1 torque sensor continuity, and the autofeather unit to torque sensor continuity to be correct. Upon removal of the airframe harness canon plugs for the above checks both the torque probe and autofeather unit canon plugs showed slight water ingress to canon plug retaining collar. The connector pin seats appeared to be dry. The airframe harness was retained for separate investigation.

The following listed components were removed and forwarded to Transportation Safety Board Canada for routing to their respective vendors for investigation and analysis under the oversight of Transportation Safety Board Canada or the United States National Transportation Safety Board as appropriate.

5.3.1 **Hydromechanical Control System**

Due to the flight data recorder information showing no indications of any anomalies the hydromechanical control system, these components were not removed.

5.3.2 **Electronic Control System**

Propeller Electronic Control: Hamilton Sundstrand Model EPC100-1, P/N 816332-5-401, S/N 13080013. The unit was re-immersed in fresh water and packed sealed in water for shipping. Please refer to photos No. 49 and 50.

Photo No. 49
Propeller Electronic Control.

Photo No. 50
Propeller electronic control data plate.

Engine Electronic Control: Hamilton Sundstrand Model EEC132-190, P/N 1012974-002, P&WC P/N 3373309-4, S/N 13100020. The unit was re-immersed in fresh water and packed sealed in water for shipping. Please refer to photos No. 51 and 52.

Photo No. 51
Engine electronic control.

Photo No. 52
Engine electronic control data plate.

Autofeather Unit: Rosemont P/N 30048-0000-28 Rev D, P&WC P/N 3078166-01 S/N RT2362. The lower canon plug boss was deformed by impact. The unit was re-immersed in fresh water and packed sealed in water for shipping. Please refer to photos No. 53 through 55.

Photo No. 53
Autofeather unit.

Photo No. 54
Autofeather unit data plate.

Photo No. 55
Autofeather unit torque sensor canon plug fitting.

Data Collection Unit: Safran P/N 62133, P&WC P/N 3075879-0, S/N 13014743. Please refer to photos No. 24 and 25.

Photo No. 56
Data collection unit.

Photo No. 57
Data collection unit data plate.

5.3.3 **Inlet Temperature and Torque Sensing Systems**

Torque Sensor No. 1: P/N 3073471-01, S/N CH1468. Please refer to photo No. 58 and 59.

Photo No. 58
Torque sensor No. 1, in situ.

Photo No. 58
Torque sensor No. 1.

Torque Sensor No. 2: P/N 3073471-02,S/N CH1457. Please refer to photo No. 59.

Photo No. 59
Torque sensor No. 2.

5.3.4 **Performance Indicating System**

Nh Sensor (upper): P/N 3077761-01,S/N CH2108. Please refer to photo No. 60.

Nh Sensor (lower): P/N 3077761-01,S/N CH2106. Please refer to photo No. 61.

Photo No. 60
Nh sensor upper.

Photo No. 61
Nh sensor lower.

Nl Sensor: P/N 3033509, S/N CH20768. Please refer to photo No. 62.

Photo No. 62
Nl sensor.

NP Sensor: P/N3077761-01, S/N CH2128. Please refer to photo No. 63.

Photo No. 63
Np sensor

5.3.5 **Ignition System**

No ignition system components were removed.

5.3.6 **Air System**

No ignition system components were removed.

6.0 **CLOSING**

These factual notes are based upon observations made on 7-8 February 2015, and may be altered or corrected on the basis of further analysis or information.

PRATT & WHITNEY CANADA CORP.
Thomas A. Berthe
Service Investigation
12 February 2015

Appendix 2. Field Notes, Examination of Autofeathering

A. OCCURENCE

Location: Taipei, Taiwan
Date: February 4, 2015
Time: 1054 (local)
Aircraft: ATR72-212A ver 600 Reg. No. B -22816 TransAsia Airways flight GE235

B. PARTICIPANTS

Name	Representing
XXXXX	ASC, Taiwan
XXXXX	BEA, France
XXXXX	NTSB, USA
XXXXX	Transport Canada
XXXXX	TransAsia Airways
XXXXX	ATR
XXXXX	ATR
XXXXX	PWC
XXXXX	PWC
XXXXX	UTAS
XXXXX	UTAS
XXXXX	UTAS

C. SUMMARY

On February 04, 2015, TransAsia Airways (TNA) passenger flight GE235, an ATR72-212A aircraft, took off from Taipei bound for Kinmen. Just after take-off, the No. 2 engine propeller was feathered automatically. About 40 second later, engine No. 1 was manually shutdown. The aircraft crashed into Keelung River of Nankang section at 1053 Taipei time.

The UTAS Rosemount Aerospace autofeather units (AFUs) removed from the occurrence aircraft, and another AFU removed from an ATR72 aircraft that experienced an uncommanded autofeather event following the GE235 occurrence were tested at UTAS Rosemount Aerospace facilities in Eagan/Burnsville, Minnesota April 8 – 11, 2015.

D. HARDWARE

Removed from B-22816

S/N	P/N	POS	J2 DOM (lot no.)	TSN / CSN
RT3077	30048-0000-28	1	1301	826 / 1,236
RT2362	30048-0000-28	2	1315	1,624 / 2,352

Removed from B-22806

S/N	P/N	POS		TSN / CSN
RT2354	30048-0000-28	1	1315	1,180 / NP

E. OBSERVATIONS

CMM testing

Testing was performed in accordance with P/N 30048-0000-* CMM, Testing and Fault Isolation, 73-20-03R11. Detailed test data sheets are provided in a separate document.

AFU	RT3077	RT2362	RT2354
Continuity	NFF	Pin H ; Pin J (See Note 1.)	Pin J (See Note 1.)
Function	NFF	Not possible to	NFF

		complete (See Note 2.)	
Thermal cycle	NFF	-----	NFF
Vibration	NFF	-----	-----

Note 1 : A continuity failure was located at the end of the ribbon inside the 90° connector.
Note 2 : A short occurred approximately 10 minutes into the test.

Special tests

A test to more closely emulate the torque transducer operating voltage levels and temperatures was performed using AFU RT2354. 25V square wave was applied using CONFIG 1 and CONFIG2 (See Table). No leakage was found in either configuration.

	33 (H)	34 (J)	35 (U)
CONFIG 1	I	M	
CONFIG 2	M	I	M

I-input M-monitored

F. FURTHER ACTION

RT3077
No further investigation required. This AFU will be secured at UTAS until further notice.

RT2362
Repair of the 5v rail was discussed and the group decided against it.
The following destructive testing was proposed/recommended:
1. Perform 500v dielectric test
2. Section J2 ribbon/flex circuit 90° (“header strip”)
The work will be performed at UTAS Rosemount Aerospace. UTAS will submit a proposed protocol to the ASC for approval.

RT2354 (incident unit)
This unit is not evidence retained in connection with the GE235 occurrence. The same work recommended for RT2362 is also recommended for RT2354.

Appendix 3. Technical document, Cable TQ sensor – AFU engine 1 & 2, X-Ray and macroscopic examination report

BEA2015-0039_tec08
Date of issue 20/03/2015

Technical document

Cable TQ sensor - AFU engine 1 & 2

X-Ray and macroscopic examination report

Accident on **04/02/2015**
at **Taipei (Taiwan)**
to the **Aeroplane ATR - ATR72 - 200 - 212A (ATR72-600)**
registered **B-22816**
operated by **Transavia**

BEA

Bureau d'Enquêtes et d'Analyses
pour la sécurité de l'aviation civile

Ministère de l'Ecologie, du Développement durable et de l'Energie

Foreword

This document and the photographs and technical information contained herein are subject to the laws relating to communication and confidentiality embodied in European Regulation 996 of 20 October 2010.

The conclusions of this document are based on the work undertaken by the BEA (Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile). They should not be used to prejudge the final conclusions of the safety investigation.

Contents

Glossary

AFU	Auto Feather Unit
TQ	Torque

1 - EQUIPEMENT EXAMINED

Following the accident of the ATR 72-212A registered B-22816, the following devices were sent by the ASC to the BEA.

	Cable TQ sensor 1- AFU engine 1	Cable TQ sensor 1- AFU engine 2
		
Manufacturer	ATR	ATR
Part number	44KF1-A	44KF2-A
ASC identification (Exm. Id)	65	66

For the investigation process, it was requested to check the cable in a non-destructive means. An X-Ray examination and a macroscopic examination were performed.

1.1. Connectors references

Figure 1: AFU connector

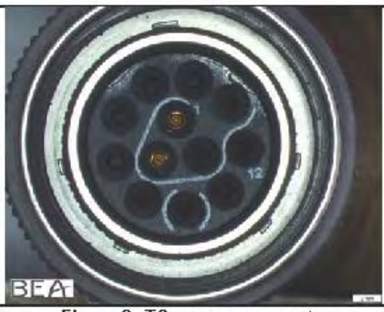

Figure 2: TQ sensor connector

The connection between the TQ sensor and the AFU is made through:
- pin N°1 and pin N°2 on the TQ sensor connector
- pin H and pin J on the AFU connector

2 - RESULTS

2.1. X-Ray examination

No defect was found on the cables:

- No wire damage/disruption
- Connection done between the female pin connectors and the wires on both end of the cable

The X-Ray pictures taken during this examination are provided in Appendix 1.

2.2. Macroscopic examination

The macroscopic examination showed a difference between the pin H of AFU connector on cable 2 and the other pins on this connector.

The following picture was taken with a magnification of 15.

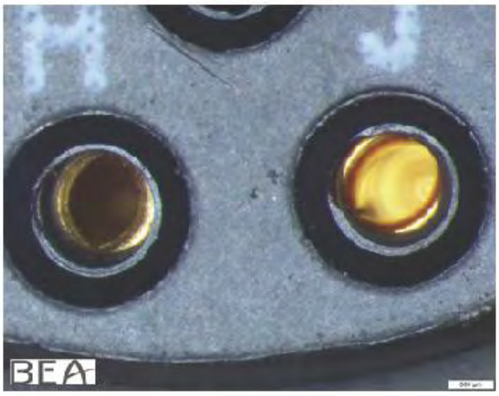

Figure 3: Pin H and J

The following pictures were taken with a magnification of 35.

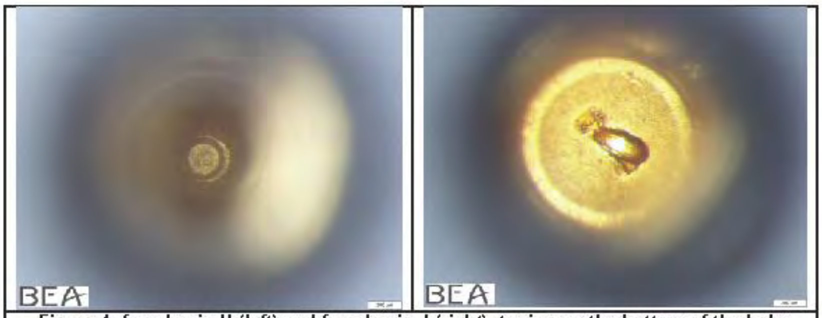

Figure 4: female pin H (left) and female pin J (right), tuning on the bottom of the hole

Pictures of the female pin H of cable 1 and the female pin 1 of TQ sensor (cable 2) were taken.

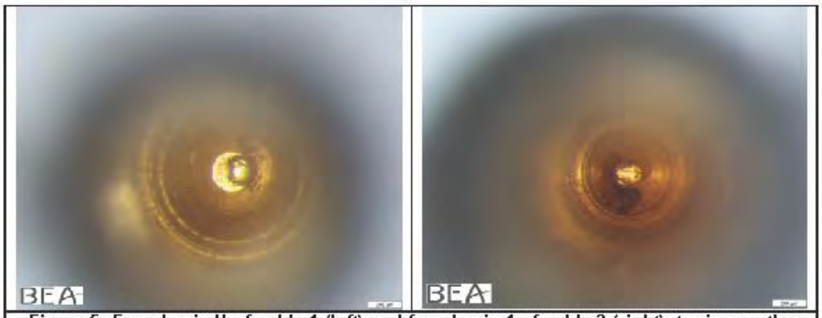

Figure 5: Female pin H of cable 1 (left) and female pin 1 of cable 2 (right), tuning on the bottom of the hole

All these macroscopic views do not allow us to conclude.

2.3. Additional examinations possibilities

All the additional proposed examinations may be considered as destructive examinations.

- Socket disassembly
  - Open the socket
  - Remove of the female pins from the connector
- Microscopic examination
  - Preparation of a longitudinal section of:
    - pin H
    - pin J
    - pin 1
  - Dimensional computation
  - Raw material determination.

Appendix 1. ***X-RAY EXAMINATION PICTURE***

X-Ray examination creates a 2 dimensional picture of the examined object. Depending on the raw material the X-Ray beam goes through, the voltage shall be adapted to spot the desired item. This does not allow taking picture of wire continuity when the surrounding raw material of the wire changes (e.g. when the cable crosses the boundary of a connector).
The continuity is then checked by the X-Ray machine operator, by increasing step by step the voltage.

A1.1. ***Cable picture***

Figure 6: typical RX picture of the cable between the 2 connectors

Both cables RX examination provide the same result. No defect was detected on these cables.

A1.2. ***Cable 1 (ASC identification: exm. Id. 65)***

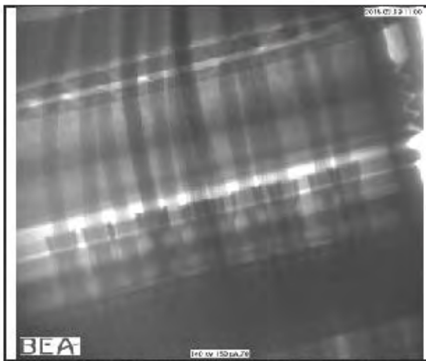

Figure 7: AFU female connector with the connections wire/female pins	Figure 8: AFU connector: location of the connected pins

A1.3. *Cable 2 (ASC identification: exm. Id. 66)*

TQ sensor connector

Figure 9: TQ sensor connector

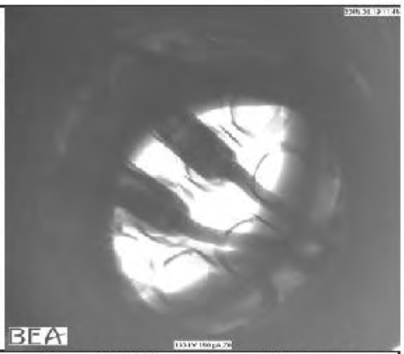

Figure 10: tilt view of the TQ sensor connector

Only 2 female pins are connected to wires (pins 1 and 2). No trouble with these connections was detected by this examination. The other holes of the connector are empty.

AFU connector

Figure 11: AFU connector

Figure 12: view of the AFU connector

Inside the AFU connector, 15 female pins are connected to wires. Their references are: A-B-E-F-H-J-N-P-R-S-U-W-a-b-c. No trouble with these connections is detected by this examination.
The other holes of the connector are empty (references: C-D-G-K-L-M-T-V-X-Y-Z).

BEA

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Appendix 4. Test results of torque and speed sensors

No. 1 engine			
Accessary	P/N	S/N	Result
Torque sensor left	3073471-01	CH1282	Satisfactory
Torque sensor right	3073471-02	CH1734	1. Resistance check below minimum limit of 40 mega-ohms (note 1) 2. Test point voltage slightly below minimum limit of 1.5 volts
Np speed sensor	3077761-01	CH2615	1. Three resistance checks below minimum limit of 100 mega-ohms (note 1) 2. Resistance at each coil and between the coils and the housing was within limits but fluctuating (note 2). 3. One of the wires was detached from the pin.
Nh speed sensor (lower)	3077761-01	CH2595	1. Three resistance checks below minimum limit of 100 mega-ohms (note 1)
Nh speed sensor (upper)	3077761-01	CH2610	1. Resistance check below minimum limit of 100 mega-ohms
Nl speed sensor	3033509H	CH21092	Satisfactory
No. 2 engine			
Accessary	P/N	S/N	Result
Torque sensor left	3073471-02	CH1468	1. Open circuit exited in a coil winding resistance check. 2. Three test point voltages at different RPM settings were below minimum limit of 1.5/8.9/8.9 volts. 3. Voltage was erratic

			throughout this series of tests.
Torque sensor right	3073471-02	CH1457	1. Two test point voltages at different RPM settings were slightly below minimum limit of 1.5/8.9 volts.
Np speed sensor	3077761-01	CH2128	Satisfactory
Nh speed sensor (lower)	3077761-01	CH2106	Satisfactory
Nh speed sensor (upper)	3077761-01	CH2108	Satisfactory
Nl speed sensor	3033509H	CH20768	Satisfactory
Note 1. This test point was repeated after heating the sensor at 100° C then allowing it to cool to room temperature resulting in acceptable resistance. 2. Following heating of the sensor to 100° C and allowing it to cool to room temperature there were no open circuit existed.			

V. Attachment

1. V-3000/15 - GE235 Answer to Action Log Revision #4 Toulouse, May 19th 2015
2. B-22816 Occurrence-Site Wreckage Field Notes
3. Technical document, AFUs tests, BEA2015-0039_tec10, 12/04/2015
4. AFU INVESTIGATION Document Number D06429311, Non Technical Rev A
5. Technical document, Computer MFC 1 and computer MFC 2 Memories readout, BEA2015-0039_tec11, 16/04/2015
6. Records of EEC, PEC NVM data downloads
7. ACCESSARIES ACCIDENT REPORT, document number RFA No 15ECN00082 SI File No: 15-006
8. Service Bulletin, P&WC SB No. 21742R2, Apr 01, 2011
9. Service Information Letter, P&WC SIL No. PW100-138, December 14, 2010
10. Service Information Letter, P&WC SIL No. PW100-147, September 26, 2011
11. Wreckage structure database
12. Wreckage LRUs database

Aviation Safety Council

Taipei, Taiwan

GE235 Occurrence Investigation
Factual Data Collection
Group Report

ATC/Weather Group

July 2, 2015

ASC-FRP-15-07-004

I. Team Organization

Chairman:
Kuo-Chih Chang Aviation Safety Council
Members:
1 Chih-Ting Hsu Chief, Air Traffic Services Management Office, ANWS, CAA, MOTC
2. Wei-Chun Chang Controller, Air Traffic Services Management Office, ANWS, CAA, MOTC
3. Shih-Ping Hsiung Section Chief, Air Traffic Services Division, CAA, MOTC

(i) MOTC - Ministry of Transportation and Communication

(ii) CAA - Civil Aeronautics Administration

(iii) ANWS - Air Navigation and Weather Services

II. History of Activities

Date	Activities
Feb. 4, 2015	1. Collected initial weather information. 2. Arranged Interviews of the airport tower. 3. Obtained ATC radio and hotline communication recordings and transcripts. 4. Obtained MSTS track data, flight plan & NOTAM
Feb. 5, 2015	1. Observed the recovery of wreckage at occurrence site. 2. On duty at air disaster central response center. 3. Interviewed the supervisor and local controller of Songshan Tower.
Feb. 6, 2015	1. Prepared request of documents/data list and sent to CAA. 2. Reviewed ATC recordings.
Feb. 7, 2015	1. Wrote interview notes. 2. Reviewed weather information.
Feb. 8, 2015	1. Finished interview notes. 2. Reviewed ATC communication transcripts.
Feb. 9, 2015	1. Interview notes translation. 2. Checked and synchronized the ATC radio & hotline communication transcripts.
Feb. 10, 2015	1. Obtained and reviewed documents/data from CAA.
Feb. 11, 2015	1. Translation of the ATC hotline communication transcripts and interview notes.

III. <u>Factual Description</u>

[Note: Paragraphs 1.1-1.6, 1.10-1.17 are covered in other Group Reports.**]**

1.7 Weather Information

Aerodrome routine meteorological report (METAR) of Songshan airport after the occurrence is as follows:

METAR at 1100 hours, wind from 100 degrees at 10 knots, visibility greater than 10 kilometers, few clouds at 1,500 feet, broken at 2,800 feet, broken at 4,000 feet, temperature 16℃; dew point temperature 13℃, altimeter setting 1024 hPa, trend forecast-no significant change, Remarks: altimeter setting 30.25 in-Hg

There was no low level wind shear detected around the time of the occurrence.

1.8 Aids to Navigation

There were no reported difficulties with navigational aids along the GE235 flight path.

1.9 Communication

The frequencies used by Songshan tower are 121.9 and 118.1 MHz. The ATC radio and hotline communication transcripts are shown in appendix 1.

1.18 Additional Information

1.18.1 Interview Summaries

1.18.1.1 The Local Controller of Songshan Tower

The interviewee was on the local controller shift from 1030 hours and the work load was moderate to light. Around the time of occurrence, visibility was greater than 10 km but there were some patches of low-level clouds to the east of the airport. Because of a landing aircraft approached to Runway 10, the GE235 was instructed to hold short of the runway initially. The process from entering runway to take-off was normal. The interviewee then instructed GE235 to change frequency to

Taipei Approach after it climbed through 1,000 feet right after passing the end of the runway. She directed her attention to the other aircraft and vehicles after the pilot read back and everything continued as normal. Afterwards, Taipei Approach called “tower transfer transasia two tree five again” via loud speaker and GE235 called her simultaneously. The sound from the loud speaker was louder so the interviewee didn’t hear what the pilot said through her headphone. The interviewee instructed GE235 to contact Taipei Approach again when she thought there was a communication problem, but no answer received. Taipei Approach asked her if she saw the aircraft, she then observed the departure route but found nothing. Afterwards she discovered that the tracking of the occurrence flight on the radar display did not coincide with the normal flight path of Mucha departure and there was no indication of its altitude, even Taipei Approach couldn’t contact GE235, so the interviewee began to call it several times but got no response. Because the situation of the occurrence flight was unknown, she informed Taipei Approach and the supervisor of the status quo, and then she was ordered to suspend take-off and landing operation, and proceeded with accident notification procedures by directives from her supervisor.

1.18.1.2 The Supervisor of Songshan Tower

The interviewee was on duty from 0800 hours to 1800 hours. Before the occurrence, he was dealing with paper works and his work load was close to light, in the meantime his fellow colleagues were working normally. While the local controller performing the duty, he heard from loudspeaker (on the right of the local controller and front right side of him) that there was no contact from GE235 and Taipei Approach requested the local controller to transfer it again. He immediately got up to look for the traffic, and asked the take-off status of the occurrence aircraft. The local controller replied the aircraft had taken off. The interviewee roughly remembered that the position of occurrence flight appeared on the radar display for a while (but it was not stable), and he was not very sure about this. In addition to the runway extension lines, he also observed the whole area of the airport, he could not found the occurrence flight. According to the narrative of the local controller, in order to determine whether the aircraft was in the airport, he immediately requested the local controller to call the aircraft at channel 118.1 continuously, and he called by the emergency channel and observed the airport and its surroundings with a telescope. There was still no reply during the broadcast of the call, the interviewee considered this situation as an emergency and instructed the local controller to stop the next aircraft entering the runway from take-off, and carry on the observation and broadcast. At that time, there was a controller under familiarization training beside him, so he asked that controller to inform the tower chief at the 4th Floor. Due to the departure route might overlap with the accident site and not knowing the exact location of GE235 (due to situation unknown), the interviewee asked his colleagues to suspend aircraft take-off and landing, and began to clear the airspace through notification. He then examined the airport and its surroundings again by telescope, and asked his colleague to notify Flight Operations Office to conduct a runway inspection to see if the runway could be operational.

The visibility was more than 10 kilometers as per the weather report at that time, but he observed the clouds were not very high. After the airport resumed normal operation for take-off and landing, the observation of departure aircraft was not in sight (in clouds) within one minute from take-off rolling.

IV. Appendices

Appendix 1: The ATC radio and hotline communication transcripts

GC: Ground Controller of Songshen Tower
LC: Local Controller of Songshen Tower
GE235: GE235 pilots
SP: Supervisor of Songshen Tower
WR: West Songshen Radar Position Controller of Taipei Approach
WM: Songshen Monitoring Position Controller of Taipei Approach
NM: North Taoyuan Monitoring Position Controller of Taipei Approach
Note: shaded columns indicate the hotline communications between Songshen Tower and Taipei Approach

TIME	COM.	CONTENTS
1034:28	GE235	songshan ground good morning transasia two tree…uh five at bay one two request start … uh flight level one four zero to kinmen with sierra
1034:38	GC	transasia two tree five songshan ground copy clearance cleared to sandy d m e fix via mucha two quebec departure whiskey six maintain five tousand squawk four six zero two
1034:51	GE235	cleared to sandy via mucha two quebec departure …uh join whiskey six maintain five tousand squawk four six zero two transasia two tree five
1034:59	GC	transasia two tree five clearance read back correct
1040:51	GE235	songshan ground transasia two tree five bay one two request start up and push back
1040:55	GC	transasia two tree five start up and push back approved runway one zero
1040:59	GE235	start up and push back approved runway one zero transasia two tree five
1044:59	GE235	songshan ground transasia two tree five request taxi
1045:01	GC	transasia two tree five runway one zero taxi via whiskey
1045:05	GE235	taxi via whiskey to runway one zero transasia two tree five
1045:52	GC	transasia two tree five contact tower one one eight decimal one good day
1045:55	GE235	contact tower one one eight one transasia two tree five good day

1046:06	GE235	songshan tower good morning transasia two tree five taxi with you
1046:10	LC	transasia two tree five songshan tower due to initial separation hold short runway one zero for landing traffic
1046:16	GE235	hold short runway one zero transasia two tree five
1050:09	LC	transasia two tree five line up and wait runway one zero
1050:12	GE235	line up and wait runway one zero transasia two tree five
1050:14	LC	復興兩三五 起飛五兩 *[transasia two tree five take off at five two]*
1050:17	WR	好 *[okay]*
1051:13	LC	transasia two tree five runway one zero wind one zero zero degrees niner knots cleared for takeoff
1051:19	GE235	cleared for takeoff runway one zero transasia two tree five
1052:34	LC	transasia two tree five contact taipei approach one one niner decimal seven good day
1052:38	GE235	one one niner seven transasia two tree five good day
1053:35	GE235	tower transasia two tree five mayday mayday engine flame out
1053:37	WR	塔臺 復興兩三五再換 *[tower transfer transasia two tree five again]*
1053:39	LC	transasia two tree five please try again contact taipei approach one one niner decimal seven
1053:44	LC	我再換一次給你 *[i transfer it to you again]*
1053:47	WR	好 謝謝 *[okay thanks]*
1054:08	WM	塔臺你有看到復興兩三五嗎 *[tower do you see transasia two tree five]*
1054:14	LC	我看不到實機 *[i cannot see the aircraft]*
1054:33	WM	塔臺 你再幫我叫一下復興兩三五 *[tower please help me to call transasia two tree five again]*
1054:35	LC	叫 叫他 然後呢 *[call call him and than]*

1054:38	WM	和他確認一下叫他換近場臺啊 他高度一直往下掉 *[confirm with him and instruct to contact approach he is losing altitude]*
1054:41	LC	transasia two tree five songshan tower
1054:47	LC	transasia two tree five songshan tower
1054:53	LC	教官我叫不到復興兩三五 *[sir i cannot contact transasia two tree five]*
1055:03	LC	transasia two tree five songshan tower
1055:12	NM	塔臺 approach 復興兩三五剛剛有滾行嗎 *[tower approach did transasia two tree five have rolling take off a moment ago]*
1055:15	LC	有有有 *[yes yes yes]*
1055:16	NM	然後咧 *[and than]*
1055:17	LC	有爬到高度么千 有有換出來 *[climbed to one thousand and was handed off]*
1055:20	NM	他有跟你講話是嗎 *[did he speak with you]*
1055:22	NM	叫不到他耶 *[i cannot contact him]*
1055:23	LC	我現在也叫不到他 *[i also cannot contact him now]*
1055:24	NM	OK
1055:58	WR	你們也叫一下復興哦 *[please call the transasia too]*
1056:05	LC	transasia two tree five songshan tower
1056:09	LC	transasia two tree five songshan tower
1056:20	LC	教官我還是叫不到他 *[sir i still cannot contact him]*
1056:23	NM	所以他剛剛有爬到一千多 *[so he did climbed to more than one thousand a moment ago]*
1056:25	LC	有 *[yes]*

1056:26	NM	完全看不到 完全 coast 掉了 *[connot see him entirely has been coasted entirely]*
1056:33	NM	塔臺 guard 波道叫叫看啊 謝謝 *[tower try to call him by guard channel thanks]*
1056:47	LC	transasia two tree five songshan tower
1056:53	LC	transasia two tree five songshan tower
1057:09	WR	塔臺 approach *[tower approach]*
1057:11	LC	請 *[go ahead]*
1057:11	WR	取消自動放行 *[cancel auto release]*
1057:12	LC	好 *[okay]*
1057:13	WR	好 *[okay]*
1057:14	SP	我們持續的呼叫啦 厚 阿你那邊也叫一下 *[we continue to call him oh you call him too]*
1057:38	NM	塔臺 approach 妳不要再放起飛的了 先暫停 暫停放行 喔 *[tower approach please don't release take-off suspend release oh]*
105743	SP	取消自動放行 我們先等一下 看一下情況再跟你講喔 *[cancel auto release we wait a while look at the situation and then tell you oh]*
1059:09	SP	欸 哈囉 *[hey hello]*
1059:12	WR	請 是 *[go ahead]*
1059:13	SP	欸那個我們叫不到啦 厚 *[hey we cannot contact him oh]*
1059:15	WR	教官你們叫他換的時候有回你們嗎 *[sir did he read back when you instructed him to change frequency]*
1059:17	LC	有 有 *[yes yes]*
1059:17	SP	有他有回 *[he did read back]*

1059:18	WR	他有回是不是 *[he did read back yes or no]*
1059:19	SP	有換走 換么么 *[has been transferred transferred to one one]*
1059:20	WR	因為沒有來我們這裡 *[because he didn't contact us]*
1059:21	SP	蛤 *[what]*
1059:22	WR	我們 他們沒有跟我們聯絡 我們也叫不到他 *[we they didn't contact us we cannot contact him]*
1059:24	SP	好 好 *[okay okay]*
1059:24	WR	對 *[right]*
1059:25	SP	OK 好
1059:24	WR	好 *[okay]*
1104:38	NM	塔臺 approach 請問跑道有可以正常進去嗎 航務有出來巡跑道嗎 *[tower approach could the runway be entered normally does the flight operations go checking the runway]*
1104:46	LC	教官 我問一下好了 *[sir i ask for it]*
1104:47	NM	好 謝謝 *[okay thanks]*
1105:11	LC	approach 塔臺 *[approach tower]*
1105:12	WR	請講 *[go ahead]*
1105:13	LC	教官我們請航務組出來巡 預計要等五分鐘 *[sir we ask the flight operations to go checking the runway expected to wait five minutes]*
1105:18	WR	要等五分鐘 好 *[wait five minutes okay]*
1107:13	SP	Approach 塔臺 *[approach tower]*
1107:16	NM	請講

		[go ahead]
1107:17	SP	那個我們請航務組做場面最後確認 那沒有問題跑道就開放會儘快通知你 *[we ask the flight operations office to do the final surface confirmation if there are no problems the runway will be open will tell you soon]*
1107:23	WR	暫時不進去嘛喔 *[not to enter temporarily oh]*
1107:24	SP	唉 對 先暫時 對 不好意思 *[alas yes temporarily sorry]*
1107:28	WR	好 *[okay]*
1109:49	LC	Approach 塔臺 跑道現在開放 *[approach tower the runway is open now]*
1109:53	WR	好 *[okay]*
1109:59	LC	Approach 塔臺 是否恢復自動放行 *[approach tower could auto release be resumed]*
1110:03	WR	好 *[okay]*
1110:31	WR	塔臺 approach *[tower approach]*
1110:32	LC	請 *[go ahead]*
1110:33	WR	那個 放行還是先暫停 等確切的消息 *[suspend release wait for the exact message]*
1110:40	LC	教官 那要等多久 *[sir how long]*
1110:42	WR	等塔臺長告訴我們 *[wait for the chief]*
1110:44	LC	好 好 *[okay okay]*

Attachments

No	Item
3-1	The telephone communication recordings between Songshen tower and Taipei approach
3-2	ATC recordings and transcripts of GE235
3-3	Interview recordings
3-4	Air Situation Display videos and screen captures
3-5	72hrs. rosters of the Songshen tower controllers
3-6	The work reports and duty logs of the Songshen tower controllers
3-7	GE235 Flight plan
3-8	Songshen airport ATIS recordings and transcripts
3-9	NOTAMs of Songshen airport
3-10	ATC general operations manual
3-11	Taipei Approach operations manual
3-12	Songshen Tower operations manual
3-13	AIP Taipei FIR
3-14	METAR/SPECI and TAFs
3-15	AWOS records of Songshen airport
3-16	Central Weather Bureau weather radar data
3-17	AIRMETs
3-18	SIGWX charts
3-19	Satellite images
3-20	Weather analysis charts

Note: Attachments 5-4 to 5-20 are currently not cited in the report. These may be used as future references for the investigation.

Aviation Safety Council

Taipei, Taiwan

GE235 Occurrence Investigation
Factual Data Collection
Group Report

Flight Recorders Group

July 2, 2015

ASC-FRP-15-07-005

Contents

I. Team Organization

Chairman:
GUAN, Michael /Aviation Safety Council, Taiwan
Members:
1 CHUANG, Eric / Aviation Safety Council, Taiwan
2 KUO, Brian/ Aviation Safety Council, Taiwan
3 JIH, Richard / Aviation Safety Council, Taiwan
4 CHEN, Martin / Aviation Safety Council, Taiwan
5 DENIS, Henri / (Bureau d'Enquêtes et d'Analyses, France)
6 HUANG, Mango /TransAsia Airways
7 WU, Shi Hong /TransAsia Airways

II. History of Major Activities

Date	Activities
02/04	On scene tasks: 1. 1140 Go team launched. 2. 1220 Arrived at crash site. 3. 1250~1420 Performed site survey at Huan-Dong Blvd. 4. 1430~1530 Performed site survey at the main crash site. 5. 1540~1630 Retrieved both recorders from the tail section 6. 1630~1730 Arranged a ground vehicle and transported both recorders to ASC Lab. Lab tasks: 1. 1400~1500 Contacted Air Navigation and Weather Services for GE235 radar track data. 2. 1530~1630 Contacted TNA, and requested two serviceable recorders (FDR and CVR). 3. 1630~1700 Processed GE235 radar track and converted it into a KML format. 4. 1730~1800 Prepared L-3 AIK and golden chassis for readout 5. 1800~1930 Utilized high compression air and an oven to clean and dry the PCB, CMSU of both recorders. 6. 1930~2100 Utilized the L-3 AIK and a CVR chassis (2100-1020-02) to download the CVR raw data. 7. 2000~2100 Utilized the L-3 AIK and a FDR chassis (2100-4045-00) to download the FDR raw data. 8. 2100~2240 Readout and CVR and FDR data quality check. 9. 2240~2300 Wrap-up for the day and discussion.

02/05	On scene tasks: 1. 1000~1200 Observed, photographed and tagged wreckages on the site. 2. 1400~2000 Escorted the wreckage moving to trucks. 3. 2000~2100 Transported all wreckages to air force base at Songshan Airport. Lab tasks: 1. 0600~0800 Synchronized timing of CVR and FDR with ATC timing system 2. 0800~0900 Released confirmed FDR engineering data to IIC/ Deputy IIC and FlightOps group (noted as version 1) 3. 0900~1200 Cross-checked CVR audio and FDR VHF keys, confirmed the result of the timing system. 4. 0930~1000 Generated FDR data plots - Longitudinal, Lateral, Engine, and Electric related parameters. 5. 1000~1200 Presented the CVR/FDR readout findings to ARs 6. 1400~1800 Continued to confirm the reading parameters, cross-check flight paths 7. 1600~1800 Drafted CVR transcript. 8. 1800~2200 Meeting with IIC, Deputy IIC, BEA advisors.

02/06	On scene tasks: 1. 1330~1630 Worked together with TNA engineers to observe, photographed and tagged wreckages in the storage site. Brought both MFC computers back to ASC. 2. 1800~2200 Created a spreadsheet for wreckages database and keying the data into the database. Lab tasks: 1. 0600~0900 Cross-checked CVR warning sound and FDR data. 2. 0900~1100 Organizational meeting and recorder group meeting. 3. 1000~1100 Discussed engine autofeather issue with ARs. 4. 1100~1200 Prepared CVR summary for press conference. 5. 1300~1400 Prepared FDR summary for press conference. 6. 1500~1700 Press conference. 7. 1700~1800 CVR-FDR data cross-check and correction. Released the confirmed FDR engineering data to IIC/ Deputy IIC and FlightOps group (noted as version 2) 8. 1800~2130 Meeting with IIC, Deputy IIC, BEA advisors.

02/07	On scene tasks: 1. 1000~1230 Combined the site-survey data into the wreckage database. 2. 1300~1700 Added hyperlinks with the wreckage photos into the database. Lab tasks: 1. 0700~0900 Cross-checked the FDR DB and readout values. Released the confirmed FDR engineering data to IIC/ Deputy IIC and FlightOps group (noted as version 3) 2. 0900~1000 Progress meeting and flight recorders meeting. 3. 1000~1230 Drafted CVR transcript. 4. 1000~1500 Based on recorded Lat./Long. to generating Google Earth-based animation with event tags. 5. 1100~1500 Discussed with BEA investigators, to create the sequence of event for IIC/Deputy IIC. 6. 1340~1700 Drafted CVR transcript. (Last 4 min) 7. 1340~1700 Site-survey data mapping. 8. 1500~1700 Released the confirmed FDR engineering data (noted as version 4) 9. 1600~1730 Discussed with BEA investigators and IIC/Deputy IIC about dashcam video to check the anti-collision lighting in the last frame of the video.

02/08	On scene task: 1. 1330~1630 Assisted Airworthiness Group at the wreckage storage site to collect relevant on-board computers, and transported to ASC Lab. Lab tasks: 1. 0700~0900 Cross-checked FDR data, verified FDR DB and readout values. 2. 0900~1000 Progress meeting and flight recorders group meeting. Presented the CVR/FDR sequence of event to the investigation team. 3. 1000~1100 Discussed with ATR, BEA investigators about the ATPCS system logic and FDR recording parameters. 4. 1100~1200 Flushed and immersed MFCs & EECs in a clean water tank. 5. 1100~1330 Confirmed FSK time of CVR 6. 1300~1500 Checked the entire of FDR data. It contained 70 previous flights. Checked to see if any engine feather condition existed. 7. 1330~1600 Drafted CVR transcript. (Last 10 min) 8. 1100~1230 Finished the wreckage database with wreckage photos associated, and then submitted the result to the wreckage recovery group. 9. 1300~1630 Finished site-survey data mapping with lower resolution satellite image. 10. 1500~1730 Verified invalid recording data in the FDR, and consulted with ATR technical advisor.
02/09	Lab tasks: 1. 0900~1000 Progress meeting and flight recorders group meeting. 2. 1000~1830 Teardown, water cleaned and documented relevant NVMs: CAC-1, CAC-2, DU 1-5,MPC x1, MFC x2, ATPCS panel, target speed panel x 2. 3. 1100~1200 CVR sound and dashcam video superposition analysis 4. 1400~1800 CVR transcript verification. 5. 1630~2030 Observed and photographed AFU part.

02/10	Lab tasks: 1. 0900~1000 Progress meeting and flight recorders group meeting. 2. 1000~1200 Documentation of the NVMs, prepared shipping for further examination at TSB and BEA 3. 1000~1250 CVR transcript verification. (1051:12.7~1054:36.6) 4. 1300~1500 Photographed & documented the NVMs & ENG no.1, no.2 LRUS with Wreckege_ID & Examination Database. 5. 1500~1700 Joined the investigation team to discuss the function of ATPCS, along with FDR recorded data. 6. 1400~1700 Observed and photographed AFU part.
02/11	Lab tasks: 1. 0900~1000 Progress meeting and flight recorders group meeting. 2. 1000~1500 Drafted CVR transcript (first 10 minutes.) 3. 1000~1200 Assisted IIC to prepare factual information for CAAC team briefing. 4. 1000~1200 Amended the wreckage examination database, and packed examined items into pelican cases, and arranged them for shipping to BEA and TSB. 5. 1330~1500 Prepared official document to request DSM, DTM, and aerial photos. 6. 1330~1500 Used Dashcam videos to reconstruct GE235 flight track and attitudes. 7. 1500~1800 Packed the wreckage examination items.
02/12	Lab tasks: 1. 0900~1500 Used Dashcam videos to reconstruct GE235 flight track and attitudes. 2. 0900~1700 Packed the wreckage examination items. 3. 1000~1100 Visited NASC to request aerial photo and video information from two rescue helicopters.

02/13	Lab tasks: 1. 0830~1200 Prepared shipping document for wreckage examination. 2. 0900~1500 Used dashcam videos to reconstruct the impact sequence. 3. 1000~1700 Backuped all of the group's factual information, and collected all of data into DVDs. 4. 1330~1530 CVR transcript verification. (the first 10 min) 5. 1330~1500 Prepared the shipping document for wreckage examination. Packaged the engine components into pelican cases.
03/03 ~ 03/05	Lab tasks: 1. 0900~1500 Processed the precise digital terrain data and aerial photos to superposed with GE235 flight path.

III. Factual Description

1.11 Flight recorders

Both Cockpit Voice Recorder (CVR) and Flight Data Recorder (FDR) of the occurrence aircraft were recovered by ASC investigators in Keelung River (Figure 1.11-1) at 1605 hrs on Feb. 4th. Upon the first inspection by ASC investigators, it was found that there was no external damage on both recorders but immersed with water. The photo of CVR and FDR was shown in Figure 1.11-2.

Both recorders were transported to the ASC Investigation Laboratory for disassembling and readout on Feb. 4th. The Crash Survival Memory Unit (CSMU) of CVR and FDR were in good condition. After cleaning and drying the CSMUs, data from both recorders were successfully downloaded for readout.

Figure 1.11-1 Flight recorders were recovered by ASC investigators

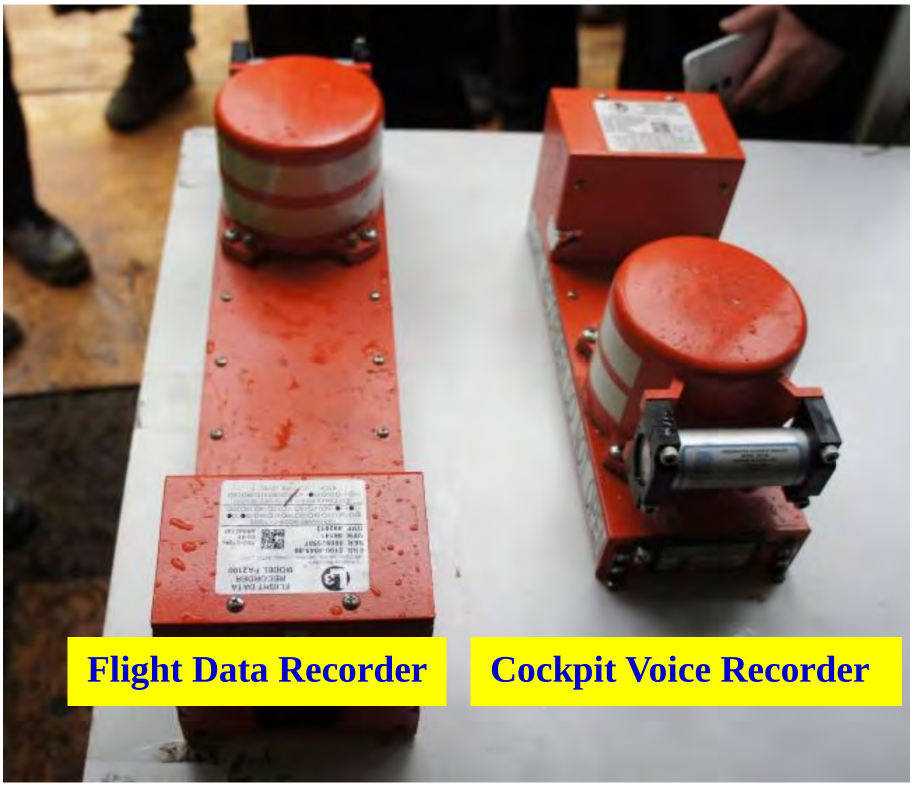

Figure1.11-2 External view of Cockpit Voice Recorder and Flight Data Recorder

1.11.1 Cockpit Voice Recorder

<u>CVR Description</u>

The aircraft was equipped with an L-3 Communications CVR, model FA2100. The CVR is capable of recording 2 hours of 4-channel high quality cockpit audio. The 4 channels of cockpit audio are comprised of two channels from each flight crew, one Cockpit Area Microphone (CAM) channel, and the fourth channel from public address system. The model, part number and serial number of the Solid-State Cockpit Voice Recorder (SSCVR, or CVR thereafter) as follows,

- ✓ Manufacturer: L-3 Communications
- ✓ Model: FA2100
- ✓ Part Number: 2100-1020-02
- ✓ Serial Number: 000706983
- ✓ Hardware Modification Number: 13

<u>CVR Damage and Disassembly</u>

The CVR was recovered by ASC go-team at the tail section of main wreckage at 1605 hrs on Feb. 4th. Upon the first inspection by ASC investigators, it was evident that the CVR did not have any punctures, fire, or other penetration traces, and was found in good condition.

After cleaning and drying process, ASC investigators utilized the L-3 Accident Investigation Kits (AIK) to download voice data according to L-3 FA2100 manual and ASC's download procedures, shown in Figure 1.11-3. The CVR data was downloaded, and contained 124 minutes 14.4 seconds of 4 channel audio data. The audio quality of each channel is either good or excellent, and the quality level are shown in the Table 1.11-1. Detailed definition of SSCVR audio quality is available in Appendix 1:

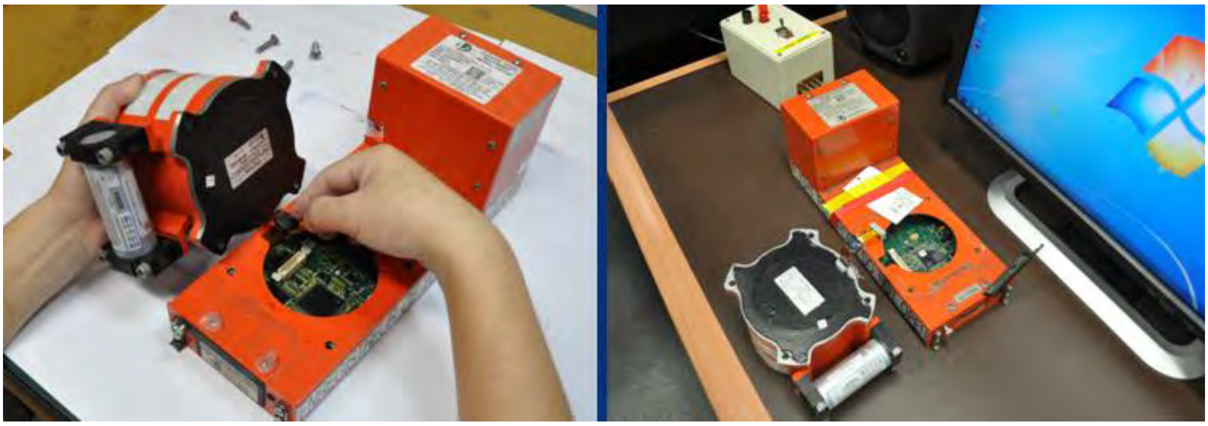

Figure 1.11-3 Connecting the CSMU of GE235 SSCVR to chassis

Table 1.11-1 SSCVR recording quality

Channel #	**Content/Source**	**Recording Quality**
1	Public Address, 3rd Crew Member	Excellent
2	Captain	Good
3	First Officer	Good
4	Cockpit Area Microphone	Excellent

1.11.1.1 Timing Synchronization and Correlation

Timing synchronization of the CVR recording was established by correlating the CVR events to common events on the FDR, and then was correlated to the timing system of Songshan Tower. The entire air traffic equipment and surveillance radar timing system is based on GPS Time, whose source is provided by the National Time and Frequency Standard Laboratory, Telecommunication Laboratories, Chunghwa Telecom Co., Ltd[1].

Radio transmission made by the aircraft recorded throughout the flight were correlated to the radio transmit microphone key parameter of the FDR. There were two reference time on the FDR: (1) synchronization words no.1, no.2, no.3, and no.4 repeated every 4 seconds, the total number of synchronization words is called Signal Reference Number (SRN); and (2) SSFDR recorded parameter “UTC”. With the common events of both recorders, such as the warning, the time correlation between CVR and FDR could be established, then CVR time was offset to synchronize with the FDR time. Usually the radio transmission events made by the aircraft are useful to correlate the recorders time to the air traffic control time system. A time synchronization event listing can be found in the Table 1.11-2:

Table 1.11-2 Time Synchronization

ATC Time (UTC+8)	FDR SRN	FDR UTC Time	CVR Time	Common Events
1052:38	26468	0252:38	1052:37.6	Communication with ATC *“one one niner seven transasia tree two five good day”*
N/A	26468	0252:38	1052:38.3	1st master warning
1053:35	26526	0253:36	1053:34.9	Communication with ATC *“tower transasia two tree five mayday mayday engine flame out”*
N/A	26584	0254:34	1054:34.4	2nd master warning

1 Website http://www.stdtime.gov.tw/english/e-home.aspx

1.11.1.2 Audio Spectrum

The whole SSCVR recording included the occurrence flight and two previous flights, GE231 from Taipei to Kinmen and GE232 from Kinmen to Taipei. The occurrence flight GE 235 began at 1041:15.4 hrs and ended at 1054:36.6 hrs. It covered from standing, pushback to the occurrence happened. The CVR transcript of the occurrence flight can be found in Appendix 2.

Figure 1.11-4 presents some selected CVR transcript and superposing with the relevant spectrogram that contains audio information from the CAM track between 1051:23.8 hrs and 1053:38.8 hrs. Both engines operated normally prior to 1052:39 hrs when the first sound of engine dropped off was heard. The trend matches the observation from FDR data that, engine no.2 propeller speed (denoted as NP) dropped immediately right after the autofeather of engine no.2. At 1052:43.0 hrs, Pilot Flying (denoted as PF) said that "*i will pull back engine one throttle*"; and at 1053:06.4, PF said that "*pull back number one*", FDR data indicated that no.1 engine NP dropped off immediately.

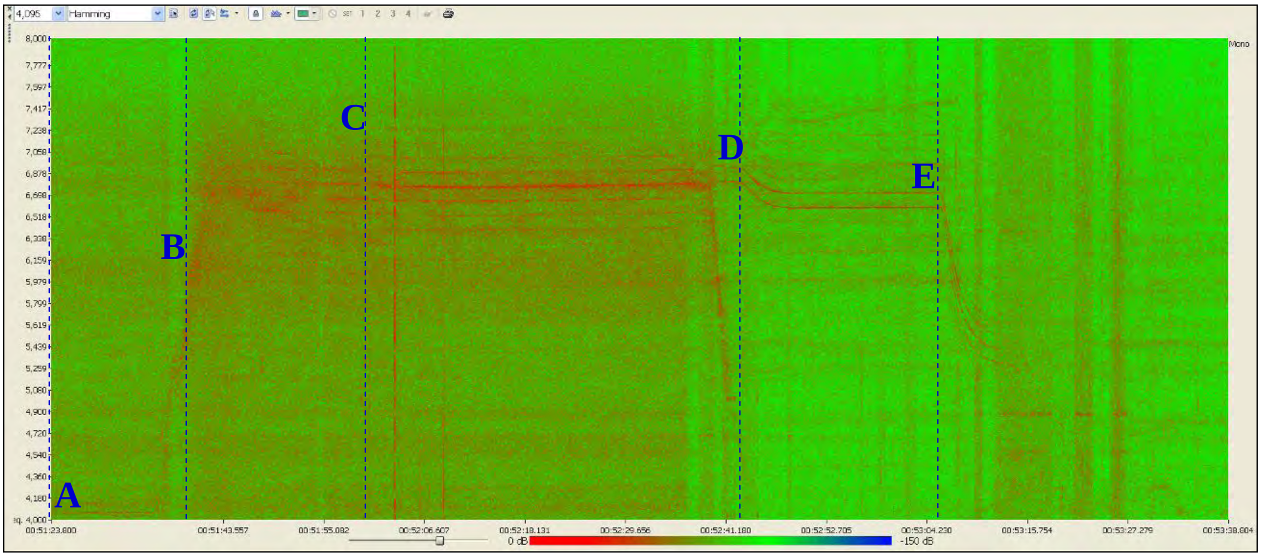

Figure1.11-4 GE235 Spectrogram of the CAM recording

Table 1.11-3 GE235 sequence of engine propeller speed dropped off

Item	Time	CVR Context
A	1051:23.8	PF : “*cleared for takeoff*”
B	1051:39.6	CAM : *(sound of engine spool up)*
C	1052:00.2	PF : “*rotate*”
D	1052:43.0	PF : “*i will pull back engine one throttle*”
E	1053:06.4	PF :” *pull back number one*” FDR data: engine no.1 torque dropped off

1.11.2 Flight Data Recorder

<u>FDR Description</u>

The aircraft was equipped with an L-3 Communications Solid-State Flight Data Recorder (SSFDR, or FDR thereafter). The model, part number and serial number of the FDR as follows,

- ✓ Manufacturer: L-3 Communications
- ✓ Model : FA2100
- ✓ Part Number: 2100-4045-00
- ✓ Serial Number: 00925587
- ✓ Hardware Modification Number: 12

<u>FDR Damage and Disassembly</u>

The FDR was recovered by ASC Go-team at the tail section of main wreckage at 1605 hrs on Feb. 4th. Upon the first inspection by ASC investigators, it was evident that the FDR did not have any punctures, fire, or other penetration traces, and was found in good condition. After cleaning and drying the CSMU and chassis, ASC investigators used normal procedure to download FDR raw data, shown as in Figure 1.11-5.

Figure1.11-5 Connecting the CSMU of GE235 FDR to chassis

The FDR recording contained 67 hours 22 minutes and 56 seconds of data. The occurrence flight was the last flight of the recording and its duration was 13 minutes and 18 seconds. According to ATR readout document[2], FDR raw data was converted into engineering units and total number of the recording parameters were about 750. All the recorded parameters are listed in Appendix 3. Data plots for the entire occurrence flight are included in Appendix 4.

GE235 FDR began recording at 1041:18 hrs and continued recording to the crash of the flight, 1054:35.9 hrs. Summary of CVR and FDR readout is as follows:

1. Based on CVR transcript, flight crew said "*no a-t-p-c-s armed*" at 1051:43.3 hrs. About 8 seconds later, flight crew announced *"oh there it is a-t-p-c-s armed"*. The related FDR parameters are shown in Table 1.11-4:

Table 1.11-4 ATPCS related FDR parameters before take off

Time (mm:ss)	AIR/GND mode	PWR MGT Switch	PLA_no.1 (deg)	TQ_no.1 (%)	PLA_no.2 (deg)	TQ_no.2 (%)
51:43	GND	TO	74.9	83.8	74.2	84.7
51:52	GND	TO	74.9	89.9	74.2	90.3

2. At 1052:02 hrs, the aircraft took off. 14 seconds later (1052:16 hrs), the autopilot was engaged, power lever angle (denoted as PLA) of engine no.1 and no.2 were 74.9 and 74.2 degrees, respectively.

[2] ATR service letter no. ATR72-31-6010, V4.

3. Between 1052:16 and 1052:35 hrs, all of FDR recording parameters did not record any warning signals; at 1052:35 hrs, no.1 engine TQ started to increase towards 100% (the increase on engine 1 TQ in conjunction with the other parameters and according to timing , can be interpreted as an uptrim commanded by the ATPCS). Two seconds later, both torque and objective torque of no.1 engine increased to 100.9% and 99.9%. In the meantime, both torque and objective torque of no.2 engine maintained at 89.7% and 89.9%.
4. Between 1052:38 and 1052:40 hrs, master warning was triggered. No.2 engine flameout procedure was also displayed on Engine and Warning Display (EWD). During the three seconds, no.2 propeller started to move towards the feather position, beta angle increased from 28.3 degrees to 46.4 degrees; no. 2 engine TQ initially increased to 114.2% before dropping to 0% at 1052:42; fuel flow also dropped from 1,286 pph to 1,024 pph. The "ENG2 Flame Out at Take Off" procedure was also displayed on EWD at 1052:38 hrs, and stayed until the procedure was replaced by "After Take Off - 1EO" at 1054:30 hrs (6 seconds before the end of FDR recording).
5. At 1052:43 hrs, no.2 propeller was in the feather position, its beta angle at maximum position of 77 degrees, torque dropped to zero, and fuel flow dropped to 204 pph then maintained between 200 and 300 pph until 1054:31 hrs (5 seconds before the end of FDR recording).
6. Between 1052:41 and 1052:44 hrs, autopilot was manual disengaged by flight crew, no.1 engine PLA reduced from 74.9 to 66.4 degrees, no.2 engine PLA maintained in the notch position at74.2 degrees (takeoff position), and computed airspeed (denoted as CAS) decreased from 117 knots to 111 knots.
7. Between 1053:05 and 1053:07 hrs, no.1 engine PLA decreased from 66.4 to 49.2 degrees, no.2 engine PLA remained at 74.2 degrees, CAS decreased to 101~102 knots.
8. At 1053:10 hrs, the first stall warning[3] was triggered while right-hand side angle of attack[4] (denoted as AOA 2) was greater than 10.9 degrees, and the stick shaker (F/O side) was triggered for one second. At 1053:13 hrs, both stick shakers (Captain side and F/O side) were triggered and continued for 6 seconds. At 1053:17 hrs, AOA 2 was 13.9 degrees, and both stick pushers were triggered

[3] ATR-72-600 FCOM (Rev.DEC 13, Mod:5948) P.16, 1.02.10: Critical angle of attack detected by angle of attack probes leads to aural alert (cricket), stick shaker activation, and then stick pusher activation, stick shaker and stick pusher triggering thresholds at FLAP 15 configuration are AOA 10.9 and 14.1 degrees.
[4] There are two angle of attack recorded parameters in the FDR (denoted as “AOA 1” and “AOA 2”), the AOA values provided in the FCOM and mentioned in the factual report are "Reference AOA".

for two seconds, the aircraft pitch changed from +8.25 to -4.99 degrees nose down in three seconds. After no.2 engine was autofeathered until the end of FDR recording, the FDR recorded several activations of stick shakers and stick pushers, the relevant records are listed in Table 1.11-5:

9. Table 1.11-5 AOAs, CAS and RALT parameters with stall warning trigged

Time (mm:ss)	Stick Shaker (Capt)	Stick Shaker (F/O)	Duration (sec)	Stick Pusher	Duration (sec)	AOA 1 (deg)	AOA 2 (deg)	CAS (kt)	RALT (ft)
53:10	-	V*	1	-	-	9.6	11.1	100	1628
53:13	V	V	6	-	-	10.2	12.0	99	1610
53:14	V	V	6	-	-	10.8	12.0	100	1596
53:15	V	V	6	-	-	10.8	11.8	99	1501
53:16	V	V	6	-	-	11.4	12.4	100	1528
53:17	V	V	6	V	2	13.4	13.9	101	1531
53:18	V	V	6	V	2	13.1	11.8	101	1526
53:22	V	V	2	V	2	12.6	13.1	107	1445
53:23	V	V	2	V	2	9.3	8.5	107	1383
53:26	V	V	2	-	-	11.2	11.1	114	1267
53:27	V	V	2	-	-	8.9	9.1	114	1234
53:56	V	V	4	-	-	10.8	11.0	101	833
53:57	V	V	4	-	-	11.2	11.9	101	791
53:58	V	V	4	-	-	11.9	12.0	102	169
53:59	V	V	4	-	-	10.5	10.5	100	719
54:06	V	-	-	-	-	10.6	10.0	108	609
54:07	V	V	4	-	-	11.5	11.0	109	583
54:08	V	V	4	-	-	11.0	10.7	109	533
54:09	V	V	4	-	-	11.0	11.0	112	474
54:10	V	V	4	-	-	10.1	8.7	110	548
54:13	V	V	9	-	-	11.9	12.3	104	563
54:14	V	V	9	-	-	12.7	12.4	105	544
54:15	V	V	9	-	-	11.9	11.8	101	515
54:16	V	V	9	-	-	11.8	11.7	98	521
54:17	V	V	9	-	-	12.0	11.8	98	559
54:18	V	V	9	-	-	12.4	11.9	97	575
54:19	V	V	9	-	-	13.0	12.7	95	580
54:20	V	V	9	V	2	13.5	13.5	96	575
54:21	V	V	9	V	2	11.0	9.3	97	556
54:24	V	V	10	-	-	14.5	15.3	101	439
54:25	V	V	10	-	-	15.1	14.0	106	401
54:26	V	V	10	-	-	13.5	13.6	102	368
54:27	V	V	10	-	-	14.3	13.7	105	310
54:28	V	V	10	-	-	16.6	15.7	106	107
54:29	V	V	10	-	-	17.1	16.3	106	168
54:30	V	V	10	-	-	16.9	16.5	110	107
54:31	V	V	10	-	-	17.0	16.7	108	101
54:32	V	V	10	-	-	17.4	17.3	108	86
54:33	V	V	10	-	-	17.9	16.3	109	153

54:34				-	-	16.3	10.1	108	84
54:35				-	-	8.4	3.3	106	55

* V stands for activation of the stick shaker or stick pusher.

9. Between 1053:12 and 1053:17 hrs, no.1 engine PLA decreased from 49.2 to 34.5 degrees (flight idle) and no.2 engine PLA increased from 74.2 to 85.8 degrees (ramp). Both engines related parameters (NP, Torque and fuel flow) is shown in Table 1.11-6.

Table 1.11-6 Engine related parameters change during 1053:12 to 1053:17

Time (mm:ss)	No.1 Engine parameters				No.2 Engine parameters			
	PLA (deg)	NP (%)	TQ (%)	FF (pph)	PLA (deg)	NP (%)	TQ (%)	FF (pph)
53:12	49.2	95.1	24.4	518	74.2	14.3	0	265
53:17	34.5	88.3	13.8	386	85.8	15.2	0	265

10. Between 1053:22 and 1053:24 hrs, both stick shakers and stick pushers were triggered again for 2 seconds, Y/D (yaw damper) was disengaged, and CAS increased to 107 knots.
11. At 1053:25 hrs, the condition lever of no.1 engine was moved to the fuel shutoff position. Accordingly, no.1 propeller was feathered. Six seconds later (1053:31 hrs), beta angle reached the maximum position of 79.9 degrees, and the related parameters (NH, NP, torque) were declined to 0 %. And hydraulic blue pressure started to decrease from 3,000 psi and reached 0 psi until 3 seconds before the end of FDR recording.
12. Between 1053:31 and 1054:16 hrs, the aircraft glided with no engine torque output, and maintained CAS between 100 and 110 knots, AOA 1 and AOA 2 ranged between 10 to 13 degrees, and baro-corrected altitude declined from 1,326 to 643 ft.
13. At 1053:48 hrs, flight crew attempted to engage the autopilot. At 1053:56 hrs the stick shakers were activated and the autopilot was disengaged automatically.
14. At 1054:23 hrs, first EGPWS warning was triggered - “Too Low Gear” and then “Too Low Terrain”, ”Caution Terrain”, “Warning Terrain” while aircraft altitude kept decreasing.
15. Between 1054:16 and 1054:17 hrs, no.1 engine PLA increased from 34.5 to 38 degrees, after 4 seconds (1054:20 hrs) CLA fuel shut off parameter from "fuel SO" to "no FSO". After 5 seconds (1054:25 hrs), no.1 engine fuel flow increased from 17 to 114 pph, and continued increasing. From 1054:25 to 1054:31 hrs, no.1 engine PLA increased from 38.0 to 45.7 degrees and no.2

engine PLA decreased from 86.1 to 47.1 degrees where PLA had reached a position that ATPCS autofeather request was cancelled. With a feathered no.1 engine propeller, no.2 engine propeller went out of feathered position and propeller speed gradually increased from 15.6% to 17.7% as a result of beta angle increase. Parameters related to engines were listed in Table 1.11-7.

Table 1.11-7 Engine related parameters after engine restart sequence

Time (mm:ss)	No.1 Engine parameters					No.2 Engine parameters				
	PLA (deg)	NP (%)	TQ (%)	FF (pph)	Beta (deg)	PLA (deg)	NP (%)	TQ (%)	FF (pph)	Beta (deg)
54:16	34.5	0	0	0	79.0	86.1	15.3	0	283	77.2
54:20	38.0	0	0	17	79.5	86.1	15.3	0	283	77.3
54:25	38.0	0	0	114	79.8	86.1	15.7	0	283	77.2
54:30	49.2	0.4	0	122	80.0	47.8	15.3	0	282	77.3
54:31	45.7	1.0	0	131	80.1	47.1	15.6	0	309	71.5
54:33	45.7	1.9	0	157	80.2	42.5	17.7	35.4	345	56.2
54:35	33.4	3.0	0	209	78.8	32.0	25.4	27.9	433	43.7

16. At 1054:33 hrs, the aircraft began to bank left with pitch down and altitude dropped rapidly. EGPWS warning was triggered with "Pull Up" until the end of FDR recording. Parameters including attitude, altitude, CAS, AOA and pilot control inputs before the crash are listed in Table 1.11-8.

Table 1.11-8 Altitude, attitude and pilot control input parameters before crash

Time (mm:ss)	Baro. Alt. (ft)	CAS (kt)	AOA 1 (deg)	Pitch (deg)	Roll[5] (deg)	Vert. Accel. (g's)	Ctrl Col. Pos. (deg)	Ctrl Wheel[6] (deg)
54:33	291	109	17.9	7.11	-22.8	0.8876	11.03	-28.3
54:34	245	108	16.3	4.15	-54.5	0.8143	6.77	-77.7
54:35	161	106	8.4	-2.25	-82.4	0.5190	13.19	-43.2
54:35.5	-	-	-	-8.38	-100.1	0.4709	1.64	-34.8

17. At 1054:35.9 hrs, FDR stopped recording, the relevant parameters are as follows:
    - FDR path, speed and attitudes: indicated airspeed 106 knots, ground speed 91 knots, baro-corrected altitude 161 ft, GPS position N25°3'46.576", E121°37'1.291"; pitch nose down 12.2 degrees; left bank 100.1 degrees; magnetic heading 57.3 degrees.
    - No.1 engine: PLA 34 degrees, NP 3%, Torque 0%, fuel flow 209 pph, beta 79 degrees.
    - No.2 engine: PLA 34 degrees, NP 35.3%, Torque 27.9%, fuel flow 433 pph, beta 44 degrees.

[5] Plus(+) means right wing down.
[6] Plus(+) means bank left control.

For ATR 72-600 aircraft, there was a parameter called “Procedure Displayed ID (denoted as Proc Disp. ID)” recorded in FDR, which showed the displayed message on the Engine and Warning Display (EWD), relevant information of the occurrence flight was listed in Table 1.11-9:

Table 1.11-9 Procedure displayed in EWD during the accident flight

Time (mm:ss)	Proc Disp. ID	Procedure Displayed
51:10~52:02	178	Screen cleared (NO procedure displayed)
52:03~52:37	416	After Take Off
52:38~54:29	192	ENG 2 Flame Out at Take Off
54:30~54:33	417	After Take Off - 1EO
54:34~54:35	181	ENG 1 Fire in Flight

1.11.3 Other Flight Data and Radar Track Data

1.11.3.1 Quick Access Data

The damaged Quick Access Recorder (QAR) and its PCMCIA card of the occurrence flight were recovered by ASC investigators on Feb. 5th. There was no evidence of heat or fire damage on the exterior of the PCMCIA card. After utilizing compressed cool air to dry the PCMCIA card, all data were downloaded successfully. The last flight segment data was consistent with FDR readout data, except the QAR stopped recording at 1054:34 hrs of Taipei time. Detailed QAR data plot can be found in Appendix 4.

1.11.3.2 Secondary Surveillance Radar Data

Figure 1.11-6 shows GE235 radar track superposing with satellite image. There are three red triangular marks, which were predicted positions from radar system and they were invalid for future analysis. The original radar data indicated that the last valid data occurred at local time 1054:35.26 hrs, slant range between the aircraft to the runway 28 threshold of Songshan airport was 2.84NM and bearing angle was 98.1 degrees.

Figure 1.11-6 GE235 radar track

1.11.3 Flight Path Reconstruction

The flight path is determined by three recording parameters- GPS latitude, GPS longitude, and baro-corrected altitude, with sampling rate 1 Hz. At 1054:35 hrs, the last recorded position was N25°03’46.576”, E121°37’1.291”. Based on the CVR and FDR factual information, the sequence of events of GE235 is listed in Table 1.11-10. Figure 1.11-8 shows GE235 flight path and radar track, superposing with an aerial photo. Figure 1.11-9 also indicates ten place marks during 1053:07.7 hrs and 1053:59.7 hrs. Figure 1.11-10 presents GE235 flight path, satellite image and eight place marks during the last 23 seconds.

Figure 1.11-8 Superposing of GE235 flight path, radar track and warnings

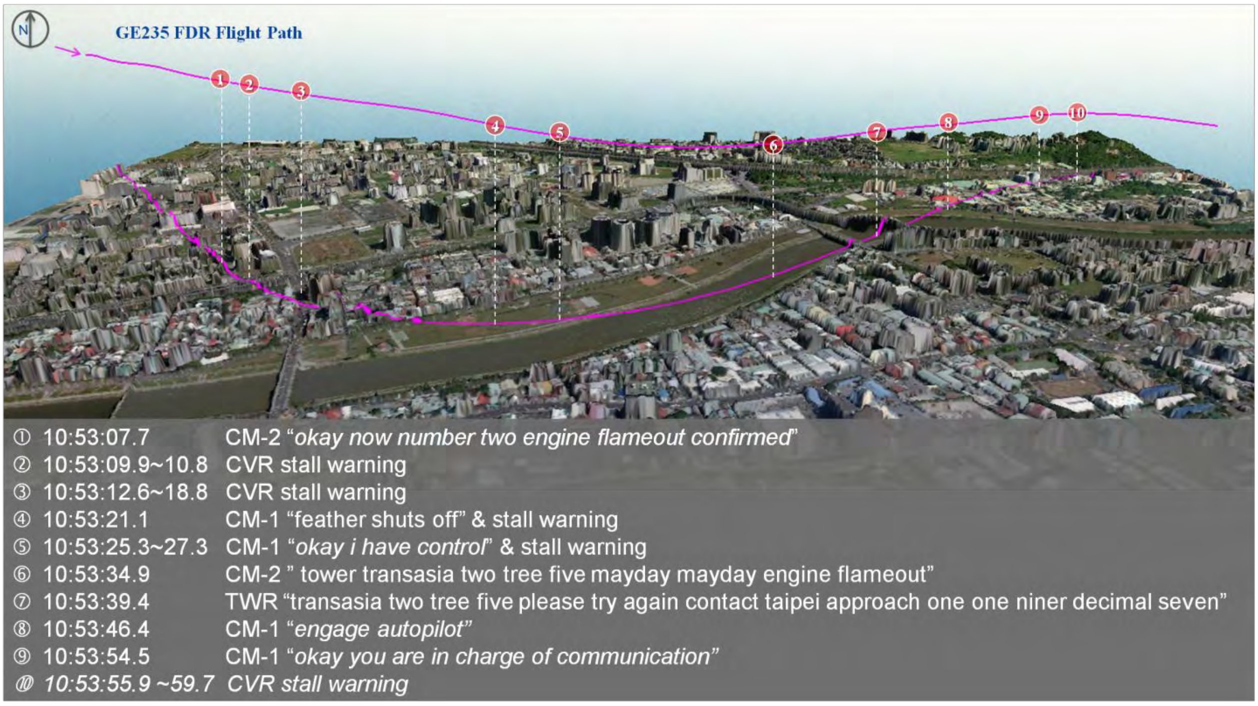

Figure 1.11-9 Superposing of GE235 flight path with an aerial photo and digital surface model between 1053:07.7 and 1053:59.7

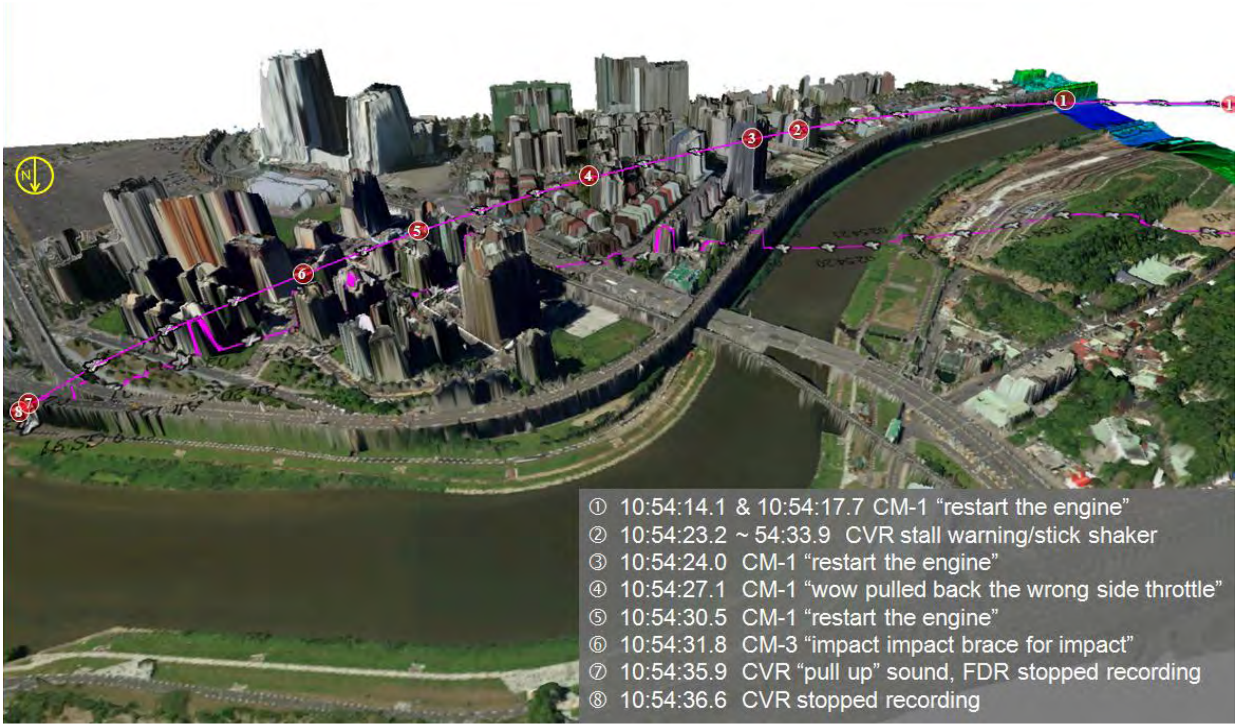

Figure 1.11-10 Superposing of GE235 flight path with an aerial photo and digital surface model during the last 23 seconds.

Table 1.11-10 GE235 CVR/FDR Sequence of Events

UTC 1	AP/YD	RALT	CAS	IAS1	Fact	Display EWD (PROC ID MSG)	Comment
					LNAV Armed – Selected speed 115 kt.	Before Take OFF	
02:51:34			-	-	increased PLA	No Procedure Displayed	TO sequence began
02:51:43.5			37	37	ATPCS not armed (CVR)		
02:51:59.4			114	114	V1 (CVR)		
02:52:00			116	116	Parameter discrete main gear=0 ALT armed – Selected altitude 5,000 ft		Airborne
02:52:03		6.4	123	127	highest CAS 134 kt	After Take off	
02:52:08	YD	91	133	135			
02:52:16	YD-AP LNAV IAS	361	129	130			
02:52:37	~	1,165	116	117	ENG 1 uptrimed ENG bleed VLV LH closed		ATPCS sequence began (52:35 ~ 52:37)
02:52:38	~	1,193	117	119	Master warning ENG 2 flame out		
02:52:39	~	1,246	117	119	ENG 2 feathering began	ENG 2 Flame Out at Take Off	ATPCS sequence: 2.15 s after trigger, feathering
02:52:40	YD LNAV IAS	1,283	117	117	AP disconnection		Manual disconnection
02:52:42	~	1,352	114	114	ENG 2 propeller feathering (beta angle 78 deg)		ATPCS sequence ended
02:52:50	YD HDG SEL IAS	1,470	106	104			
02:53:07	YD HDG SEL	1,582	102	99			ALT not armed: Vertical Speed below 80ft/min

UTC 1	AP/YD	RALT	CAS	IAS1	Fact	Display EWD (PROC ID MSG)	Comment
	PITCH HLD						
02:53:08	~	1,627	102	100	Two sec later, highest alt 1,661 ft (baro corrected)		
02:53:10		1,628	100	97	1st stick shaker F/O		
02:53:13	~	1,621	98	96	1st stick shaker CAPT		CAS: 98kt
02:53:14	~	1,596	100	96	PLA2 moved forward (86 deg)		Expected to be before or at the ramp position (theoretically value is 88 deg)
02:53:17	~	1,535	101	97	1st stick pusher		
02:53:21	HDG SEL PITCH HLD	1,470	102	101			
02:53:24	~	1,344	107	106	CLA 1 fuel SO		No.1 propeller was feathered and no1. Engine was shut off
02:53:49	YD – AP HDG SEL PITCH HLD	875	109	109			
02:53:57	YD HDG SEL PITCH HLD	791	101	98			AP Manual disconnection
02:54:08	HDG SEL PITCH HLD	533	112	108			
02:54:14	~	544	105	98	DC essential BUS 1 voltage dropped from 28V down to 18V		Engine 1 restart request
02:54:20	~	575	96	91	CLA1 no more fuel SO		Engine 1 restart cont'd
02:54:25	~	401	106	96	NH1 reached 30% increasing		Engine 1 restart cont'd
02:54:30	~	107	110	97	PLA2 decreased down to 48°	After Take Off - 1EO	ATPCS disarming condition
02:54:31	~	101	108	97	ENG2 left feather + MW ENG 2 flame out disappeared		

UTC 1	AP/YD	RALT	CAS	IAS1	Fact	Display EWD (PROC ID MSG)	Comment
02:54:33							
02:54:34	~	83.5	108	100	NH1 reached 50%	ENG 1 Fire in Flight	
02:54:35.9	~	55.1	106	103	End of recording –CVR (0254:36.6 sec) ; FDR (0254:35.9 sec)		

1.12 Wreckage and Impact Information

1.12.1 General

The impact mark made by GE235 indicated the aircraft impacted the Huan-Dong Blvd viaduct before crashing into Keelung Rive. Refer to Figure 1.12-1, there are several high buildings in the southern area of the Huan-Dong Blvd. Keelung River is at the north side of the Huan-Dong Blvd, and the water depth of the river is between one to two meters.

Figure 1.12-1 Aerial Photo of GE235 crash site

1.12.1.1 Wreckage mapping

The site survey was conducted by ASC investigators with a Trimble GEO XH GPS receiver and a Leica D510 laser ranger on the date of occurrence. When Go-team arrived at the occurrence site, IIC requested 3 investigators went to the Huan-Dong Blvd to find the first impact point. There were some small debris left on the Huan-Dong Blvd, and one light pole on the Huan-Dong Blvd was broken, and fell down to the river side. There were several debris of control surfaces located at the river side. The aircraft fuselage and the flight deck were in the middle of the

Keelung River.

Figure 1.12-2 shows the site survey data superposing with an aerial photo. The wreckage identification numbers and photos were shown in Figure 1.12-3, full database with detail information of site survey was listed in Appendix 5.

The height above ground level of the Huan-Dong Blvd was about 21 meters (its height above the ellipsoid was 48 meters and HAE of the ground was 27 meters), and the reference impact area on the Huan-Dong Blvd was about 20 meters by 10 meters. A scratch mark was found on the road surface, the total length of the scar was about 2.5 meters, and heading was about 60 degrees. Some wreckage debris was found near the impact point on the barrier with reference position N25^{o}3’46.45”, E121^{o}37’1.15”. The aircraft stroke a light pole, which was very close to the impacted barrier (on the right upper corner of Figure 1.12-1). The distance from the impacted barrier to main wreckage on the river was about 90 meters, and the distance from the impacted taxi to the impacted barrier was about 9 meters.

Main wreckage was nearly upside down in the middle of the Keelung River, and the reference heading was about 25 degrees. The reference position was N25^{o}3’48.54, E 121^{o}37’3.13”, the height above the ellipsoid was 20 meters, and the water depth was about one to two meters.

Figure 1.12-2 Site survey data superposing with an aerial photo

Figure 1.12-3 Site survey- wreckage identification numbers and photos.

1.12.1.2 LIDAR data

While ASC was conducting the site survey, the Criminal Investigation Bureau (CIB) performed parallel investigation and utilized its 3D LIDAR on the Huan-Dong Blvd to collect the impact information. CIB scanned the area near the first impact point, and provided ASC the survey result. The LIDAR data was recorded as three-dimensional point clouds. The height of street light were 7 meters, and the width of the Huan-Dong Blvd was 10 meters. There were some electrical power transmission lines above the Huan-Dong Blvd, over 20 meters high. Figure 1.12-4 shows the point clouds of the crash site, and the impacted barrier on the Huan-Dong Blvd was reconstructed by a LIDAR scanner. In addition, the perspective view of the occurrence site was collected from Google 3D view browser in Figure 1.12-5.

Figure 1.12-4 Perspective view of the point clouds at crash site (Huan-Dong Blvd.)

Figure 1.12-5 Perspective view of the Huan-Dong Blvd, which reconstructed by Google.

The Department of Urban Development of Taipei City Government provided

ASC a set of precise digital terrain data and aerial photos, and ASC created the surface models of the taxi, part of Huan-Dong Blvd, and street lights. Flight path and related ground building models were illustrated in Google Earth, shown in Figure 1.12-6. There are two building marks (denoted as A and B) equipped with video camera that captured last few moment of the flight, the relevant video frame presented at section 1.12.1.3. Figure 1.12-7 shows an aerial photo of the crash site taken from a rescue helicopter.

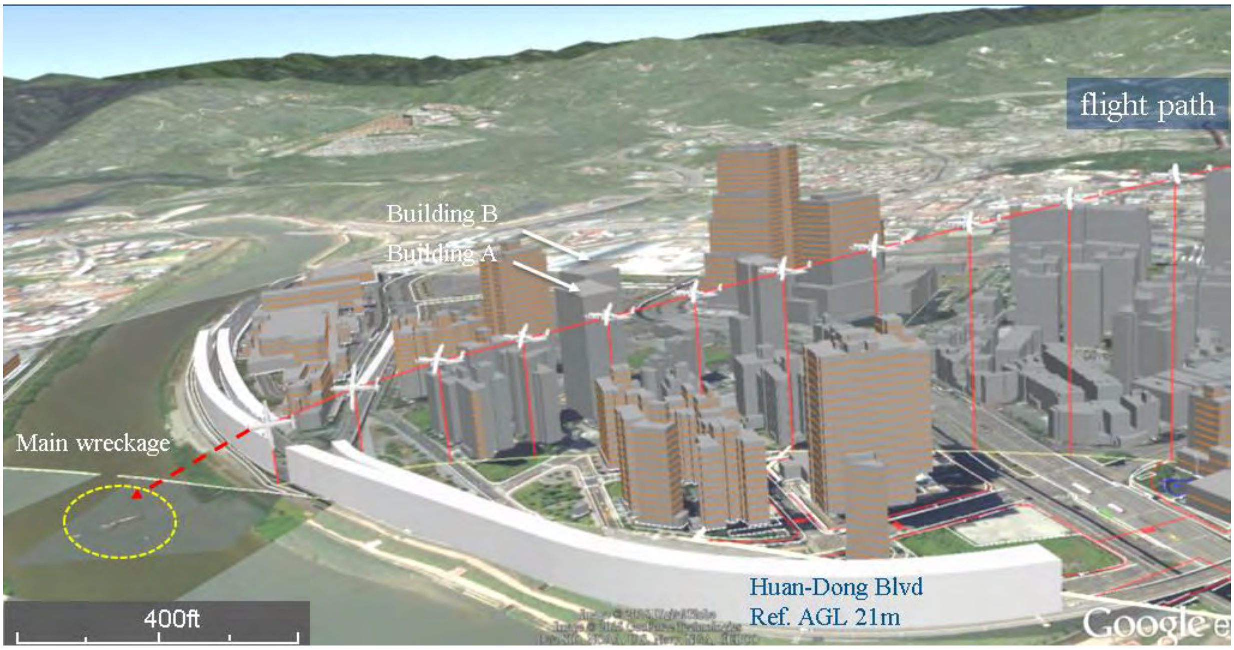

Figure 1.12-6 Perspective View of the crash site, mapping with FDR flight path

Figure 1.12-7 Aerial photo of crash site taken from a rescue helicopter

1.12.1.3 Video frame before crashing

After the occurrence, ASC investigators collected traffic surveillance video at Huan-Dong Blvd and several dashcam videos from nearby vehicles. Several videos showed that the aircraft hit a taxi, impacted the viaduct, and then crashed into Keelung River. All videos were examined during the investigation. When the occurrence happened, two ground vehicles (noted as black color and silver color) were traveling westbound on Huan-Dong Blvd. Their dashcam videos contained clear images and were helpful for the investigation. To correlate the time of video and flight recorders, the unidentified sound (1054:34.8 hrs) of CVR before aircraft crash was used to be the common event of the aircraft hitting the taxi and viaduct on the video. Relevant video snapshots of the silver car dashcam with CVR time are shown in Figure 1.12-8, the copyright of video was authorized by TVBS for public publication.

The video frame rate of the silver vehicle dashcam was 25 frames per second, meaning that a frame equals to 0.04 second. Based on the dashcam video and the site survey data, the aircraft banked to left at about 90 degrees and the distance between the taxi and the barrier was about 9 meters. The aircraft flew 9 meters in 5 frames (0.2 seconds), shown in Figure 1.12-9 to Figure 1.12-11. Figure 1.12-11 showed that the aircraft impacted the north barrier of Huan-Dong Blvd, represented by the 19th frame of the video timing at 1107:07 hrs, which can be correlated to CVR time as 1054:34.76 hrs.

Figure 1.12-8 Dashcam video snapshots extracted from the silver car (authorized by TVBS)

Figure 1.12-9 The 14 th frame of dashcam videos of the silver car (CVR 1054:34.56 hrs)

Figure 1.12-10 The 17 th frame of dashcam videos of silver car (CVR 1054:34.68 hrs)

Figure 1.12-11 The 19 th frame of dashcam videos of silver car (CVR 1054:34.76 hrs)

ASC investigators also collected six surveillance videos from the buildings in Jingmao 2nd Rd. Positions of building A and building B are shown in Figure 1.12-6. The videos showed that the aircraft passed near building A before it impacted the Huan-Dong Blvd. Three surveillance video clips were clear, some of video snapshots were shown in Figure 1.12-12 to Figure 1.12-14. Figure 1.12-15 showed surveillance videos location at the roof of building A and the flight path was on its western side. The height above ground of building A was 74 meters. The HAE at the roof of building A was 107 meters, and the HAE on ground near building A was 33 meters.

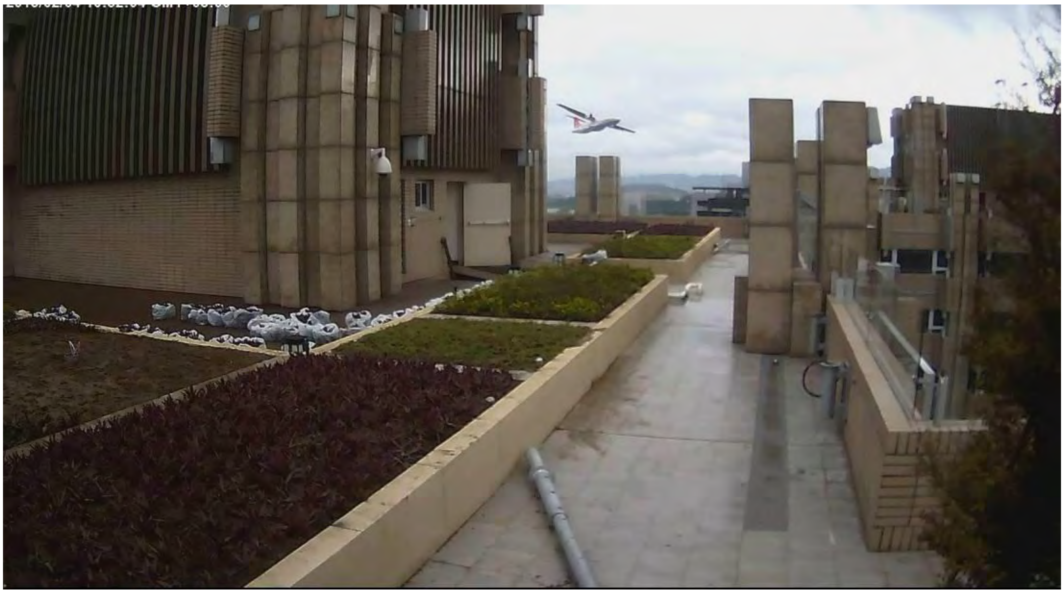

Figure 1.12-12   Surveillance videos snapshot of channel 19 in building B

Figure 1.12-13 Surveillance video snapshot of channel 26 in building A

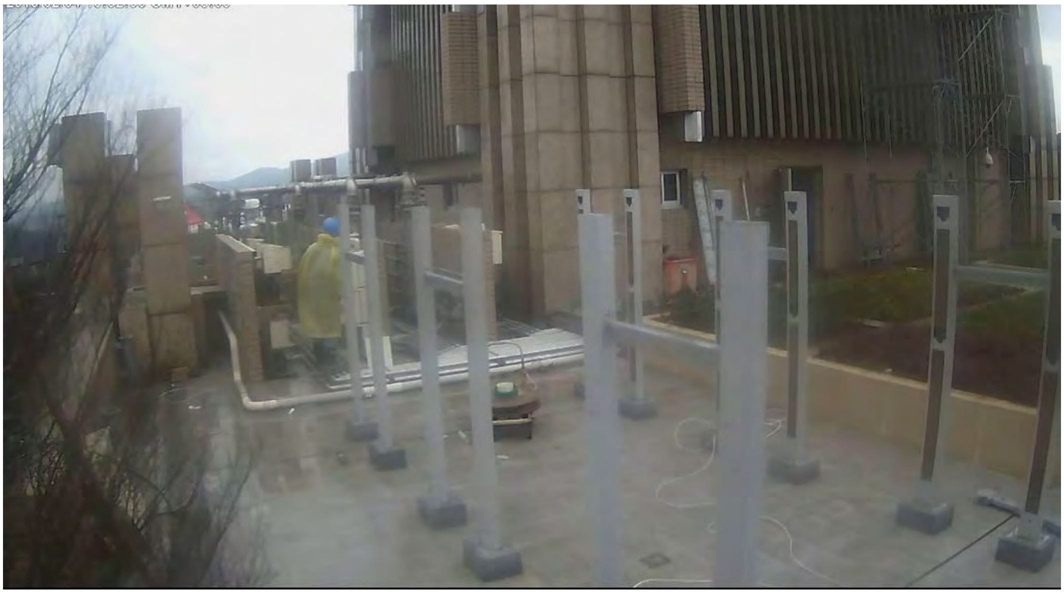

Figure 1.12-14 Surveillance video snapshot of channel 32 in building A

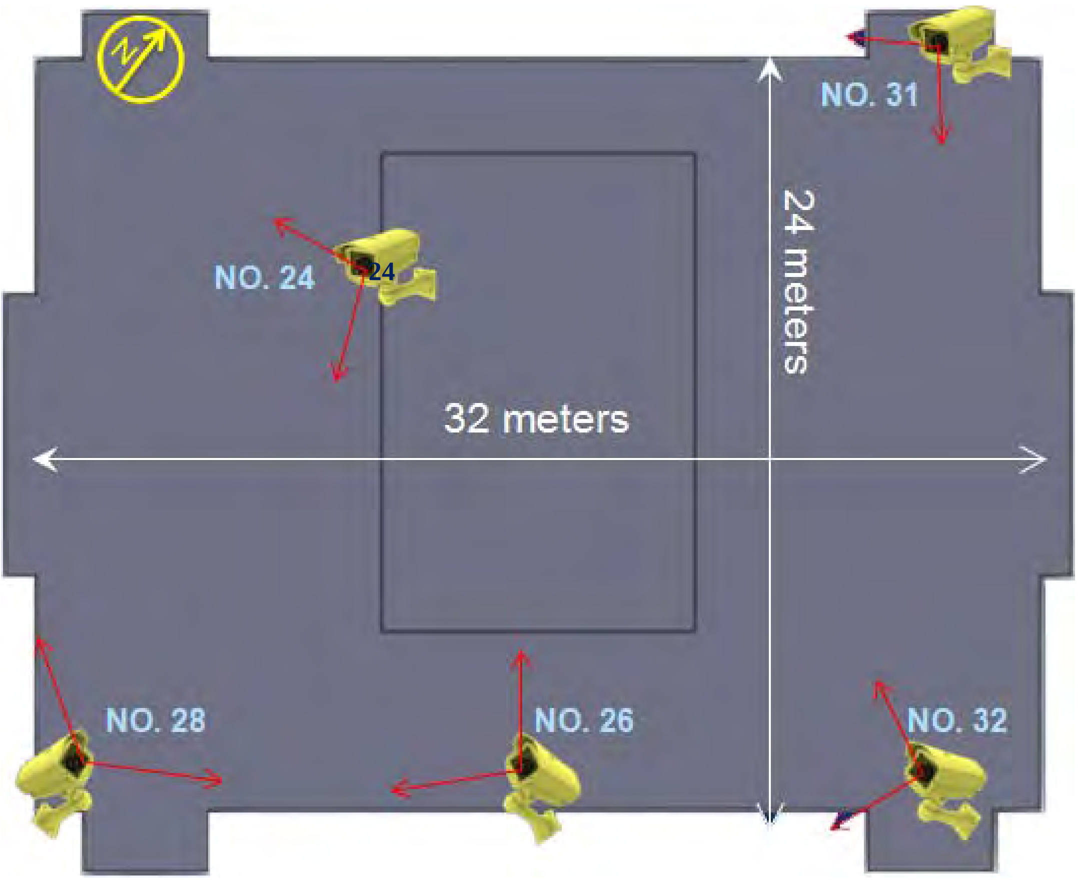

Figure 1.12-15 Surveillance video locations at roof of building A

1.16 Tests and Research

1.16.1 Non Volatile Memory Related Information

There are 66 items of wreckage including avionic devices and wire harnesses that have been collected for further examination, detailed information can be found in appendix 6. To preserve the evidence, there are 14 avionic devices contained the NVMs being immersed in clear water before examination, including- MFC 1/ MFC 2 (each has 11 PCBs), CAC 1/ CAC 2 (each has 5 PCB), DU 1/ DU 2/ DU 3/ DU 4/ DU 5, MPC, EEC 1 / EEC 2, PEC 1/ PEC 2.

Because of the cockpit instrument panel was seriously deformed, investigators used electrical tools, such as grinder and drill, to remove these DUs. The external case of both MFC were slightly deformed. All PCBs were cleaned with water and removed from MFC before shipping to BEA, photo shown as Figure 1.16-1. Each device was tagged and photo documented into the wreckage database. Those devices were then packaged into water proof hard cases for shipping to BEA or TSB.

Figure 1.16-1 PCBs teardown from CAC rack

Twenty-five devices were shipped to BEA for NVM readout, including AFU cables from both engines, MPC and PCBs from MFC 1/MFC 2. Twenty-two devices were shipped to TSB for readout and further examination, including AFUs, DCUs, FEUs, TQ Sensors, NL Sensors, NH Sensors, NP Sensors, EECs and PECs from both engines. There are five DUs and PCBs from CAC 1/ CAC 2 stored in ASC for examination if necessary.

IV. Section Summary

According to the collected factual information, the group concludes a sectional summary into three categories: flight recorders, time synchronization and site survey.

Flight Recorders:

1. CVR stopped recording at local time 1054:36.6 hrs; FDR stopped recording at local time 1054:35.9 hrs.
2. CVR related findings:
   - Right after the throttle was advanced for takeoff, flight crew mentioned "*no a-t-p-c-s armed*".
   - The flight crew called ATPCS back to armed during takeoff roll around seventy knots.
   - After the first master warning, PF said he would like to reduce power on no.1 engine.
   - While PF mentioning to retard power lever of no.1 engine, the PM confirmed no.2 engine flameout.
   - From 1054:05 to 1054:07, flight crew realized they lost both engines.
   - From 1054:09.2 to the end of recording, PF called out "*restart the engine*" 8 times.
3. FDR related findings:
   - Based on CVR/FDR factual information, the group has drafted a sequence

of events. (Table 1.11-10)

- At 1052:35 hrs, no.1 engine started to uptrim, its objective TQ changed from 90% to 100%; two seconds later, both torque and objective torque of no.1 engine increased to 100.9% and 99.9%. In the meantime, both torque and objective torque of no.2 engine maintained at 89.7% and 89.9%.
- Between 1052:38 and 1052:40 hrs, master warning was triggered. No.2 engine flameout procedure was also displayed on the EWD. During the three seconds, no.2 propeller started to move towards the feather position.
- Based on the FDR database document, several recorded parameters were invalid (true heading 1&2, true track Angle 2, latitude 2, longitude 2, GPS Alt 2, Radio Alt 2, temperature gauge 1&2, Ground Speed 2, Selected speed 2, Vert. Accel., AHRS 1&2, Fuel Quantity 1&2_KPH, Fuel Quantity 1&2_PPH, vertical rate 1 &2, FCU status).

Time synchronization:

1. FSK time of CVR was recorded in GMT time. FDR time was found closely matching to TSA's tower time. CVR GMT time = FDR UTC 1 time - 1 second

Site survey:

1. Based on the site survey data and the dashcam videos, the aircraft banked to left about 90 degrees, hit a taxi and a barrier of the Huan-Dong Blvd., then crashed into Keelung River.
2. Available evidence indicated the first impact of the aircraft was on the taxi.

V. **Appendix**

Appendix 1 CVR Quality Rating Scale

Appendix 2 GE235 CVR Transcript

Appendix 3 FDR recording parameters list

Appendix 4 Flight Data Plots

Appendix 5 Site Survey Database

Appendix 6 Wreckage Examination Database

Appendix 1 CVR Quality Rating Scale

The levels of recording quality are characterized by the following traits of the cockpit voice recorder information:
Excellent Quality Virtually all of the crew conversations could be accurately and easily understood. The transcript that was developed may indicate only one or two words that were not intelligible. Any loss in the transcript is usually attributed to simultaneous cockpit/radio transmissions that obscure each other.

Good Quality Most of the crew conversations could be accurately and easily understood. The transcript that was developed may indicate several words or phrases that were not intelligible. Any loss in the transcript can be attributed to minor technical deficiencies or momentary dropouts in the recording system or to a large number of simultaneous cockpit/radio transmissions that obscure each other.

Fair Quality The majority of the crew conversations were intelligible. The transcript that was developed may indicate passages where conversations were unintelligible or fragmented. This type of recording is usually caused by cockpit noise that obscures portions of the voice signals or by a minor electrical or mechanical failure of the CVR system that distorts or obscures the audio information.

Poor Quality Extraordinary means had to be used to make some of the crew conversations intelligible. The transcript that was developed may indicate fragmented phrases and conversations and may indicate extensive passages where conversations were missing or unintelligible. This type of recording is usually caused by a combination of a high cockpit noise level with a low voice signal (poor signal-to-noise ratio) or by a mechanical or electrical failure of the CVR system that severely distorts or obscures the audio information.

Unusable Crew conversations may be discerned, but neither ordinary nor extraordinary means made it possible to develop a meaningful transcript of the conversations. This type of recording is usually caused by an almost total mechanical or electrical failure of the CVR system.

Appendix 2 GE235 CVR Transcript

CVR Transcript

RDO : Radio transmission from occurrence aircraft
CAM : Cockpit area microphone voice or sound source
INT : Interphone
PA : Cabin announcement
(RDO, CAM, INT, PA)-1 : Voice identified as captain
(RDO, CAM, INT, PA)-2 : Voice identified as first officer
(RDO, CAM, INT, PA)-3 : Voice identified as observer
(RDO, CAM, INT, PA)-4 : Voice identified as cabin crew
TWR : Songshan Tower
GND : Songshan Ground
OTH : Communication from other flights
GC : Ground crew
… : Unintelligible
( ) : Remarks
[ ] : Translation
* : Communication not related to operation / expletive words

hh[7]	mm	ss	Source	Context
10	41	14.6		(GE235 CVR 錄音開始) *[GE235 recording begins]*
1041:15.4 ~ 1054:36.6				
10	41	15.4	PA	(客艙安全廣播) *[cabin safety announcement]*
10	41	15.6	CAM-2	oil pressure
10	41	16.4	CAM-1	check
10	41	19.4	CAM-2	forty five starter off
10	41	20.3	CAM-1	start lights off
10	41	21.4	CAM-1	i-t-t 六 七 零三 走 watch down *[i-t-t six seven zero three go watch down]*
10	41	22.3	CAM-2	六 七 零一 *[six seven zero one]*
10	41	24.2	CAM	(發動機啟動聲響) *[sound of engine start]*
10	41	29.8	CAM-1	許可後推 *[pushback granted]*
10	41	30.6	CAM-2	許可

7 本抄件時間以 TWR 時間作為基準。

hh[7]	mm	ss	Source	Context
				[granted]
10	41	31.2	INT-1	ground 外電拆除 煞車收 鼻輪轉向 off 許可後推 么洞跑道 *[ground external power off brake release nose wheel steering off pushback granted runway one zero]*
10	41	35.7	GC	拆外電源 *[external power off]*
10	41	37.1	CAM-1	好 before propeller rotation checklist *[okay before propeller rotation checklist]*
10	41	38.5	CAM-2	okay c-d-l-s
10	41	40.5	CAM-1	on
10	41	41.3	CAM-2	f-m-s takeoff data
10	41	42.5	CAM-1	confirmed
10	41	43.2	CAM-2	confirmed 了 *[confirmed]*
10	41	44.1	CAM-2	tail trims 一點零 *[tail trims one point zero]*
10	41	45.2	CAM-1	一點零 *[one point zero]*
10	41	46.2	CAM-2	check
10	41	46.9	CAM-2	他 trim 那裏可以同時 這邊的 trim 跟這邊的 trim 在看 … 知道看兩邊了喔 *[if it is trimmed to there they can be simultaneously watch trim here and here … you know to watch both side right]*
10	41	51.0	CAM-3	我有我有看到 剛剛就看這個 前面都有 show 出來 *[i did i did see it i just saw it a moment ago it was shown]*
10	41	53.7	CAM-2	對 好 *[yes okay]*
10	41	54.6	CAM-2	tail prop
10	41	55.2	CAM-1	in sight
10	41	55.8	CAM-2	doors
10	41	56.3	CAM-1	closed
10	41	56.9	CAM-2	seatbelt
10	41	57.4	CAM-1	on
10	41	58.0	CAM-2	beacon on
10	41	58.1	GND	(與其他航機通話)

hh[7]	mm	ss	Source	Context
				[communication with other aircraft]
10	41	58.6	CAM-1	on
10	41	58.9	CAM-2	procedure complete
10	42	00.0	CAM-1	是 *[yes]*
10	42	01.7	INT-1	ground 可以後推了 *[ground we can pushback now]*
10	42	03.4	OTH	(其他航機與地面席對話) *[communication between other aircraft and ground]*
10	42	03.8	GC	教官稍等一下 等等車子撤離 *[sir wait a second wait until cars left]*
10	42	03.9	CAM-3	這個與那個 *[this and that]*
10	42	05.1	CAM-2	你在看甚麼 *[what are you looking at]*
10	42	05.4	CAM-3	b-t-c 都看得出來 *[b-t-c both are shown]*
10	42	07.6	INT-1	喔車子 謝謝 *[oh cars thank you]*
10	42	08.2	CAM-2	你再按一次 *[you can push it again]*
10	42	09.6	GC	謝謝教官喔 我要後推了 麻煩鬆煞車 么洞跑道 *[thank you sir i am going to push you back please release the brake runway one zero]*
10	42	12.0	INT-1	好 謝謝 解二號 *[okay thank you number two good to go]*
10	42	12.0	CAM-3	對對對 *[right right right]*
10	42	13.1	CAM-2	但是我現在還沒開完車 我們還不會轉 *[but i have not finished engine start up yet it is not turning]*
10	42	14.0	GC	好教官解二號來 *[okay sir number two good to go]*
10	42	15.5	CAM-2	我把二號一號開完 d-c 再按一次啊 *[let me start number two number one reconnects d-c once again]*
10	42	15.6	CAM-3	喔喔 okay 還有 d-c 的 d-c 的 *[oh oh okay there is d-c d-c]*

hh[7]	mm	ss	Source	Context
10	42	19.5	CAM-2	在這邊 *[it is here]*
10	42	20.2	CAM-1	rotation 開一號 *[rotation start number one]*
10	42	20.4	CAM-3	啊 d-c 的啊 *[ah it is d-c]*
10	42	24.1	GC	教官…來 *[sir ...]*
10	42	27.0	CAM-1	start lights on
10	42	27.8	CAM-2	starter on
10	42	28.8	CAM-1	n-h rising
10	42	29.9	CAM	(single chime)
10	42	30.2	CAM-1	time
10	42	30.8	CAM-2	timing
10	42	31.2	CAM-2	fuel open
10	42	31.9	CAM-1	check
10	42	32.4	CAM-2	ignition
10	42	33.5	CAM-1	check
10	42	41.1	CAM-2	oil pressure 上升 *[oil pressure rising]*
10	42	42.0	CAM-1	check
10	42	42.7	CAM-2	forty five
10	42	43.3	CAM-1	start lights off
10	42	44.4	CAM-2	cut off
10	42	47.6	CAM-2	那個 有的時候那個 com hatch 太早關 *[that sometimes com hatch is closed too early]*
10	42	50.6	CAM-1	是 *[yes]*
10	42	50.9	CAM-2	會那個 一推上來的時候 那個衝得很 很大 *[it will when it goes up that will jump really really high]*
10	42	54.6	CAM-1	yah
10	42	54.9	CAM	(single chime)
10	42	55.6	CAM-2	是等它 啊穩定後再關 把 condition 推到 auto 之後再關這樣 *[wait until it stable then close it close it after you push condition to auto]*
10	42	59.4	CAM-1	穩定後 兩個 *[after stable two]*
10	43	02.6	CAM-1	是

hh[7]	mm	ss	Source	Context
				[yes]
10	43	08.7	CAM-3	這已經在放 com 的地方… *[it is already at com…]*
10	43	10.0	CAM-2	好 *[okay]*
10	43	11.8	CAM-2	好現在…　在這邊　這裡是 d-c 跟 a-c 的電 *[okay now ... here　here is d-c power and a-c power]*
10	43	16.0	CAM-1	對 *[yes]*
10	43	16.9	CAM-2	auto 推 推上去　好 你現在幫我看 hydraulic system page *[push to auto　push it up　okay　now you help me check hydraulic page]*
10	43	21.2	CAM-2	再另外這個對 … *[and then another ...]*
10	43	44.1	CAM-3	那個 com hatch 那個那個那邊可以顯示 *[and that that com hatch where is it shown]*
10	43	47.9	CAM-2	這邊沒辦法顯示要看那邊 *[it is not shown here　you have to check there]*
10	43	49.7	CAM-3	只有看那邊是吧　那沒有辦法顯示 *[it only can check from there　that cannot be shown]*
10	43	50.4	CAM-2	嗯對 沒有辦法 沒有 *[hmmm yes　it cannot　no]*
10	43	52.6	CAM-3	我那一邊 上了當著了道 那沒有關 我們看不到 (笑聲) *[i　take the bait and get possessed　if that is not closed then we will not see it (laughing)]*
10	43	56.3	CAM-2	對啊 *[right]*
10	43	56.7	GC	報告教官 飛機完成 請煞車 *[sir　aircraft is ready　please brake]*
10	43	58.1	INT-1	好 煞車煞上 安全銷拆除 人員撤離 下午見 *[okay　brake on　safety pin off　staff off　see you in the afternoon]*
10	44	01.8	GC	…撤離完成 麻煩看我們手勢回頭見 *[... staff off complete　please watch our gesture see you]*
10	44	03.4	CAM-2	好　single channel 二號

hh[7]	mm	ss	Source	Context
				[okay single channel number two]
10	44	04.9	CAM-1	check
10	44	09.7	CAM-2	一號 *[number one]*
10	44	10.3	CAM-1	check
10	44	14.3	CAM-2	low pitch
10	44	14.8	CAM-1	check
10	44	17.4	CAM-2	low pitch 二號一號 *[low pitch number two number one]*
10	44	17.9	CAM-1	check
10	44	21.8	CAM	(發動機轉速提高聲響) *[sound of engine spool up]*
10	44	22.3	CAM-2	好 b-t-c 接上 *[okay connect b-t-c]*
10	44	24.0	CAM-1	check before taxi procedure
10	44	25.3	CAM-2	before taxi procedure
10	44	29.0	CAM	(single chime)
10	44	30.8	CAM-2	before taxi procedure complete
10	44	30.9	CAM	(single chime)
10	44	32.4	CAM-1	before taxi checklist
10	44	33.7	CAM-2	好 recall 了 對 *[okay it is recalled right]*
10	44	36.9	CAM-2	好 f-w-s *[okay f-w-s]*
10	44	37.8	CAM-1	recall
10	44	38.3	CAM-2	propeller brake
10	44	39.0	CAM-1	off
10	44	39.5	CAM-2	cockpit com hatch
10	44	40.3	CAM-1	closed
10	44	40.8	CAM-2	condition lever 一二 *[condition lever one and two]*
10	44	41.6	CAM-1	auto
10	44	42.2	CAM-2	anti icing
10	44	42.4	OTH	(與 GND 通話) *[communication between other aircraft and ground]*
10	44	42.9	CAM-1	not required
10	44	43.7	CAM-2	anti skid
10	44	44.1	CAM-1	test
10	44	44.7	CAM-2	flaps

hh[7]	mm	ss	Source	Context
10	44	45.0	CAM-1	fifteen
10	44	45.7	CAM-2	nose wheel steering
10	44	46.6	CAM-1	on
10	44	47.0	CAM-2	procedure complete
10	44	47.6	GND	(與其他航機通話) *[communication with other aircraft]*
10	44	47.9	CAM-1	謝謝 *[thank you]*
10	44	53.7	OTH	(與 GND 通話) *[communication between other aircraft and ground]*
10	44	56.7	CAM	(sound of cabin call)
10	44	57.9	INT-1	嗨 *[hello]*
10	44	58.2	INT-4	教官 cabin ready *[sir cabin ready]*
10	44	58.9	RDO-2	songshan ground transasia two tree five request taxi
10	44	59.0	INT-1	好知道了謝謝 *[okay roger thank you]*
10	45	01.8	GND	transasia two tree five runway one zero taxi via whisky
10	45	05.1	RDO-2	taxi via whisky to runway one zero transasia two tree five
10	45	07.7	CAM-2	好 whisky 到么洞 右邊 clear *[okay whisky to one zero right side is clear]*
10	45	09.8	CAM-1	左邊 clear *[left side is clear]*
10	45	17.0	CAM-1	taxi procedure please
10	45	18.1	CAM-2	taxi procedure
10	45	19.7	CAM-2	好 *[okay]* f-m-s f-m-s heading select l-nav i-a-s autospeed taxi procedure complete
10	45	26.1	CAM-1	好 *[okay]* taxi checklist
10	45	27.1	CAM-2	taxi checklist taxi takeoff lights
10	45	29.1	CAM-1	on
10	45	29.9	CAM-2	brakes
10	45	30.4	CAM-1	check
10	45	31.0	CAM-2	f-g-c-p f-m-a
10	45	32.0	CAM-1	heading selected i-a-s f-d left side l-nav blue one five magenta

hh[7]	mm	ss	Source	Context
10	45	36.3	CAM-2	好 check *[okay check]*
10	45	37.1	CAM-2	takeoff configuration test okay
10	45	42.8	CAM-2	takeoff briefing
10	45	43.8	CAM-1	好 muzha two quebec 離場 initial 五千加速高度一千一 complete *[okay muzha two quebec departure initial five thousand acceleration altitude one thousand one hundred complete]*
10	45	46.6	CAM-2	roger 是 thank you procedure complete *[roger yes thank you procedure complete]*
10	45	51.6	CAM-3	還是叫 procedure… 按… *[is it still called procedure… push…]*
10	45	52.4	GND	transasia two tree five contact tower one one eight decimal one good day
10	45	55.5	RDO-2	contact tower one one eight one transasia two tree five good day
10	46	05.5	RDO-2	songshan tower good morning transasia two tree five taxi with you
10	46	10.4	TWR	transasia two tree five songshan tower due to initial separation hold short runway one zero for landing traffic
10	46	15.7	RDO-2	hold short runway one zero transasia two tree five
10	46	17.9	CAM-2	好 hold short runway *[okay hold short runway]*
10	46	18.3	OTH	(與 TWR 對話) *[communication between other aircraft and tower]*
10	46	19.3	CAM-1	是 跑道外等待 *[yes hold short runway]*
10	46	20.3	CAM-2	喔 *[oh]*
10	46	23.5	TWR	(與其他航機對話) *[communication with other aircraft]*
10	46	24.8	CAM-2	跑道外等 *[hold short runway]*
10	46	26.7	CAM-1	是 *[yes]*
10	46	33.7	OTH	(與 TWR 對話) *[communication between other aircraft and tower]*

hh[7]	mm	ss	Source	Context
10	46	39.9	CAM-3	*教官這落地了以後啊 把 f-m-s 就放在 f-m-s *[sir after landing put f-m-s at f-m-s]*
10	46	44.3	CAM-2	喔它嗯它 調整 f-m-s 喔 *[oh it yes it adjust f-m-s]*
10	46	47.0	CAM-3	對對對 *[right right right]*
10	46	47.6	CAM-2	是 *[yes]*
10	46	47.9	CAM-3	這樣在 f-m-s *[at f-m-s like this]*
10	46	49.0	CAM-2	是 *[yes]*
10	46	49.3	CAM-3	先配合到它的步伐 *[in coordination with its pace]*
10	46	51.2	CAM-2	對啊 *[yes]*
10	46	54.1	CAM-2	它只是 先把提前做 下一步的動作這樣 可是剛它開始不熟來不及 所以 就保持 v-o-r 靠擋後弄也可以… *[it just reacts in advance the next step but if not too familiar while it is new so remain at v-o-r then do it later is fine too…]*
10	47	02.6	CAM-3	對啊對啊其實我看它那 *[right actually i see it]*
10	47	04.8	CAM-2	因為他熟了當然知道怎麼做 *[because he is so used to it he know what to do]*
10	47	06.9	CAM-3	對啊下一步要幹甚麼呢 *[yes and what to do next]*
10	47	09.1	CAM-2	嗯 他不熟的就先一步步 先把 *[hmm if not familiar with it then do it step by step first]*
10	47	10.8	CAM-3	因他扭那個動作好像都 連你這個這個 都不知道轉過去啊 *[because he turned it as if and even you do not know to turn it]*
10	47	14.6	CAM-2	喔 *[oh]*
10	47	15.0	CAM-3	(笑聲) *[(laughing)]*
10	47	16.7	CAM-2	我們這個都是太快了 因為你 剛剛開始 使

hh[7]	mm	ss	Source	Context
				用這個最精準 *[we do this too quickly　because you just begins it is more precise to use this]*
10	47	20.3	CAM-3	對啊 一步一步啊 我　就是說　我們是比較慢 其實說老外　就很給你時間 *[oh yes step by step　i　i mean　we are slower and actually for foreigners　give you a lot of time]*
10	47	25.2	CAM-2	給你時間啊 *[give you time]*
10	47	26.1	CAM-3	他給你他 *[they give you]*
10	47	26.6	CAM-2	因為他看的不是那個　他看的重點不是在那邊 *[because he does not want to see that　he does not put too much focus on that]*
10	47	27.8	CAM-3	…
10	47	28.9	TWR	(與其他航機對話) *[communication with other aircraft]*
10	47	32.2	CAM-2	因為 教官你剛剛講到是說　甚麼時候轉到 n-d 頁面 當你做到這個程序 bleed valve 的情況下 它會轉換成這個頁面給你看 *[because　sir you just mentioned　when to switch to n-d page　when you are doing this procedure　at bleed valve　it will switch to this page for you]*
10	47	40.9	CAM	(疑似按鍵聲響) *[sound similar to clicking pushbutton]*
10	47	41.8	CAM-2	轉到這個頁面　當你做到這個頁面之後呢 你就檢查完了 … 你就自己把它換到 n-d page 就好了 *[turn to this page　when you are up to this page you are done with the check…　you switch to n-d page on your own]*
10	47	48.3	CAM-3	它是甚麼時候會轉到這個頁面你說 *[again when will it switch to this page]*
10	47	49.8	CAM-2	我剛就是講 bleed valve 這個 我我現在示範給你看嘛 *[i just said bleed valve　i i will show you]*
10	47	51.7	CAM-3	… bleed valve 是不是啊 *[…is it bleed valve]*

hh[7]	mm	ss	Source	Context
10	47	53.5	CAM-2	啊我我現在試給你看 *[ah i now will show you]*
10	47	54.6	CAM-3	你按到它 bleed valve 它就會轉過去是不是啊 *[when you proceed to bleed valve it will switch over right]*
10	47	55.5	CAM-2	嗄 呃 a little 啊 air flow 那邊啊 這邊轉它這邊它會 它先不會的那一種 *[ah uh a little as for air flow if i turn this then here it would will it not]*
10	48	02.4	CAM-3	你沒有放 system 頁面 *[you did not display system page]*
10	48	03.9	CAM-2	嗄 喔 對 喔對 剛好在 system 頁面這邊 *[uh oh yes oh yes it is right at the system page]*
10	48	08.6	CAM-2	等一下喔 我先跳回這個頁面 我剛在這邊嘛這樣 *[wait a second let me jump back this page where i was]*
10	48	10.7	CAM-3	欸 啊 *[hey uh]*
10	48	15.4	CAM-2	…這樣 自己做 *[… like this will do on its own]*
10	48	19.7	CAM-2	(台語)抱歉抱歉 *[sorry sorry]*
10	48	20.3	CAM-3	你只要按到這邊 你 啊 *[you only have to press here you uh]*
10	48	23.1	CAM-2	我剛在 air flow air flow 那邊好像就會這樣跳了 *[i was at the air flow air flow page and it would switch like this]*
10	48	23.5	CAM-3	… 呃 *[… uh]*
10	48	28.7	CAM-2	等一下 *[wait a second]*
10	48	28.9	CAM-3	現在怎麼辦 這個時候 才轉轉過去 *[what to do now right now it just switched]*
10	48	31.5	CAM-2	好的 好先等一下喔 我再轉另外一個 頁 system *[okay okay wait a second let me switch to another page system]*
10	48	35.0	CAM-2	好

hh[7]	mm	ss	Source	Context
				[okay]
10	48	36.5	CAM-2	不好意思 *教官 *[sorry sir]*
10	48	37.6	CAM-1	hey 怎樣 *[hey what's up]*
10	48	37.8	CAM-2	對啊 我在給它測試這樣 *[oh yah i want to give it a check]*
10	48	40.6	CAM-1	沒問題 *[no problem]*
10	48	41.0	CAM-2	好 *[okay]*
10	48	42.0	CAM-2	等一下 它它跳到 air flow 的時候就會自己轉換 *[wait a second it it will automatically switch when jumping to air flow page]*
10	48	44.5	CAM-3	嗄 呃 air flow 嗯 *[uh uh air flow hmmm]*
10	48	46.1	CAM-2	它可以看 它都可以看啊 我們平常有 high 跟 low 嘛 *[it will show it will show normally it would be high or low]*
10	48	49.6	CAM-3	嗯 high 是甚麼樣子 *[hmm so what does is look like when at high]*
10	48	51.6	CAM-2	high 它變成藍 藍 air flow 這邊 *[for high it will turn blue blue here air flow]*
10	48	53.5	CAM-3	啊有一個 high high 長什麼樣子 看看 *[ah there is a high what does it look like check it out]*
10	48	58.8	CAM-3	因為它 這個 轉過去 *[because it this switch it over]*
10	49	00.8	CAM-2	它自己跳過去了 跳到這一邊之後呢 你做到這個程序 你這個呃 *[it switched over automatically after switching over here you proceed to this procedure you uh]*
10	49	04.9	CAM-3	然後這個 bleed valve 這個時候呢 *[then the bleed valve and now]*
10	49	07.4	CAM-2	嗯 *[hmmm]*

hh[7]	mm	ss	Source	Context
10	49	07.7	CAM-3	它還是保持 *[it will remain]*
10	49	08.3	CAM-2	它還是會保持 它就不會跳了 *[it will remain it will not switch]*
10	49	09.2	CAM-3	… 就可以轉過去是吧 *[… will switch over right]*
10	49	10.7	CAM-2	這邊就要靠自己用手動的方式了 *[here you have to do it manually]*
10	49	11.0	CAM-3	嗯 嗯 嗯 *[hmmm hmmm hmmm]*
10	49	14.3	CAM-3	就是那 *[this is it]*
10	49	15.0	CAM-2	對啊 *[yes]*
10	49	18.9	CAM-2	好教官不好意思 冒犯了 *[all right sir excuse me for disturbing you]*
10	49	20.9	CAM-3	沒有沒有沒有沒有 沒有沒有 我不好意思啊 我要問 *[no no no no not at all i shall say excuse me instead it is me who asked help]*
10	49	23.9	CAM-2	嗯 *[hmmm]*
10	49	24.7	CAM-3	…
10	49	24.9	CAM-2	我是冒犯了 *教官打斷他的 呃 抱歉 *[oh i meant to apologize to captain for interrupting his uh sorry for that]*
10	49	28.0	CAM-1	我在放空你們繼續繼續 放空 *[i was in numb you guys can continue in numbness]*
10	49	39.2	CAM-1	(疑似伸懶腰聲音) *[sound similar to yawning while stretching]*
10	50	08.2	TWR	transasia two tree five line up and wait runway one zero
10	50	11.2	RDO-2	line up and wait runway one zero transasia two tree five
10	50	13.6	CAM-1	進跑道等待 *[line up runway and wait]*
10	50	13.8	CAM-2	他許可進跑道 *[it grants to line up runway]*
10	50	16.0	PA-1	cabin crew prepare for takeoff

hh[7]	mm	ss	Source	Context
10	50	18.4	CAM-1	哇 before takeoff procedure *[wow before takeoff procedure]*
10	50	20.8	CAM-2	好 roger *[okay]*
10	50	23.1	CAM-2	gust lock 我就會鬆掉它同時打開 radar *[gust lock i will release it and open radar]*
10	50	26.3	CAM-3	這是一個一連串 *[these are actions in a row]*
10	50	27.3	CAM-2	一連串動作就這樣就好了 好 before takeoff left side spoiler up *[a series of actions like these and we are done now okay before takeoff left side spoiler up]*
10	50	30.4	PA-4	各位貴賓我們即將起飛請您確實扣緊您的安全帶謝謝 (台語)各位貴賓我們即將起飛請您確實扣緊您的安全帶感謝 *[ladies and gentlemen we will be taking off shortly please fasten your seatbelt thank you (repeat in Taiwanese)]*
10	50	32.2	CAM-1	left up
10	50	33.1	CAM-2	right side spoiler up
10	50	34.4	CAM-1	lights on
10	50	34.6	CAM-2	lights on
10	50	37.4	CAM-2	因為剛好那個 比較順手嘛這樣做 好 before 嗯 before takeoff procedure complete *[because it is right at that doing this way makes it more smoothly okay before uh before takeoff procedure complete]*
10	50	40.2	TWR	(與其他航機對話) *[communication with other aircraft]*
10	50	42.9	CAM-1	before takeoff checklist
10	50	44.2	CAM-2	跑道是么洞 verified *[runway one zero verified]*
10	50	45.5	OTH	(與 TWR 對話) *[communication between other aircraft and tower]*
10	50	46.0	CAM-1	么洞 verified *[one zero verified]*
10	50	46.8	CAM-2	gust lock
10	50	47.5	CAM-1	released
10	50	48.1	CAM-2	flight control

hh[7]	mm	ss	Source	Context
10	50	49.0	CAM-1	check
10	50	49.4	CAM-2	transponder tcas
10	50	50.7	CAM-1	check
10	50	51.6	CAM-2	air flow
10	50	52.3	CAM-1	normal
10	50	52.9	CAM-2	現在看那個 normal 呃 有沒有跳回來 好 bleed valves *[now watch that normal uh did it switch back good bleed valves]*
10	50	56.0	CAM-1	on
10	50	57.2	CAM-2	external lights
10	50	58.3	CAM-1	on
10	50	59.0	CAM-2	when line up standby f-d bar 我就這樣換回來這樣 *[when line up standby f-d bar i will switch it back like this]*
10	51	02.4	CAM-3	這樣子喔換回來 line up standby *[switch it back like this line up standby]*
10	51	07.5	CAM-3	而且 line up 這 when line up standby 是不是啊 *[and line up this when line up standby isn’t it]*
10	51	09.7	CAM-2	啊對 standby 對啊 那這個要等到 when line up *[oh yes standby yes that has to wait until when line up]*
10	51	12.5	CAM-3	沒有…這句話怎麼講的 line up 等待 *[no… what does that mean line up and wait]*
10	51	12.7	TWR	transasia two tree five runway one zero wind one zero zero degree niner knots cleared for takeoff
10	51	15.2	CAM-2	等一下 *[wait a second]*
10	51	18.1	CAM-1	…
10	51	18.9	RDO-2	cleared for takeoff runway one zero transasia two tree five
10	51	23.4	CAM-2	好 許可起飛了 *[ok cleared for takeoff]*
10	51	23.8	CAM-1	許可起飛 *[cleared for takeoff]*
10	51	28.9	CAM-2	好 f-d bar *[okay f-d bar]*
10	51	29.7	CAM-1	center
10	51	30.2	CAM-2	center

hh[7]	mm	ss	Source	Context
10	51	31.6	CAM-2	rudder cam
10	51	32.4	CAM-1	center
10	51	33.9	CAM-2	center procedure complete
10	51	35.4	CAM-1	yes sir
10	51	35.8	CAM-2	好 *[okay]*
10	51	35.9	CAM-1	五么分 v one 么洞六 *[time five one v one one zero six]*
10	51	36.6	CAM-2	嗯 五么分 roger check *[hmmm time five one roger check]*
10	51	39.6	CAM	(發動機轉速提高聲響) *[sound of engine spool up]*
10	51	42.4	CAM-2	欸 *[hey]*
10	51	42.8	CAM-1	欸 *[hey]*
10	51	43.3	CAM-2	沒有 a-t-p-c-s armed *[no a-t-p-c-s armed]*
10	51	44.5	CAM-1	是喔 *[really]*
10	51	46.2	CAM-2	好 takeoff inhibit *[okay takeoff inhibit]*
10	51	47.7	CAM-1	takeoff inhibit
10	51	48.4	CAM-2	好 *[okay]*
10	51	48.7	CAM-1	好繼續起飛 *[ok continue to takeoff]*
10	51	49.2	CAM-2	我們繼續走喔 seventy *[we will continue seventy]*
10	51	50.6	CAM-1	seventy i have control
10	51	50.6	OTH	(其他航機通話) *[communication between tower and other aircraft]*
10	51	51.5	CAM-2	喔有啊 a-t-p-c-s armed 有 *[oh there it is a-t-p-c-s armed]*
10	51	53.7	TWR	(與其他航機對話) *[communication with other aircraft]*
10	51	57.9	CAM-2	engine instrument check normal
10	51	58.8	CAM-1	v one v r
10	51	59.4	CAM-2	v one v r

hh[7]	mm	ss	Source	Context
10	52	00.2	CAM-1	rotate
10	52	01.7	CAM	(pitch trim 聲響) *[sound of pitch trim]*
10	52	03.7	CAM-2	好 positive rate *[okay positive rate]*
10	52	05.0	CAM-1	gear up
10	52	05.4	CAM-2	gear up
10	52	07.4	CAM	(pitch trim 聲響) *[sound of pitch trim]*
10	52	07.8	CAM-1	l nav green
10	52	09.0	CAM-2	check
10	52	13.9	CAM-1	au autopilot on
10	52	15.5	CAM-2	autopilot on
10	52	16.0	CAM	(pitch trim 聲響) *[sound of pitch trim]*
10	52	17.1	CAM-1	a-p green
10	52	17.7	CAM-2	check
10	52	20.8	CAM-2	gear up set
10	52	21.1	CAM-1	… check
10	52	32.1	CAM-2	他可能 throttle 補一下就有了 呃大概 *[it came back after we advanced the throttle uh maybe]*
10	52	33.6	CAM-1	yes
10	52	33.8	TWR	transasia two three five contact taipei approach one one niner decimal seven good day
10	52	34.3	CAM-2	yah…
10	52	36.7	CAM	(bleed valve 關閉聲響) *[sound of bleed valve closure]*
10	52	37.7	RDO-2	one one niner seven transasia two tree five good day
10	52	38.3	CAM	(master warning 至 1052:40.0) *[sound of master warming until 1052:40.0]*
10	52	39.4	CAM-2	欸 看一下 來 欸 *[hey take a look hey]*
10	52	39.4	CAM-1	* 好 i i have control *[* okay i i have control]*
10	52	41.4	CAM	(自動駕駛解除聲響) *[sound of autopilot disengagement]*
10	52	41.6	CAM-2	you have control
10	52	43.0	CAM-1	我把 一號發動機 收回來

hh[7]	mm	ss	Source	Context
				[i will pull back engine one throttle]
10	52	43.0	CAM	(pitch trim 聲響) *[sound of pitch trim]*
10	52	43.6	CAM-2	等一下　cross check *[wait a second　cross check]*
10	52	44.8	CAM	(sound of single cavalry charge)
10	52	46.1	CAM-1	heading mode
10	52	46.6	CAM-2	heading mode
10	52	47.3	CAM-1	好 我們繼續 *[okay let us continue]*
10	52	48.4	CAM-2	heading mode 嘛還是 *[heading mode or]*
10	52	48.5	CAM	(single chime)
10	52	50.0	CAM-1	好 *[okay]*
10	52	50.1	CAM-2	我們… 呃 低於兩千五 我們 heading 轉去 啊 那個 *[we are… uh lower than twenty five hundreds we turn the heading to　that]*
10	52	54.1	CAM-1	繼續 *[continue]*
10	52	54.3	CAM-2	洞 洞九五那邊 *[zero　zero niner five]*
10	52	55.6	CAM-1	好 *[okay]*
10	52	56.3	CAM-2	… heading select
10	52	57.4	CAM-1	check
10	52	58.5	CAM-1	那我速度 *[and speed]*
10	52	58.9	CAM-2	好 check *[okay check]*
10	52	58.9	CAM	(pitch trim 聲響) *[sound of pitch trim]*
10	52	59.4	CAM	(sound similar to single chime)
10	53	00.4	CAM-2	好 engine flameout　check *[okay engine flameout　check]*
10	53	01.6	CAM-1	check
10	53	01.8	CAM	(pitch trim 聲響) *[sound of pitch trim]*
10	53	02.2	CAM-2	check up trim 有

hh[7]	mm	ss	Source	Context
				[check up trim　yes]
10	53	04.1	CAM-2	auto feather 有 *[auto feather　yes]*
10	53	05.2	CAM-1	好 *[okay]*
10	53	05.5	CAM-2	速度先注意一下 *[watch the speed]*
10	53	06.4	CAM-1	number one 收回來 *[pull back number one]*
10	53	07.7	CAM-2	好 現在是確定二號 engine flameout *[okay now number two engine flameout confirmed]*
10	53	08.6	CAM	(sound of triple clicks)
10	53	09.3	CAM-1	好 *[okay]*
10	53	09.9	CAM	(失速警告聲響至 1053:10.8) *[sound of stall warning until 1053:10.8]*
10	53	10.7	CAM-2	等一下 他 *[wait a second　it]*
10	53	12.1	CAM-1	* 有地障 *[*　terrain ahead]*
10	53	12.1	CAM-2	好 低… *[okay　lower…]*
10	53	12.9	CAM-3	你低了 *[you are low]*
10	53	12.6	CAM	(失速警告聲響至 1053:18.8) *[sound of stall warning until 1053:18.8]*
10	53	12.8	CAM	(stick shaker 聲響至 1053:18.8) *[sound of stick shaker until 1053:18.8]*
10	53	13.7	CAM-2	好 推 推回 *[okay push　push back]*
10	53	15.0	CAM-1	shut
10	53	15.6	CAM-2	等一下 …油門 *[wait a second … throttle]*
10	53	17.9	CAM-2	油門 *[throttle]*
10	53	19.6	CAM-1	number one
10	53	20.2	CAM-2	number feather
10	53	21.1	CAM-1	feather shut off
10	53	21.4	CAM	(失速警告聲響至 1053:23.3)

hh[7]	mm	ss	Source	Context
				[sound of stall warning until 1053:23.3]
10	53	21.4	CAM	(stick shaker 聲響至 1053:23.3) *[sound of stick shaker until 1053:23.3]*
10	53	21.7	CAM-2	okay
10	53	22.6	CAM-1	呃 number one *[uh number one]*
10	53	25.3	CAM-1	好我繼續飛啊 *[okay i have control]*
10	53	25.3	CAM	(single chime)
10	53	25.7	CAM	(失速警告聲響至 1053:27.3) *[sound of stall warning until 1053:27.3]*
10	53	25.7	CAM	(stick shaker 聲響至 1053:27.3) *[sound of stick shaker until 1053:27.3]*
10	53	26.2	CAM-2	好 你來飛 *[okay you have control]*
10	53	27.4	CAM	(sound of one click)
10	53	27.6	CAM	(single chime)
10	53	28.1	CAM-2	好 跟著 heading bug *[okay follow the heading bug]*
10	53	29.7	CAM-1	跟著 heading bug 喔 *[follow the heading bug oh]*
10	53	30.4	CAM-2	好 heading autofeather 唉唷 *[okay heading autofeather ouch]*
10	53	32.1	CAM-1	check
10	53	34.9	RDO-2	tower transasia two tree five mayday mayday engine flameout
10	53	39.4	TWR	transasia two tree five please try again contact taipei approach one one niner decimal seven
10	53	43.1	CAM-2	好 現在航向轉一個洞九五 *[okay now heading turn to zero niner five]*
10	53	45.4	CAM-1	check
10	53	46.4	CAM-1	autopilot 接上 *[engage autopilot]*
10	53	47.0	CAM-2	好的 autopilot 好 *[okay autopilot okay]*
10	53	48.7	CAM-1	a p green
10	53	49.7	CAM-2	a p green
10	53	50.7	CAM	(pitch trim 聲響) *[sound of pitch trim]*
10	53	51.0	CAM-2	trim 打好…

hh[7]	mm	ss	Source	Context
				[put the trim right]
10	53	53.5	CAM-3	怎麼這樣子勒 *[how come it becomes like this]*
10	53	54.5	CAM-1	好你負責對外 *[okay you are in charge of communication]*
10	53	55.6	CAM-2	好　我來對啊 *[okay　will do]*
10	53	55.9	CAM	(失速警告聲響至 1053:59.7) *[sound of stall warning until 1053:59.7]*
10	53	55.9	CAM	(stick shaker 聲響至 1053:59.7) *[sound of stick shaker until 1053:59.7]*
10	53	56.7	CAM-2	不要帶太高　不要太高 *[don't pull too high　not too high]*
10	53	58.7	CAM-1	我現在是 autopilot autopilot 再接一次 *[i now have autopilot　reconnect the autopilot]*
10	54	00.0	CAM	(autopilot 解除聲響) *[sound of autopilot disengagement]*
10	54	00.3	CAM-2	好　再接一次 *[okay　reconnect it one more time]*
10	54	03.4	CAM-2	疑 沒有 *[eh　no]*
10	54	04.1	CAM	(autopilot 解除聲響) *[sound of autopilot disengagement]*
10	54	04.2	CAM-1	我先轉... *[i will turn…]*
10	54	05.0	CAM-2	兩邊都沒有… *[both sides … lost]*
10	54	06.1	CAM	(失速警告聲響至 1054:10.1) *[sound of stall warning until 1054:10.1]*
10	54	06.1	CAM	(stick shaker 聲響至 1054:10.1) *[sound of stick shaker until 1054:10.1]*
10	54	06.5	CAM	(sound of two clicks)
10	54	07.0	CAM-2	沒有 engine flameout both sides 沒有了 *[no　engine flameout　we lost both sides]*
10	54	08.9	CAM-1	好 *[okay]*
10	54	09.2	CAM-1	重新開車 *[restart the engine]*
10	54	09.9	CAM-2	好 *[okay]*

hh[7]	mm	ss	Source	Context
10	54	10.2	CAM	five hundred
10	54	10.4	CAM	(autopilot 解除聲響) *[sound of autopilot disengagement]*
10	54	11.4	CAM-1	重新開車 *[restart the engine]*
10	54	11.9	CAM-2	okay
10	54	12.4	CAM	(失速警告聲響至 1054:21.6) *[sound of stall warning until 1054:21.6]*
10	54	12.4	CAM	(stick shaker 聲響至 1054:21.6) *[sound of stick shaker until 1054:21.6]*
10	54	14.1	CAM-1	重新開車 *[restart the engine]*
10	54	14.5	CAM-2	roger
10	54	16.2	CAM-2	button on
10	54	17.7	CAM-1	重新開車 *[restart the engine]*
10	54	18.3	CAM-2	okay
10	54	18.7	TWR	(與其他航機通話) *[communication with other aircraft]*
10	54	20.4	CAM-2	okay
10	54	21.3	CAM-1	重新開車 *[restart the engine]*
10	54	21.8	CAM-2	roger
10	54	21.9	CAM	(autopilot 解除聲響) *[sound of autopilot disengagement]*
10	54	22.6	CAM-2	呃 要往左邊哪 *[uh to the left hand side]*
10	54	23.2	CAM	(失速警告聲響至 1054:33.9) *[sound of stall warning until 1054:33.9]*
10	54	23.5	CAM	(stick shaker 聲響至 1054:33.9) *[sound of stick shaker until 1054:33.9]*
10	54	24.0	CAM-1	重新開車 *[restart the engine]*
10	54	25.5	CAM-2	開不到 *[cannot restart it]*
10	54	26.3	CAM-1	重新開車 *[restart the engine]*
10	54	27.1	CAM-1	哇油門收錯了 *[wow pulled back the wrong side throttle]*
10	54	30.5	CAM-1	重新開車

hh[7]	mm	ss	Source	Context
				[restart the engine]
10	54	30.9	CAM-2	啊 *[ah]*
10	54	31.8	CAM-3	impact impact brace for impact
10	54	34.0	CAM-1	啊* *[ah]*
10	54	34.1	CAM	pull up
10	54	34.2	CAM	(sound of cavalry charge)
10	54	34.6	CAM	(master warning)
10	54	34.8	CAM	(不明聲響) *[unidentified sound]*
10	54	35.4	CAM-2	…
10	54	35.9	CAM	pull up
10	54	36.6		CVR 錄音終止 *[CVR recording ends]*

Note: The languages used in original CVR transcript include Chinese and English. To make it better understanding for investigation parties, the Chinese is translated into English in this translation version. Although efforts are made to translate it as accurate as possible, discrepancies may occur. In this case the Chinese version will be the official version.

Appendix 3 FDR recording parameters list

Parameter Name	Alternate Name
26VAC1	26VAC Bus 1 Status
26VAC2	26VAC Bus 2 Status
26VACSTBY	26VAC STBY Bus Status
4096ID	4096 Ident Code
ACB1	AC 1 BUS STATUS
ACB1OFF	AC Bus 1 OFF
ACB2	AC 2 BUS STATUS
ACB2OFF	AC Bus 2 OFF
ACCX	Acceleration X
ACCXC	Acceleration X MSB
ACCXF	Acceleration X LSB
ACCY	Acceleration Y
ACCYC	Acceleration Y MSB
ACCYF	Acceleration Y LSB
ACCZ	Acceleration Z
ACCZC	Acceleration Z MSB
ACCZF	Acceleration Z LSB
ACID1	A/C Ident 1
ACID2	A/C Ident 2
ACID3	A/C Ident 3
ACID4	A/C Ident 4
ACID5	A/C Ident 5
ACID6	A/C Ident 6
ACID7	A/C Ident 7
ACID8	A/C Ident 8
ACID9	A/C Ident 9
ACPINPROG	A/C Pin prog integrity
ACTYPE1	A/C Type 1
ACTYPE2	A/C Type 2
ACTYPE3	A/C Type 3
ACTYPE4	A/C Type 4
ACWB1	ACW Bus 1 OFF
ACWB2	ACW Bus 2 OFF
ACWGEN1F	ACW Generatrice 1 Fault
ACWGEN2F	ACW Generatrice 2 Fault
ADC1DU1	ADC selection 1 DU1
ADC1DU2	ADC selection 1 DU2
ADC2DU4	ADC selection 2 DU4
ADC2DU5	ADC selection 2 DU5

ADCSELCAP	ADC selection (Captain) CAC1
ADCSELCAP2	ADC selection (Captain) CAC2
ADCSELFO	ADC selection (F/O) CAC1
ADCSELFO2	ADC selection (F/O) CAC2
ADCSWSEL	ADC Switch Selection
ADVDWN	Advisory down
ADVRATE	Resolution Advisory (part 1)
ADVUP	advisory up
AFCSABDIS	AFCS Abnormal Disconnect CAC1
AFCSABDIS2	AFCS Abnormal Disconnect CAC2
AFCTL	AIR FLOW CONTROL
AFRMDICE	De-Icing Airframe ON
AFSCFMAM	AFCS FMA Messages CAC1
AFSCFMAM2	AFCS FMA Messages CAC2
AHRS1DU1	AHRS selection 1 DU1
AHRS1DU2	AHRS selection 1 DU2
AHRS2DU4	AHRS selection 2 DU4
AHRS2DU5	AHRS selection 2 DU5
AHRSELCAP	AHRS selection (Captain) CAC1
AHRSELCAP2	AHRS selection (Captain) CAC2
AHRSELFO	AHRS selection (F/O) CAC1
AHRSELFO2	AHRS selection (F/O) CAC2
AILL	ROLL Surf. pos. LH
AILR	ROLL Surf. pos. RH
AILT	Roll Trim Surface Position
AILTLH	Roll Trim LH Command
AILTRH	Roll Trim RH Command
AIRDISP1	Air disp 1
AIRDISP2	Air disp 2
AIRDISP4	Air disp 4
AIRDISP5	Air disp 5
AIRFRAMEF	De-Icing Airframe FAULT
APMACTEST	APM aircraft test (light test)
APMENAB	APM enable test
APMFAULT	APM FAULT
APMON	APM ON/OFF
APMV1	APM Version 1
APMV2	APM Version 2
APMV3	APM Version 3
APMV4	APM Version 4
APPCAT	Approach Category CAC1
APPCAT2	Approach Category CAC2
APYDENG	AP/YD engagement CAC1

APYDENG2	AP/YD engagement CAC2
ARMLAT2	Armed Lateral Mode CAC2
ARMLATM	Armed Lateral Mode CAC1
ARMVERTM	Armed Vertical Mode CAC1
ARMVERTM2	Armed Vertical Mode CAC2
ATRSEL	ATR42/72 selection 1
ATRSEL2	ATR42/72 selection 2
BAROCALT	Baro-corrected altitude
BAROCALT_sign	Baro-corrected altitude sign
BAROCALTC	Baro-corrected altitude MSB
BAROCALTF	Baro-corrected altitude LSB
BOOST	Boost PW127M
BRKPLC	CAPT LH Pedal Brake Application
BRKPLF	F/O LH Pedal Brake Application
BRKPRC	CAPT RH Pedal Brake Application
BRKPRF	F/O RH Pedal Brake Application
CAC1STAT	CAC 1 STATUS
CAC2STAT	CAC 2 STATUS
CAS	Computed Airspeed
CAS_sign	Computed Airspeed sign
CASC	Computed Airspeed MSB
CASF	Computed Airspeed LSB
CCLCF	Pitch Captain Axis Effort
CCLFOF	Pitch F/O Axis Effort
CCLNL	LH Pitch Ctl Position
CCLNR	RH Pitch Ctl Position
CLAFSO1	CLA 1 Fuel shut off
CLAFSO2	CLA 2 Fuel shut off
COMBCONT	combined control
CURRENTL	Current detector Left
CURRENTR	Current detector Right
CWHL	ROLL control wheel pos.
DAY	Day
DC1	DC Bus 1
DC2	DC Bus 2
DCB1ST	DC 1 BUS STATUS
DCB2ST	DC 2 BUS STATUS
DCBSTBY	DC STBY Bus OFF
DCEMERG	DC Emergency Bus
DCESS1	DC Essential Bus 1
DCESS2	DC Essential Bus 2
DCGEN1F	DC Generatrice 1 Fault
DCGEN2F	DC Generatrice 2 Fault

DCGENU12	DC Generatrice Utilities 1&2
DEGPERFL	Degraded Perf
DESTRACK1	Desired Track DU2/FMS1
DESTRACK2	Desired Track DU4/FMS2
DETREDW1	Detection_Red_Warning_1 CAC1
DETREDW1_2	Detection_Red_Warning_1 CAC2
DETREDW10	Detection_Red_Warning_10 CAC1
DETREDW10_2	Detection_Red_Warning_10 CAC2
DETREDW11	Detection_Red_Warning_11 CAC1
DETREDW11_2	Detection_Red_Warning_11 CAC2
DETREDW12	Detection_Red_Warning_12 CAC1
DETREDW12_2	Detection_Red_Warning_12 CAC2
DETREDW13	Detection_Red_Warning_13 CAC1
DETREDW13_2	Detection_Red_Warning_13 CAC2
DETREDW14	Detection_Red_Warning_14 CAC1
DETREDW14_2	Detection_Red_Warning_14 CAC2
DETREDW15	Detection_Red_Warning_15 CAC1
DETREDW15_2	Detection_Red_Warning_15 CAC2
DETREDW16	Detection_Red_Warning_16 CAC1
DETREDW16_2	Detection_Red_Warning_16 CAC2
DETREDW17	Detection_Red_Warning_17 CAC1
DETREDW17_2	Detection_Red_Warning_17 CAC2
DETREDW18	Detection_Red_Warning_18 CAC1
DETREDW18_2	Detection_Red_Warning_18 CAC2
DETREDW19	Detection_Red_Warning_19 CAC1
DETREDW19_2	Detection_Red_Warning_19 CAC2
DETREDW2	Detection_Red_Warning_2 CAC1
DETREDW2_2	Detection_Red_Warning_2 CAC2
DETREDW20	Detection_Red_Warning_20 CAC1
DETREDW20_2	Detection_Red_Warning_20 CAC2
DETREDW21	Detection_Red_Warning_21 CAC1
DETREDW21_2	Detection_Red_Warning_21 CAC2
DETREDW22	Detection_Red_Warning_22 CAC1
DETREDW22_2	Detection_Red_Warning_22 CAC2
DETREDW23	Detection_Red_Warning_23 CAC1
DETREDW23_2	Detection_Red_Warning_23 CAC2
DETREDW24	Detection_Red_Warning_24 CAC1
DETREDW24_2	Detection_Red_Warning_24 CAC2
DETREDW25	Detection_Red_Warning_25 CAC1
DETREDW25_2	Detection_Red_Warning_25 CAC2
DETREDW26	Detection_Red_Warning_26 CAC1
DETREDW26_2	Detection_Red_Warning_26 CAC2
DETREDW27	Detection_Red_Warning_27 CAC1

DETREDW27_2	Detection_Red_Warning_27 CAC2
DETREDW28	Detection_Red_Warning_28 CAC1
DETREDW28_2	Detection_Red_Warning_28 CAC2
DETREDW29	Detection_Red_Warning_29 CAC1
DETREDW29_2	Detection_Red_Warning_29 CAC2
DETREDW3	Detection_Red_Warning_3 CAC1
DETREDW3_2	Detection_Red_Warning_3 CAC2
DETREDW30	Detection_Red_Warning_30 CAC1
DETREDW30_2	Detection_Red_Warning_30 CAC2
DETREDW31	Detection_Red_Warning_31 CAC1
DETREDW31_2	Detection_Red_Warning_31 CAC2
DETREDW32	Detection_Red_Warning_32 CAC1
DETREDW32_2	Detection_Red_Warning_32 CAC2
DETREDW33	Detection_Red_Warning_33 CAC1
DETREDW33_2	Detection_Red_Warning_33 CAC2
DETREDW34	Detection_Red_Warning_34 CAC1
DETREDW34_2	Detection_Red_Warning_34 CAC2
DETREDW35	Detection_Red_Warning_35 CAC1
DETREDW35_2	Detection_Red_Warning_35 CAC2
DETREDW36	Detection_Red_Warning_36 CAC1
DETREDW36_2	Detection_Red_Warning_36 CAC2
DETREDW37	Detection_Red_Warning_37 CAC1
DETREDW37_2	Detection_Red_Warning_37 CAC2
DETREDW38	Detection_Red_Warning_38 CAC1
DETREDW38_2	Detection_Red_Warning_38 CAC2
DETREDW39	Detection_Red_Warning_39 CAC1
DETREDW39_2	Detection_Red_Warning_39 CAC2
DETREDW4	Detection_Red_Warning_4 CAC1
DETREDW4_2	Detection_Red_Warning_4 CAC2
DETREDW40	Detection_Red_Warning_40 CAC1
DETREDW40_2	Detection_Red_Warning_40 CAC2
DETREDW41	Detection_Red_Warning_41 CAC1
DETREDW41_2	Detection_Red_Warning_41 CAC2
DETREDW42	Detection_Red_Warning_42 CAC1
DETREDW42_2	Detection_Red_Warning_42 CAC2
DETREDW43	Detection_Red_Warning_43 CAC1
DETREDW43_2	Detection_Red_Warning_43 CAC2
DETREDW44	Detection_Red_Warning_44 CAC1
DETREDW44_2	Detection_Red_Warning_44 CAC2
DETREDW45	Detection_Red_Warning_45 CAC1
DETREDW45_2	Detection_Red_Warning_45 CAC2
DETREDW46	Detection_Red_Warning_46 CAC1
DETREDW46_2	Detection_Red_Warning_46 CAC2

DETREDW47	Detection_Red_Warning_47 CAC1
DETREDW47_2	Detection_Red_Warning_47 CAC2
DETREDW48	Detection_Red_Warning_48 CAC1
DETREDW48_2	Detection_Red_Warning_48 CAC2
DETREDW49	Detection_Red_Warning_49 CAC1
DETREDW49_2	Detection_Red_Warning_49 CAC2
DETREDW5	Detection_Red_Warning_5 CAC1
DETREDW5_2	Detection_Red_Warning_5 CAC2
DETREDW50	Detection_Red_Warning_50 CAC1
DETREDW50_2	Detection_Red_Warning_50 CAC2
DETREDW51	Detection_Red_Warning_51 CAC1
DETREDW51_2	Detection_Red_Warning_51 CAC2
DETREDW52	Detection_Red_Warning_52 CAC1
DETREDW52_2	Detection_Red_Warning_52 CAC2
DETREDW53	Detection_Red_Warning_53 CAC1
DETREDW53_2	Detection_Red_Warning_53 CAC2
DETREDW54	Detection_Red_Warning_54 CAC1
DETREDW54_2	Detection_Red_Warning_54 CAC2
DETREDW6	Detection_Red_Warning_6 CAC1
DETREDW6_2	Detection_Red_Warning_6 CAC2
DETREDW7	Detection_Red_Warning_7 CAC1
DETREDW7_2	Detection_Red_Warning_7 CAC2
DETREDW8	Detection_Red_Warning_8 CAC1
DETREDW8_2	Detection_Red_Warning_8 CAC2
DETREDW9	Detection_Red_Warning_9 CAC1
DETREDW9_2	Detection_Red_Warning_9 CAC2
DISINNER1	Discrete Inner 1
DISINNER2	Discrete Inner 2
DISMIDDL1	Discrete Middle 1
DISMIDDL2	Discrete Middle 2
DISMISAP1	Distance to missed approach point 1
DISMISAP2	Distance to missed approach point 2
DISOUT1	Discrete Outer 1
DISOUT2	Discrete Outer 2
DMEDIS1	DME Distance 1
DMEDIS2	DME Distance 2
DRIFANG1	Drift Angle 1
DRIFANG2	Drift Angle 2
DU1STAT	DU1 status
DU2STAT	DU2 status
DU3STAT	DU3 status
DU4STAT	DU4 status
DU5STAT	DU5 status

EEC1F	EEC 1 Fault
EEC2F	EEC 2 Fault
EGT1W	Eng Overtemp LH
EGT2W	Eng Overtemp RH
ELVL	PITCH Surf. pos. LH
ELVR	PITCH Surf. pos. RH
ELVT	Pitch Trim Surface Position
ENG1BV	Eng Bleed Valve Position LH
ENG2BV	Eng Bleed Valve Position RH
ENGLATM	Engaged Lateral Mode CAC1
ENGLATM2	Engaged Lateral Mode CAC2
ENGMOD1L	ENG mode 1 Left
ENGMOD1R	ENG mode 1 Right
ENGMOD2L	ENG mode 2 Left
ENGMOD2R	ENG mode 2 Right
ENGVERTM	Engaged Vertical Mode CAC1
ENGVERTM2	Engaged Vertical Mode CAC2
EVTMKR	Event Marker
FDALERT	FD Alert CAC1
FDALERT2	FD Alert CAC2
FDAUBITE11	FDAU BITE part 1 (bits 12-1)
FDAUBITE12	FDAU BITE part 1 (bits 24-13)
FDAUBITE13	FDAU BITE part 1 (bits 32-25)
FDAUBITE21	FDAU BITE part 2 (bits 12-1)
FDBDISEL	FD Bar Display selected CAC1
FDBDISEL2	FD Bar Display selected CAC2
FFKG1	Fuel Flow left (KPH)
FFKG2	Fuel Flow right (KPH)
FFPPH1	Fuel Flow left (PPH)
FFPPH2	Fuel Flow right (PPH)
FLIGHTID	A/C Flight ident
FLIGHTID10	A/C Flight ident 1 character 10
FLIGHTID11	A/C Flight ident 1 character 1
FLIGHTID12	A/C Flight ident 1 character 2
FLIGHTID13	A/C Flight ident 1 character 3
FLIGHTID14	A/C Flight ident 1 character 4
FLIGHTID15	A/C Flight ident 1 character 5
FLIGHTID16	A/C Flight ident 1 character 6
FLIGHTID17	A/C Flight ident 1 character 7
FLIGHTID18	A/C Flight ident 1 character 8
FLIGHTID19	A/C Flight ident 1 character 9
FLP0	Flap Command 0°
FLP15	Flap Command 15°

FLP2528	Flap Command 25°/28°
FLP33	Flap Command 33°
FLPASYM	Trailing Edge Flap Assym
FLPRH	FLAP RH POSITION
FMSPOSERR1	FMS Estimated Position Error DU2/FMS1
FMSPOSERR1_sign	FMS Estimated Position Error DU2/FMS1 sign
FMSPOSERR1C	FMS Estimated Position Error DU2/FMS1 coarse
FMSPOSERR1F	FMS Estimated Position Error DU2/FMS1 fine
FMSPOSERR2	FMS Estimated Position Error DU4/FMS2
FMSPOSERR2_sign	FMS Estimated Position Error DU4/FMS2 sign
FMSPOSERR2C	FMS Estimated Position Error DU4/FMS2 coarse
FMSPOSERR2F	FMS Estimated Position Error DU4/FMS2 fine
FQ1KG42	Fuel Quantity 1 (PPH)
FQ1KG72	Fuel Quantity 1 (KPH)
FQ1LBS42	Fuel Quantity 1 (PPH)
FQ1LBS72	Fuel Quantity 1 (KPH)
FQ2KG42	Fuel Quantity 2 (PPH)
FQ2KG72	Fuel Quantity 2 (KPH)
FQ2LBS42	Fuel Quantity 2 (PPH)
FQ2LBS72	Fuel Quantity 2 (KPH)
FWAPBUP1	FWA Primary/Backup CAC1
FWAPBUP2	FWA Primary/Backup CAC2
GPSALT1	GPS1 altitude
GPSALT1_sign	GPS altitude GPS1 sign
GPSALT1C	GPS altitude GPS1 coarse
GPSALT1F	GPS altitude GPS1 fine
GPSALT2	GPS2 altitude
GPSALT2_sign	GPS altitude GPS2 sign
GPSALT2C	GPS altitude GPS2 coarse
GPSALT2F	GPS altitude GPS2 fine
GPWS	Gpws Status
GRSPEED1	Ground Speed 1
GRSPEED2	Ground Speed 2
GW1	Gross Weight 1
GW2	Gross Weight 2
HAILELVRI	Horns Aileron & RH Elevator De-Ice
HDG	Heading
HDG_sign	Heading sign
HDGC	Heading MSB
HDGF	Heading LSB
HEMERGBAT	Hot Emergency Bat Bus
HF	HF
HFOM1	HFOM GPS1

HFOM1C	HFOM GPS1 coarse
HFOM1F	HFOM GPS1 fine
HFOM2	HFOM GPS2
HFOM2C	HFOM GPS2 coarse
HFOM2F	HFOM GPS2 fine
HIL1	HIL1
HIL1C	HIL GPS1 coarse
HIL1F	HIL GPS1 fine
HIL2	HIL2
HIL2C	HIL GPS2 coarse
HIL2F	HIL GPS2 fine
HMAINBAT	HOT Main Bat. Bus
HOUR	UTC HOUR
HOUR2	UTC HOUR
HPBLEED1	HP Air Bleed 1
HPBLEED2	HP Air Bleed 2
HRUDELVLI	Horns Rudder & LH Elevator De-Ice
HSICOUPL	HSI Coupling CAC1
HSICOUPL2	HSI Coupling CAC2
HYDAW	Hydraulic aux. low press.
HYDBP	Hydraulic Blue Pressure
HYDBW	Hydraulic blue low press.
HYDGP	Hydraulic Green Pressure
HYDGW	Hydraulic green low press.
IAS1	IAS 1
IAS2	IAS 2
IBOOTMSEL	Ice-Boots Mode Selection
ICEAOA	Icing AOA
ICEBOOT1F	De-Icing Engine 1 Boots Fault
ICEBOOT2F	De-Icing Engine 2 Boots Fault
ICEDETECT	Ice Detection
ICEPROP1F	De-Ice Propeller 1 Fault
ICEPROP2F	De-Ice Propeller 2 Fault
ILSGLID1	ILS/Glide Deviation 1
ILSGLID2	ILS/Glide Deviation 2
IMAUTOSEL	Ice-Mode Auto Selection
INCSPDL	Increase Speed
INTNUMB	intruder number
IPROPSLOW	Ice Propellers Slow
ITT1CAC1	ITT 1 CAC1
ITT1CAC2	ITT 1 CAC2
ITT2CAC1	ITT 2 CAC1
ITT2CAC2	ITT 2 CAC2

IWINDL	Ice-LH Side Windows
IWINDR	Ice-RH Side Windows
LAOA1B	AOA1 local
LAOA2B	AOA2 local
LAT1	LATitude 1
LAT2	LATitude 2
LATACC1	Lateral Acceleration 1
LATACC2	Lateral Acceleration 2
LATDEVFMS1	Lateral deviation from FMS 1
LATDEVFMS2	Lateral deviation from FMS 2
LATFINE1	Latitude Fine GPS1
LATFINE2	Latitude Fine GPS2
LATG	Lateral Acceleration
LATLSB1	LATitude LSB GPS1
LATLSB2	LATitude LSB GPS2
LATMSB1	LATitude MSB GPS1
LATMSB2	LATitude MSB GPS2
LHTRAILFLAP	LH Trailing Edge Flap
LONG	Longitudinal Acceleration
LONG1	LONGitude 1
LONG1_sign	LONGitude GPS1 sign
LONG2	LONGitude 2
LONG2_sign	LONGitude GPS2 sign
LONGACC1	Longitudinal Acceleration 1
LONGACC2	Longitudinal Acceleration 2
LONGFINE1	Longitude Fine GPS1
LONGFINE2	Longitude Fine GPS2
LONGLSB1	LONGitude LSB GPS1
LONGLSB2	LONGitude LSB GPS2
LONGMSB1	LONGitude MSB GPS1
LONGMSB2	LONGitude MSB GPS2
LOP1	Discrete Low pitch 1
LOP2	Discrete Low pitch 2
LOWSPDL	Cruise Speed Low
M04a19	S/W P/N CODE
MACH1	mach number ADC1
MACH1C	Mach Number ADC1 coarse
MACH1F	Mach Number ADC1 fine
MACH2	mach number ADC2

MACH2C	Mach Number ADC2 coarse
MACH2F	Mach Number ADC2 fine
MAGNHEAD1	Magnetic Heading 1
MAGNHEAD2	Magnetic Heading 2
MASWAR1	Master warning CAC1
MASWAR2	Master warning CAC2
MASWARN	MASTER WARNING
MFC1AF1	MFC1-A STATUS 1
MFC1AF2	MFC1-A STATUS 2
MFC1BF2	MFC1-B STATUS 2
MFC2AF1	MFC2-A STATUS 1
MFC2AF2	MFC2-A STATUS 2
MFC2BF1	MFC2-B STATUS 1
MINUTE	UTC MIN
MINUTE2	UTC MIN
MONTH	Month
MWA429INT11	MWA429Int1 (bits 12-1)
MWA429INT12	MWA429Int1 (bits 24-13)
MWA429INT21	MWA429Int2 (bits 12-1)
MWA429INT22	MWA429Int2 (bits 24-13)
MWA429OUT	MWA429out (bits 12-1)
MWA429POR11	MWA429Port1 (bits 12-1)
MWA429POR12	MWA429Port1 (bits 24-13)
MWA429POR21	MWA429Port2 (bits 12-1)
MWA429POR22	MWA429Port2 (bits 24-13)
MWANALOG1	MWANALOG (bits 12-1)
MWANALOG2	MWANALOG (bits 24-13)
MWDIS1	MWDIS1 (bits 12-1)
MWDIS2	MWDIS2 (bits 12-1)
MWDOT	MWDOT (bits 12-1)
MWFREQ	MWFREQ (bits 12-1)
MWLG	MW L/G Not Down
MWLOAD	MWLOAD (bits 12-1)
MWMPC1	MWMPC (bits 12-1)
MWMPC2	MWMPC (bits 24-13)
MWPROP	MW Prop Brake
MWRCDR1	MWRCDR (bits 12-1)
MWRCDR2	MWRCDR (bits 24-13)
MWSINT	MWSerInt (bits 12-1)
MWTO	MW T.O Config
NAVDISP1	Nav disp 1
NAVDISP2	Nav disp 2
NAVDISP4	Nav disp 4

NAVDISP5	Nav disp 5
NAVMOD1	Nav mode 1
NAVMOD2	Nav mode 2
NAVPERF1	A/C navigation performance 1
NAVPERF2	A/C navigation performance 2
NBRKP1P	Brake Pressure 1
NBRKP2P	Brake Pressure 2
NBRKP3P	Brake Pressure 3
NBRKP4P	Brake Pressure 4
NDCONFDU1	ND configuration DU1
NDCONFDU2	ND configuration DU2
NDCONFDU4	ND configuration DU4
NDCONFDU5	ND configuration DU5
NDRANGE1	ND range DU1
NDRANGE2	ND range DU2
NDRANGE4	ND range DU4
NDRANGE5	ND range DU5
NH1	NH1
NH2	NH2
NL1	NL1
NL2	NL2
NP1	NP1
NP2	NP2
OILPRESS1	Oil pressure 1
OILPRESS2	Oil pressure 2
OILTEMP1	Oil temperature 1
OILTEMP2	Oil temperature 2
PCK1VLV	PACK AIR FLOW 1
PCK2VLV	PACK AIR FLOW 2
PEC1	PEC 1 Status
PEC1F	PEC 1 fault
PEC2	PEC 2 Status
PEC2F	PEC 2 fault
PICESELC	Captain Probes De-Ice Selection
PICESELF	F/O Probes De-Ice Selection
PITCHA	Pitch angle
PITCHAC	Pitch angle MSB
PITCHAF	Pitch angle LSB
PITCHATT1	Pitch Attitude 1
PITCHATT2	Pitch Attitude 2
PLA1	PLA1
PLA2	PLA2
PRESALT1	Press Alt 1

PRESALT1SIG	Press Alt 1 sign
PRESALT2	Press Alt 2
PRESALT2SIG	Press Alt 2 sign
PRESALTF1	Press Alt 1 fine
PRESALTF2	Press Alt 2 fine
PRESALTG1	Press Alt 1 gross
PRESALTG2	Press Alt 2 gross
PROCD1	Proc Displayed ID 1
PROCD1C	Proc Displayed ID 1 (MSB)
PROCD1F	Proc Displayed ID 1 (LSB)
PROCD2	Proc Displayed ID 2
PROCD2C	Proc Displayed ID 2 (MSB)
PROCD2F	Proc Displayed ID 2 (LSB)
PROP1BETA	Beta 1
PROP2BETA	Beta 2
PROPAI1	Propeller Anti-Ice 1
PROPAI2	Propeller Anti-Ice 2
PROPBRKL	Propeller Brake lock
PROPBRKU	Propeller Brake unlock
PTDCAPT	Effort Pitch Axis (Capt Down)
PTDFO	Effort Pitch Axis (F/O Down)
PTDWNC	Pitch Trim Down Command Captain
PTDWNF	Pitch Trim Down Command F/O
PTDWNSTBY	Pitch Trim Down Command Stand By
PTUPC	Pitch Trim Up Command Captain
PTUPCAPT	Effort Pitch Axis (Capt Up)
PTUPF	Pitch Trim Up Command F/O
PTUPFO	Effort Pitch Axis (F/O Up)
PTUPSTBY	Pitch Trim Up Command Stand By
PULSEID	Special Pulse Identifier
RADALBCD1	Radio Altitude 1 (BCD)
RADALBCD2	Radio Altitude 1 (BCD)
RADALBNR1	Radio Altitude 1 BNR
RADALBNR1_sign	Radio Altitude 1 sign (BNR)
RADALBNR2	Radio Altitude 2 BNR
RADALBNR2_sign	Radio Altitude 2 sign (BNR)
RADALLSBC1	Radio Altitude 1 LSB (BCD)
RADALLSBC2	Radio Altitude 2 LSB (BCD)
RADALLSBN1	Radio Altitude 1 LSB (BNR)
RADALLSBN2	Radio Altitude 2 LSB (BNR)
RADALMSBC1	Radio Altitude 1 MSB (BCD)
RADALMSBC2	Radio Altitude 2 MSB (BCD)
RADALMSBN1	Radio Altitude 1 MSB (BNR)

RADALMSBN2	Radio Altitude 2 MSB (BNR)
RADDISP1	Rad disp 1
RADDISP2	Rad disp 2
RADDISP4	Rad disp 4
RADDISP5	Rad disp 5
ROLLA	Roll angle
ROLLAC	Roll angle MSB
ROLLAF	Roll angle LSB
ROLLATT1	Roll Attitude 1
ROLLATT2	Roll Attitude 2
ROLLEFF	Roll Axis Effort
RPB	Remote Print Button (RPB)
RUDD	YAW Surface position
RUDP	YAW control ped. pos.
RUDT	Yaw Trim Surface Position
RUDTLH	Yaw Trim LH Command
RUDTRH	Yaw Trim RH Command
SALT	Standard altitude
SALT_sign	Standard altitude sign
SALTC	Standard altitude MSB
SALTF	Standard altitude LSB
SECONDE	UTC SEC
SECONDE2	UTC SEC
SELALT1	Selected altitude CAC1
SELALT2	Selected altitude CAC2
SELBAR1	Selected Baro-Setting 1
SELBAR2	Selected Baro-Setting 2
SELBARLS1	Selected Baro-Setting 1 (LSB)
SELBARLS2	Selected Baro-Setting 2 (LSB)
SELBARMS1	Selected Baro-Setting 1 (MSB)
SELBARMS2	Selected Baro-Setting 2 (MSB)
SELCSEL	Selected Course left
SELCSER	Selected Course right
SELDH1	Selected DH 1
SELDH1_sign	Selected DH 1 sign
SELDH2	Selected DH 2
SELDH2_sign	Selected DH 2 sign
SELDHLS1	Selected DH 1 LSB
SELDHLS2	Selected DH 2 LSB
SELDHMS1	Selected DH 1 MSB
SELDHMS2	Selected DH 2 MSB
SELHEADL	Selected Heading left
SELHEADR	Selected Heading right

SELSPEED1	Selected speed CAC1
SELSPEED2	Selected speed CAC2
SELVERTS1	Selected vertical speed CAC1
SELVERTS2	Selected vertical speed CAC2
SENSIBIL	
SENSIBLEV	Sensitivity
SLDG	L/G Selector
SPEEDHENG	Speed Hold Engagement CAC1
SPEEDHENG2	Speed Hold Engagement CAC2
SPLH	Left Spoiler Position
SPRH	Right Spoiler Position
STBYPICE	STBY Probes De-Ice
STCKPUSH	Stick Pusher
STKSC	Stick shaker captain
STKSF	Stick shaker first officer
TAS1	True airspeed ADC1
TAS1C	True Airspeed ADC1 coarse
TAS1F	True Airspeed ADC1 fine
TAS2	True airspeed ADC2
TAS2C	True Airspeed ADC2 coarse
TAS2F	True Airspeed ADC2 fine
TAT1	TAT 1
TAT2	TAT 2
TAWST11	TAWS status 1 (part 1)
TAWST12	TAWS status 1 (part 2)
TAWST21	TAWS status 2 (part 1)
TAWST22	TAWS status 2 (part 2)
TCASDISP1	TCAS disp 1
TCASDISP2	TCAS disp 2
TCASDISP4	TCAS disp 4
TCASDISP5	TCAS disp 5
TCASF1	TCAS fault summary (part 1)
TCASF2	TCAS fault summary (part 2)
TCSACT	TCS Active CAC1
TCSACT2	TCS Active CAC2
TDISPCAU	T disp caution
TDISPWARN	T disp warning
TERDISP1	Ter disp 1
TERDISP2	Ter disp 2
TERDISP4	Ter disp 4
TERDISP5	Ter disp 5
TERDISR1	
TERDISR2	

TERRDISPST	Terrain Display Status part2
TMPGAUG1	Temperature gauge 1
TMPGAUG2	Temperature gauge 2
TPRESS	Total pressure
TPRESS_sign	Total pressure sign
TPRESSC	Total pressure MSB
TPRESSF	Total pressure LSB
TQ1	TQ1
TQ2	TQ2
TQO1	Objective TQ 1
TQO2	Objective TQ 2
TRACKANG1	true track angle GPS1
TRACKANG1C	True Track Angle GPS1 coarse
TRACKANG1C360	True Track Angle GPS1 coarse
TRACKANG1F	True Track Angle GPS1 fine
TRACKANG2	true track angle GPS2
TRACKANG2C	True Track Angle GPS2 coarse
TRACKANG2F	True Track Angle GPS2 fine
TRAFADV2	Traffic Advisory (part 2)
TRIMALERT	Trim Allert CAC1
TRIMALERT2	Trim Allert CAC2
TRUEHEAD1	True Heading 1
TRUEHEAD2	True Heading 2
UNITSEL	
UNITSEL2	
UTC	GMT
UTCF1	UTC Fine GPS1
UTCF1C	UTC Fine (MSB) GPS1
UTCF1F	UTC Fine (LSB) GPS1
UTCF2	UTC Fine GPS2
UTCF2C	UTC Fine (MSB) GPS2
UTCF2F	UTC Fine (LSB) GPS2
UTCFFRAC1	UTC FINE FRAC GPS1
UTCFFRAC2	UTC FINE FRAC GPS2
UTCH	GMT (hours)
UTCM	GMT (mintures)
UTCS	GMT (seconds)
VALIDR1	
VALIDR2	
VALIDR3	
VERTCONT	Vertical control
VERTDFMS1	Vertical deviation from FMS 1 DU2
VERTDFMS2	Vertical deviation from FMS 2 DU4

VERTRATE1	vertical rate ADC1
VERTRATE1_sign	Vertical Rate ADC1 sign
VERTRATE1C	Vertical Rate ADC1 coarse
VERTRATE1F	Vertical Rate ADC1 fine
VERTRATE2	vertical rate ADC2
VERTRATE2_sign	Vertical Rate ADC2 sign
VERTRATE2C	Vertical Rate ADC2 coarse
VERTRATE2F	Vertical Rate ADC2 fine
VEW1	E/W velocity GPS1
VEW1C	E/W velocity GPS1 coarse
VEW1F	E/W velocity GPS1 fine
VEW2	E/W velocity GPS2
VEW2C	E/W velocity GPS2 coarse
VEW2F	E/W velocity GPS2 fine
VFOM1	VFOM GPS1
VFOM1C	VFOM GPS1 coarse
VFOM1F	VFOM GPS1 fine
VFOM2	VFOM GPS2
VFOM2C	VFOM GPS2 coarse
VFOM2F	VFOM GPS2 fine
VHF1	VHF 1
VHF2	VHF 2
VHF3	VHF 3
VNS1	N/S velocity GPS1
VNS1C	N/S velocity GPS1 coarse
VNS1F	N/S velocity GPS1 fine
VNS2	N/S velocity GPS2
VNS2C	N/S velocity GPS2 coarse
VNS2F	N/S velocity GPS2 fine
VORBEAR1	VOR Bearing 1
VORBEAR2	VOR Bearing 2
VORLOCD1	VOR/Loc Deviation 1
VORLOCD2	VOR/Loc Deviation 2
VORSELF1	VOR Selected Frequency 1
VORSELF1C	VOR Selected Frequency 1 MSB
VORSELF1F	VOR Selected Frequency 1 LSB
VORSELF2	VOR Selected Frequency 2
VORSELF2C	VOR Selected Frequency 2 MSB
VORSELF2F	VOR Selected Frequency 2 LSB
VRTACC1	Vertical Acceleration 1
VRTACC2	vertical Acceleration 2
VRTG	Vertical Acceleration
WDICEL	LH Windshield De-Ice

WDICER	RH Windshield De-Ice
WINDIR1	Wind Direction 1
WINDIR2	Wind Direction 2
WINSPEED1	Wind Speed 1
WINSPEED2	Wind Speed 2
WOALDG	Discrete all gear
WOMLDG	Discrete main gear
XFV	X Feed Valve Position
YAWEFF	Yaw Axis Effort
YEAR	Date (year)

Appendix 4 Flight Data Plots

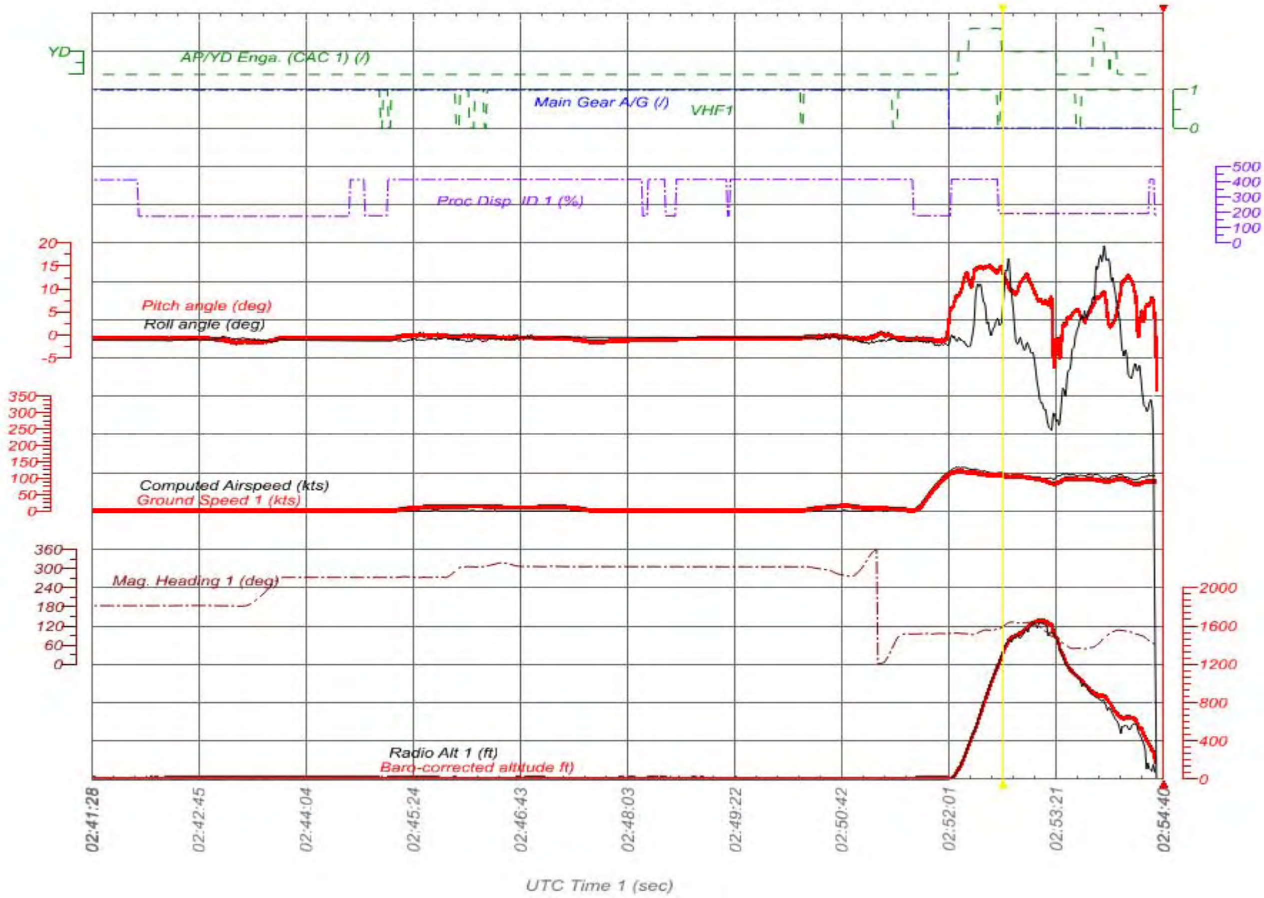

Figure A4-1 GE235 FDR selected parameters plot (1)

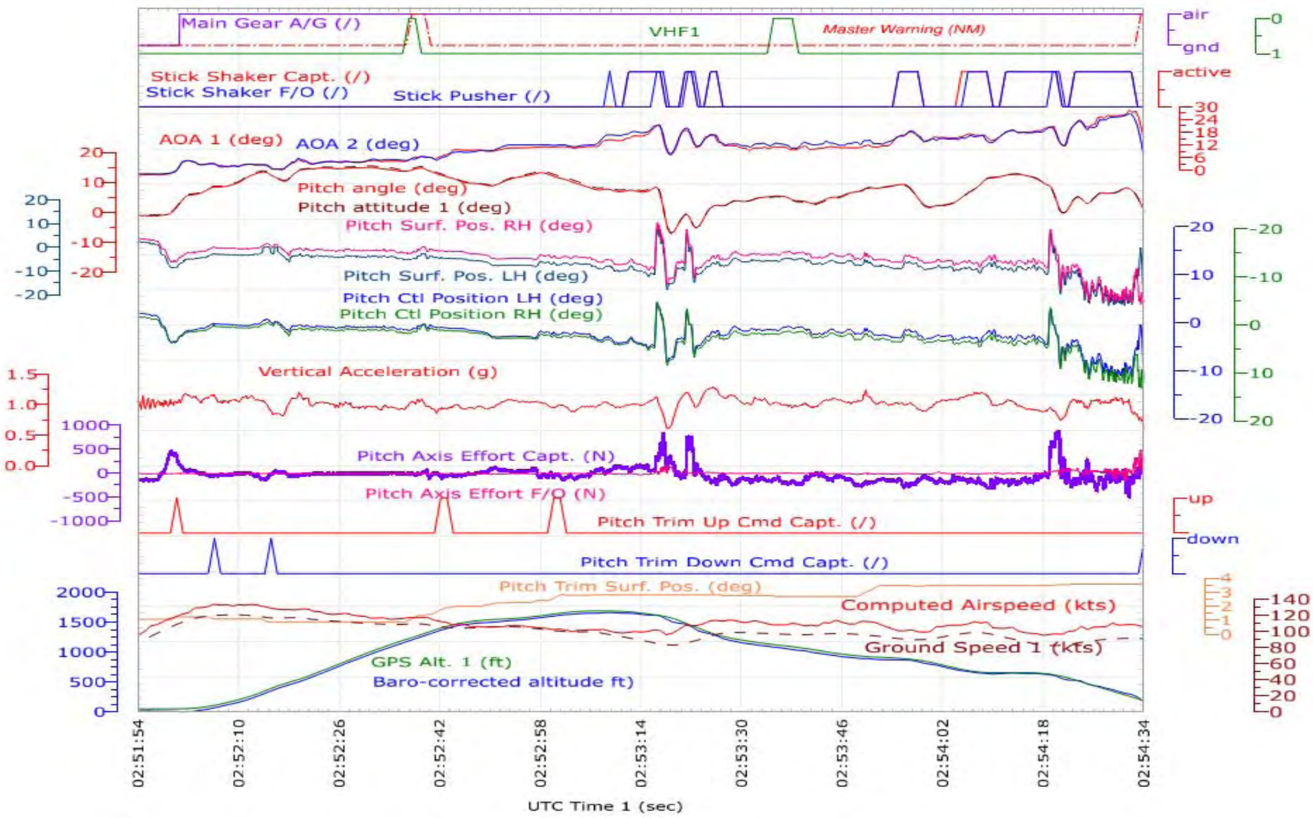

Figure A4-2 GE235 FDR selected parameters plot (2)

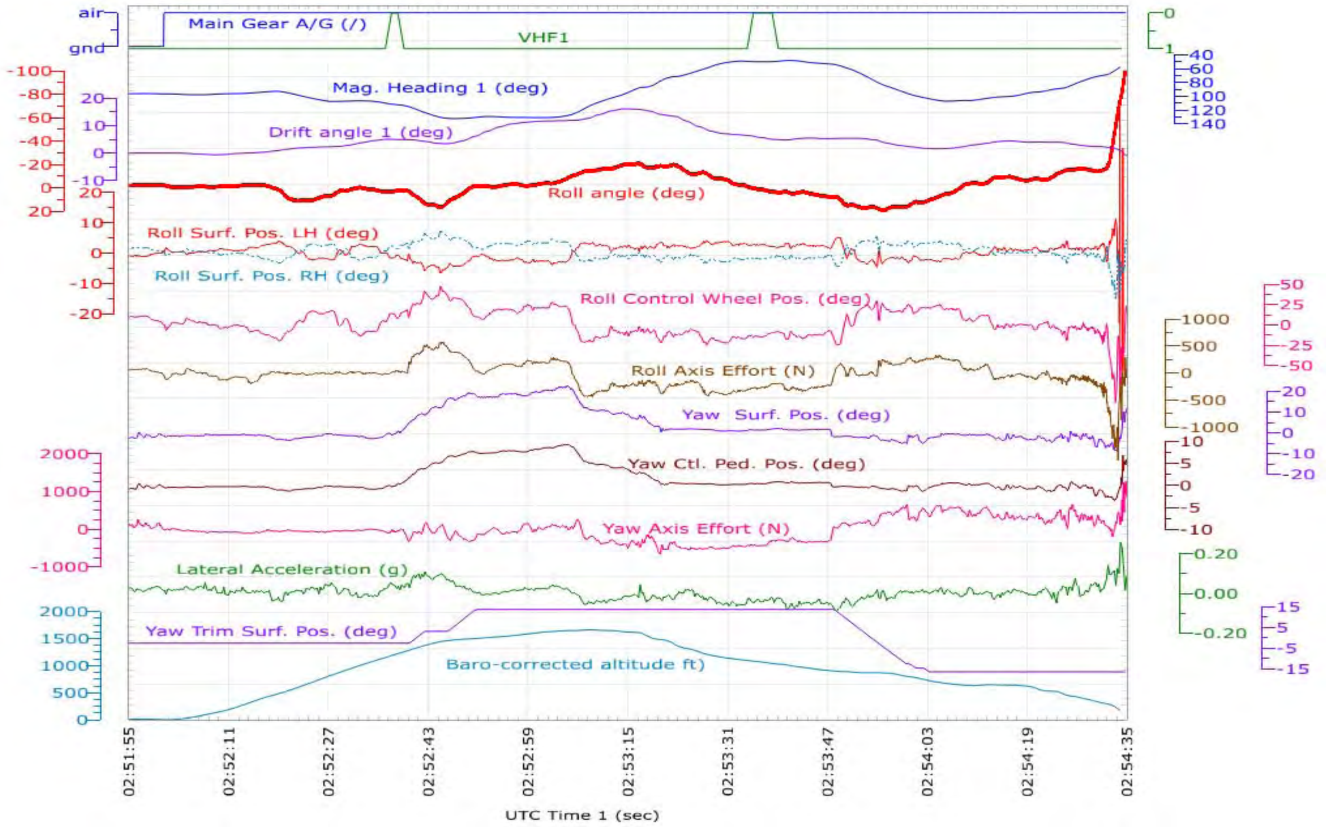

Figure A4-3 GE235 FDR slected parameters plot (3)

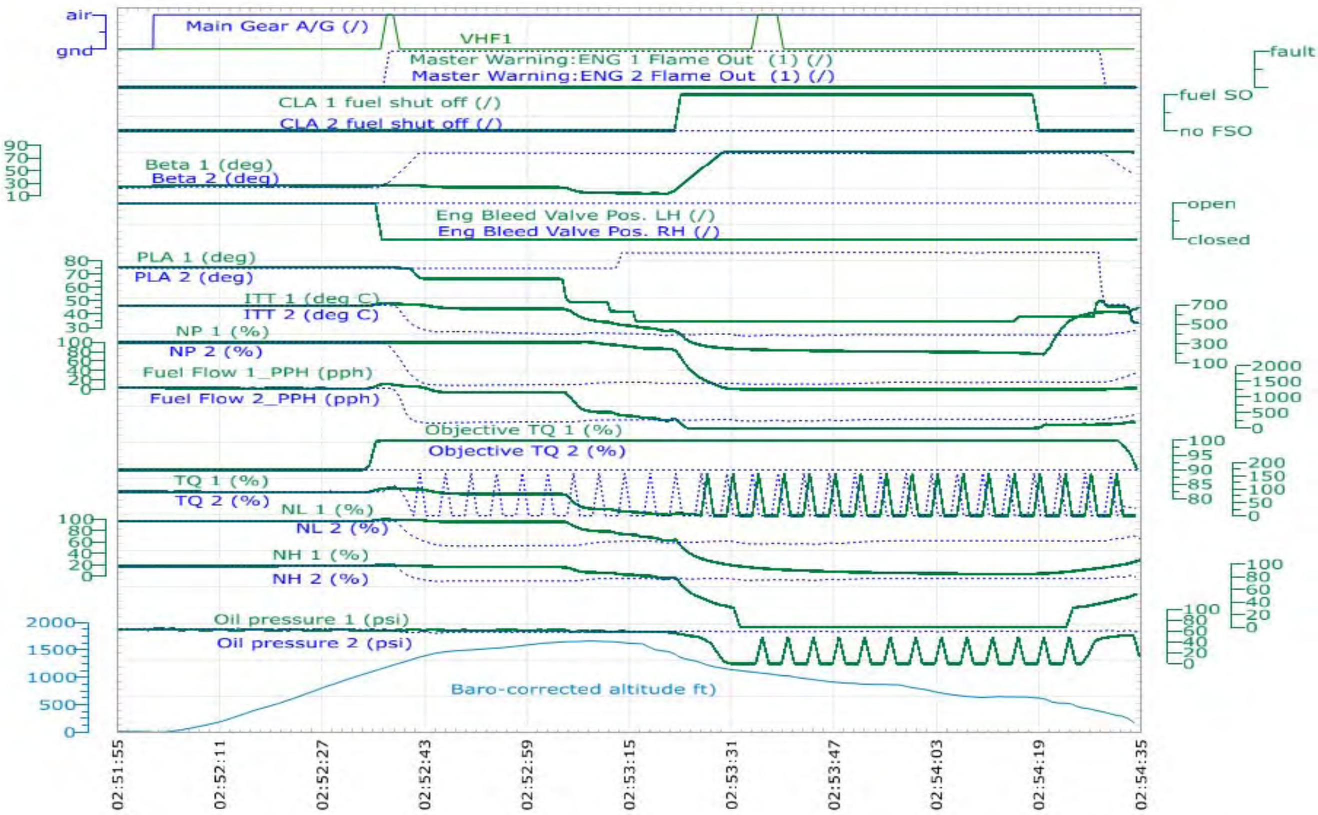

Figure A4-5 GE235 FDR parameters plot (engine related)

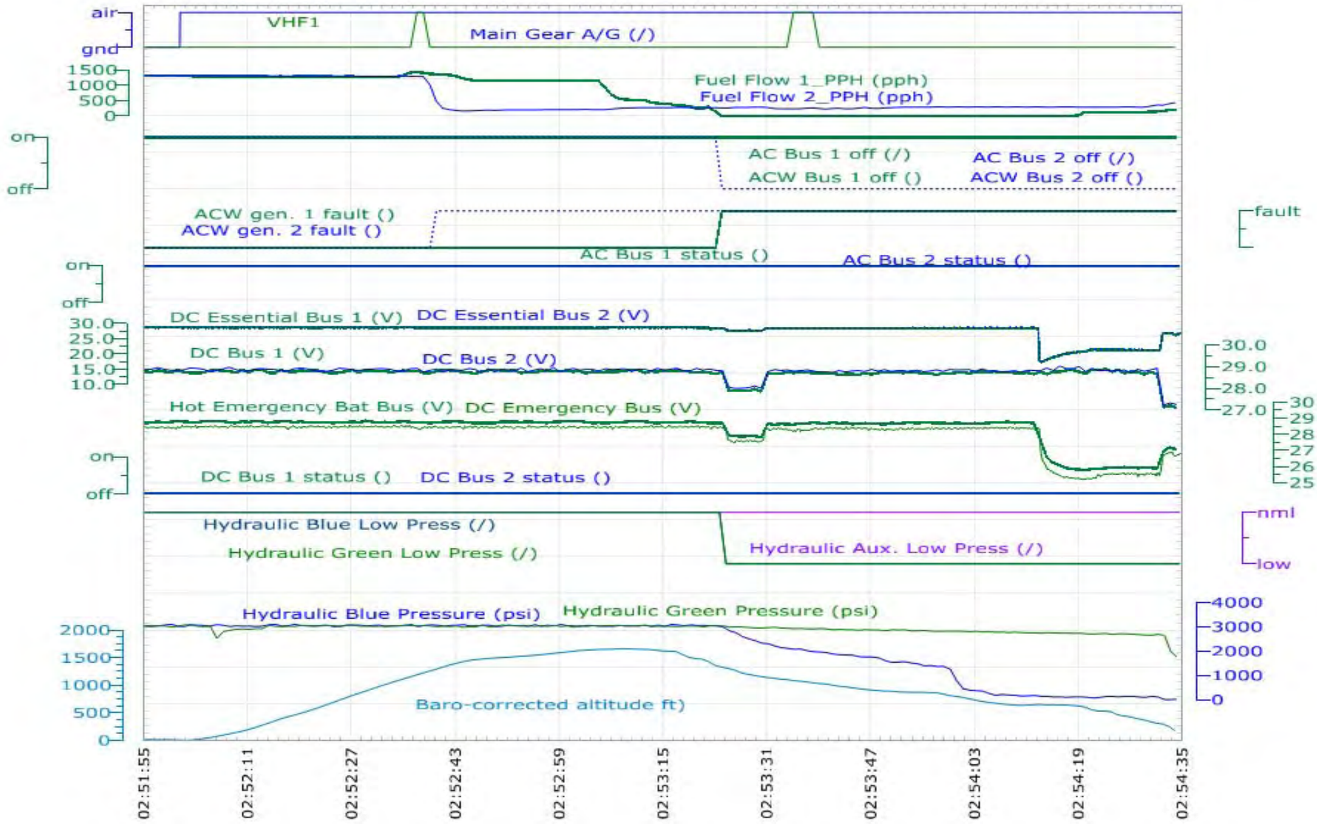

Figure A4-6 GE235 FDR parameters plot (Electrical related)

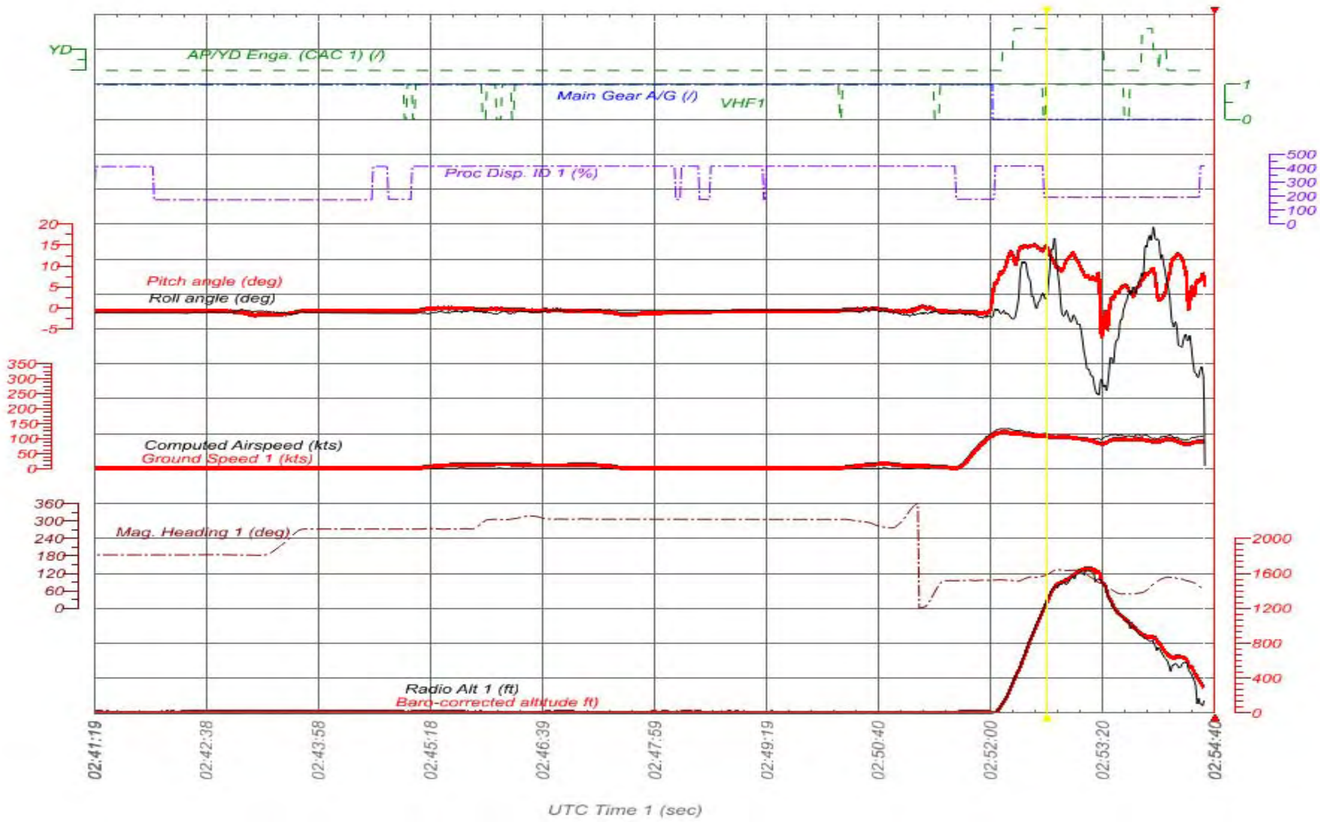

Figure A4-7 GE235 QAR selected parameters plot (entire of flight)

Appendix 5 Site Survey Database

NO.	中文名稱	english name	latitude	longitude	HAE (m)	Examination result	note	photo1 link
001(Y-009)	左副翼	left aileron	25.062973	121.616956	28.8			photo\IMG_001333.jpg
002	殘骸	wreckage	25.062878	121.617024	47.9			photo\IMG_001536.jpg
003	殘骸	wreckage	25.062859	121.617079	47.8			photo\IMG_001537.jpg
004	撞擊點	impact point	25.062904	121.616987	49.6			photo\IMG_001434.jpg
005	撞擊痕跡	scratch mark	25.062916	121.616950	48.6			photo\IMG_001538.jpg
006(Y-016)	襟翼整流罩	flap fairing	25.062901	121.617024	22.8			photo\IMG_001539.jpg
007	燈桿	light pole	25.062925	121.617034	25.1			photo\IMG_001541.jpg
008(Y-008)	左升降舵	left elevator	25.062977	121.617125	24.9			photo\IMG_001642.jpg
009(Y-004)	左襟翼	left flap	25.063031	121.617162	23.9			photo\IMG_001743.jpg
010(Y-010)	左翼	left wing	25.063081	121.617236	23.3			photo\IMG_001844.jpg
011	殘骸	wreckage	25.063078	121.617015	23.3			photo\IMG_001845.jpg
012(W-007)	機身	fuselage	25.063463	121.617663				photo\IMG_001846.jpg
013	計程車	taxi	25.062862	121.616910				photo\DSC07267.JPG
Y-001	左翼	left wing						photo\IMGP0512.JPG
Y-002	右升降舵	right elevator						photo\IMGP0518.JPG
Y-003	右翼	right wing						photo\IMGP0521.JPG
Y-004	左襟翼	left flap						photo\IMGP0525.JPG

NO.	中文名稱	english name	latitude	longitude	DTM (m)	Examination result	note	photo1 link
Y-005	左內側襟翼	left inboard flap						photo\IMGP0527.JPG
Y-006	方向舵	rudder						photo\IMGP0530.JPG
Y-007	垂直安定面	vertical stabilizer						photo\IMGP0535.JPG
Y-008	左升降舵	left elevator						photo\IMGP0537.JPG
Y-009	左副翼	left aileron						photo\IMGP0539.JPG
Y-010	水平安定面	horizontal stabilizer						photo\IMGP0540.JPG
Y-012	左翼部位	left wing part						photo\IMGP0593.JPG
Y-013	左副翼	left aileron						photo\IMGP0594.JPG
Y-014	左翼部位	left wing part						photo\IMGP0606.JPG
Y-015	垂直安定面部位	vertical stabilizer part						photo\IMGP0611.JPG
Y-016	襟翼整流罩	flap fairing						photo\IMGP0614.JPG
Y-017	右升降舵	right elevator						photo\IMGP0617.JPG
Y-018	右機翼外側	right wing outboard wing box						photo\DSCN1091.JPG
W-001	左機身蒙皮	left fuselage skin				overload damage		photo\IMGP0557.JPG
W-002	右機身蒙皮	right fuselage skin				overload damage		photo\IMGP0559.JPG
W-003	機腹	belly				overload damage		photo\IMGP0564.JPG
W-004	駕駛艙	cockpit				overload damage		photo\IMGP0571.JPG
W-005	機身蒙皮	fuselage skin				overload damage		photo\IMGP0578.JPG
NO.	中文名稱	english name	latitude	longitude	DTM (m)	Examination result	note	photo1 link
W-006	雷達罩	radome						photo\IMGP0589.JPG

W-007	機身	fuselage				overload damage		photo\IMGP0591.JPG
W-008	左機身蒙皮	left fuselage skin				overload damage		photo\IMGP0601.JPG
W-010	左主輪艙門	left main gear door						photo\IMGP0603.JPG
O-001	左發動機	Engine no.1						photo\IMGP0584.JPG
O-002	右發動機	Engine no.2						photo\IMGP0583.JPG

Appendix 6 Wreckage Examination Database

Id.	Item	P/N	S/N	Shipping in water or not	Test controlled by	Extra. Information	Photo
1	Eng #1 AFU	30048-0000-28	RT3077	not	TSB		tagging photo\DSC_0895.JPG
2	Eng #2 AFU	30048-0000-28	RT2362	wet	TSB		tagging photo\DSC_0875.JPG
3	ENG#1 DCU	3075879-01	14019276	not	TSB		tagging photo\DSC_0903.JPG
4	ENG#2 DCU	3075879-01	13-014743	not	TSB		tagging photo\DSC_0926.JPG
5	ENG#1 FIRE HANDLE (FEU)	19-51-41	2489	not	TSB	4060690006	tagging photo\DSC_0931.JPG
6	ENG#2 FIRE HANDLE (FEU)	19-51-51	2488	not	TSB	6846600600	tagging photo\DSC_0932.JPG
7	ENG#1 TQ Sensor #1	3073471-01	CH1282	not	TSB		tagging photo\DSC_0897.JPG
8	ENG#1 TQ Sensor #2	3073471-02	CH1734	not	TSB		tagging photo\DSC_0919.JPG
9	ENG#2 TQ Sensor #1	3073471-01	CH1468	not	TSB		tagging photo\DSC_0930.JPG
10	ENG#2 TQ Sensor #2	3077761-02	CH1457	not	TSB		tagging photo\DSC_0922.JPG
11	ENG#1 NL Sensor	3033509	CH21092	not	TSB		tagging photo\DSC_0914.JPG
12	ENG#1 NH Sensor (up)	3077761-01	CH2610	not	TSB		tagging photo\DSC_0908.JPG
13	ENG#1 NH Sensor (lower)	3077761-01	CH2595	not	TSB		tagging photo\DSC_0911.JPG
14	ENG#1 NP Sensor	3077761-01	CH2615	not	TSB		tagging photo\DSC_0916.JPG
15	ENG#2 NL Sensor	3033509	CH20768	not	TSB		tagging photo\DSC_0928.JPG
16	ENG#2 NH Sensor (up)	3077761-01	CH2108	not	TSB		tagging photo\DSC_0924.JPG
17	ENG#2 NH Sensor (lower)	3077761-01	CH2106	not	TSB		tagging photo\DSC_0929.JPG
18	ENG#2 NP Sensor	3077761-01	CH2128	not	TSB		tagging photo\DSC_0923.JPG
19	ENG #1 EEC	1012974-4-002	14040035	wet	TSB		tagging photo\DSC_0887.JPG
20	ENG #2 EEC	1012974-4-002	13100020	wet	TSB		tagging photo\DSC_0891.JPG
21	PEC 1	8163325401	13070018	wet	TSB/NTSB		tagging photo\DSC_0878.JPG
22	PEC 2	8163325401	13080013	wet	TSB/NTSB		tagging photo\DSC_0882.JPG
23	MFCA-I/O1	LA4E20300H30300	00006217473	wet	BEA		tagging photo\DSC_0792.JPG
24	MFCA-Output1	LA4E20300H3080A	00006215088	wet	BEA		tagging photo\DSC_0801.JPG
25	MFCA- I/O1	LA4E20300H30300	00006217508	wet	BEA		tagging photo\DSC_0804.JPG
26	MFCA-5-Analog	LA4E21100H30600	00006213970	wet	BEA		tagging photo\DSC_0806.JPG
27	MFCA-4 logic	LA4E20200H3040B	00006220104	wet	BEA		tagging photo\DSC_0810.JPG
28	MFCA-3 output 2	LA4E20300H3090A	00006215951	wet	BEA		tagging photo\DSC_0813.JPG
29	MFCA-5-Analog	LA4E21100H30600	00006213976	wet	BEA		tagging photo\DSC_0819.JPG
30	MFCA-CPU2	LA4E20706H30200	00006223072	wet	BEA		tagging photo\DSC_0817.JPG
31	MFCA-CPU1	LA4E20706H30100	00006222076	wet	BEA		tagging photo\DSC_0821.JPG

32	MFCA-I/O2	LA4E20300H30700	00006218111	wet	BEA		tagging photo\DSC_0823.JPG
33	MFCA-6 supply	LA4E20200H3050A	00006221486	wet	BEA		tagging photo\DSC_0827.JPG
34	MFCB-I/O1	LA4E20300H30300	00006217489	wet	BEA		tagging photo\DSC_0866.JPG
35	MFCB-Output1	LA4E20300H3080A	00006215143	wet	BEA		tagging photo\DSC_0870.JPG
36	MFCB-2 I/O1	LA4E20300H30300	00006217499	wet	BEA		tagging photo\DSC_0844.JPG
37	MFCB-5-Analog	LA4E21100H30600	00006213928	wet	BEA		tagging photo\DSC_0841.JPG
38	MFCB-4 logic	LA4E20200H3040B	00006220084	wet	BEA		tagging photo\DSC_0833.JPG
39	MFCB-3 output 2	LA4E20300H3090A	00006216144	wet	BEA		tagging photo\DSC_0851.JPG
40	MFCB-CPU2	LA4E21100H30200	00006223082	wet	BEA		tagging photo\DSC_0837.JPG
41	MFCB-5 analog	LA4E20706H30600	00006214005	wet	BEA		tagging photo\DSC_0854.JPG
42	MFCB-CPU1	LA4E20706H30100	00006222099	wet	BEA		tagging photo\DSC_0863.JPG
43	MFCB-8 I/O2	LA4E20300H30700	00006218128	wet	BEA		tagging photo\DSC_0859.JPG
44	MFCB-6 supply	LA4E20200H3050A	00006221547	wet	BEA		tagging photo\DSC_0847.JPG
45	MPC	261065723-1000	2610657230333	wet	BEA		tagging photo\DSC_0830.JPG
46	CAC1 rack	C13203AB	C13203000535	wet	Stored ASC		tagging photo\DSC_0572.JPG
47	SWM	C13160MA01	C13160001462	wet	Stored ASC		tagging photo\DSC_0740.JPG
48	IOM-DC	C13202BA	C13202005059	wet	Stored ASC		tagging photo\DSC_0744.JPG
49	IOM-DC	C13202BA	C13202005080	wet	Stored ASC		tagging photo\DSC_0748.JPG
50	IOM-S	C13159MA	C13159002274	wet	Stored ASC		tagging photo\DSC_0752.JPG
51	CPM	C13158MA01	C13158005024	wet	Stored ASC		tagging photo\DSC_0756.JPG
52	IOM-AP	C13216BA	C13216005049	wet	Stored ASC		tagging photo\DSC_0760.JPG
53	CAC2 rack	C13203AB	C13203000515	wet	Stored ASC		tagging photo\DSC_0611.JPG
54	SWM	C13160MA01	C13160005034	wet	Stored ASC		tagging photo\DSC_0764.JPG
55	IOM-DC	C13202BA	C13202005063	wet	Stored ASC		tagging photo\DSC_0769.JPG
56	IOM-DC	C13202BA	C13202005015	wet	Stored ASC		tagging photo\DSC_0773.JPG
57	IOM-S	C13159MA	C13159005059	wet	Stored ASC		tagging photo\DSC_0777.JPG
58	CPM	C13158MA01	C13158005045	wet	Stored ASC		tagging photo\DSC_0781.JPG
59	IOM-AP	C13216BA	C13216005063	wet	Stored ASC		tagging photo\DSC_0785.JPG
60	DU1	C19736AA01	C19736001238	wet	Stored ASC		tagging photo\DSC_0729.JPG
61	DU2	C19736AA01	C19736001239	wet	Stored ASC		tagging photo\DSC_0732.JPG
62	DU3	C19736AA01	C19736001241	wet	Stored ASC		tagging photo\DSC_0734.JPG
63	DU5	C19736AA01	C19736001154	wet	Stored ASC		tagging photo\DSC_0736.JPG
64	DU4	C19736AA01	C19736001244	wet	Stored ASC		tagging photo\DSC_0738.JPG
65	Eng #1 AFU cable assembly	44KF1-A		not	BEA	Connect AFU & TQ SN	tagging photo\DSC_0976.JPG

66	Eng #2 AFU cable assembly	44KF2-A		not	BEA	Connect AFU & TQ SN	tagging photo\DSC_0968.JPG

VI Attachment

Attachment 1 Document of L-3 FA2100 SSCVR Accident Investigator’s Kit

Attachment 2 Document of L-3 FA2100 SSFDR Accident Investigator’s Kit

Attachment 3 DFDR Recorded Parameters Decoding Law

Attachment 4 ATR 42/72 600 Systems Brief

Attachment 5 Similar Event Flight Data (GE507)

Aviation Safety Council

Taipei, Taiwan

GE235 Occurrence Investigation
Factual Data Collection
Group Report

Survival Factors Group

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Contents

I. **Team Organization**

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II. History of Activities

Date	Activities
02/04 ~ 02/12	1. Survival Factors Group convened and invited the forensic pathologists from Institute of Forensic Medicine (IFM), Ministry of Justice to join and launch to scene. 2. Coordinated： A. Coordinated with the prosecutors, the policemen from Criminal Investigation Bureau (CIB), the forensic pathologists from Institute of Forensic Medicine before performing the forensic examination process to make sure whether ASC need. B. Collected survivors interview notes from prosecutors. 3. Completed all forensic inspections and autopsies in mortuary. 4. Collected： A. Passenger names and seat numbers of flight 235. B. Inspection and autopsy records. C. Information of injured survivors status from two local hospitals.
02/05 ~ 03/03	1. Completed 9 survivors' interview. 2. Completed rescuers' interview in Fire Bureau of Taipei City and New Taipei City
02/16 ~ 02/24	1. Completed cabin wreckage and seat status report

III. Factual Description

1.2 Injuries to persons

There were a total of 58 persons on board including three pilots, two cabin crew, and 53 passengers. Four crew members and 39 passengers sustained fatal injuries. Thirteen passengers and one cabin crew sustained serious injuries and one passenger sustained minor injuries.

This aircraft hit a taxi which was driving on an elevated expressway. The taxi driver sustained serious injuries and one passenger sustained minor injuries.

Table 1.2-1 Injury table

Injuries	**Flight Crew**	**Flight Attendants**	**Passengers**	**Other**	**Total**
Fatal	3	1	39	0	43
Serious	0	1	13	1	15
Minor	0	0	1	1	2
None	0	0	0	Not applicable	0
Total	3	2	53	2	60

The TransAsia's ATR72-600 was configured with 72 economy class passenger seats. There were two pilot seats and one observer seat in the cockpit and two cabin crew seats in the cabin.

Figure 1.2-1 shows the cabin configuration with passenger injury and fatality distribution. The passenger seating positions were based on the airline seating plan and interviews with the surviving passengers.

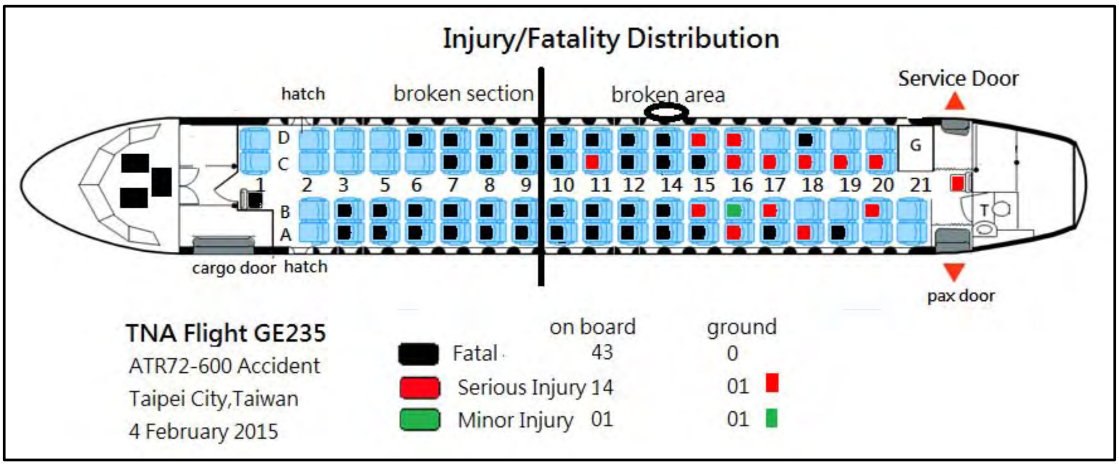

Figure 1.2-1 Injury and fatality distribution

1.3 Damage to Aircraft

As a result of the impact, the main wreckage sustained severe damage and sequentially described as follows and details were recorded in Attachment 7-1 wreckage site survey report and Attachment 7-2 seat status report.

1.3.1 Fuselage Airframe Status

Forward fuselage area including cockpit suffered severe compression and damages due to the impact, as shown in Figure 1.3-1.

Figure 1.3-1 Wreckage on Cockpit

Forward and middle-aft fuselage was separated from frame 24-25 (around seat row 9-10), as shown in Figure 1.3-2. There was also a break/hole on the right hand side fuselage located at frame 28-28A area (around seat row 14-15). This break was then sawed to a larger hole for rescue purpose. The fuselage from frame 24 to tail cone was almost kept in its original shape, as shown in Figure 1.3-3.

Figure 1.3-2 The FWD and Mid-Aft fuselage separation from frame 24-25

Figure 1.3-3 A broken area on the right hand side fuselage located at frame 28-28A area

1.3.2 Main Door / Emergency Doors

The frame that contains cockpit hatch door was severely damaged with the door missing, as shown in Figure 1.3-4. The actuator of cargo door was retracted. The cargo door was not opened before the impact; however afterward only door fitting remained connected to the actuator, as shown in Figure 1.3-5. Right hand side emergency door was dislocated from the door frame. The emergency door, with mounting hinges broken, was considered being pushed into cabin during the impact, as shown in Figure 1.3-6. Left hand side emergency door broke into halves due to the impact. The fuselage side door frame could not be located due to severity of damages to the FWD airframe. According to broken hinge location, this door was pushed into cabin during the impact, as shown in Figure 1.3-7. Left hand side passenger door was closed and intact at the time of the accident. Both internal handle and external flap handle were pulled down to un-lock position, as shown in Figure 1.3-8. Right hand side service door was still functioning, and was opened during rescue operation, as shown in Figure 1.3-9.

Figure 1.3-4 Cockpit and hatch door

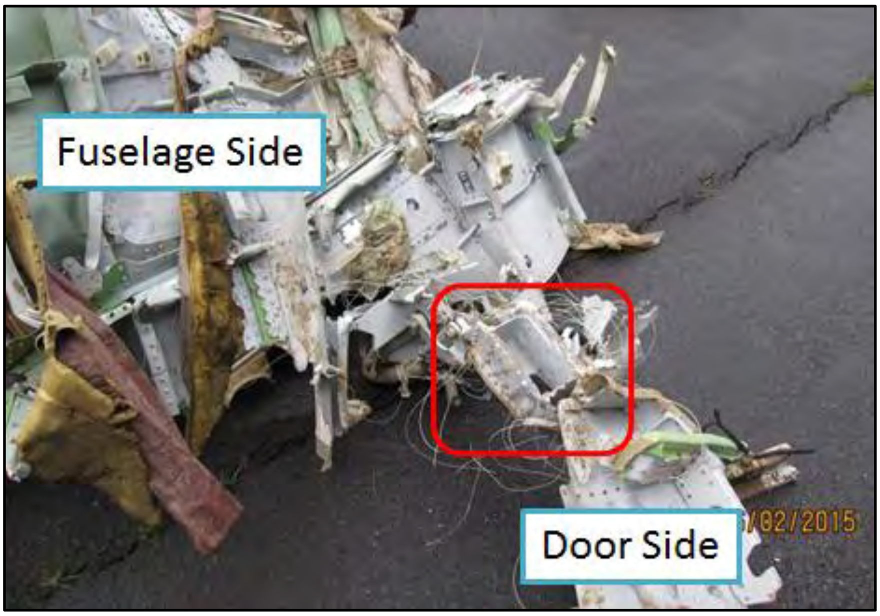

Figure 1.3-5 Cargo door

Figure 1.3-6 RHS Emergency escape door

Figure 1.3-7 LHS Emergency escape door

Figure 1.3-8 LHS Passenger door

Figure 1.3-9 RHS Service door

1.3.3 Seats and Seatbelts

There were 8 sets (2 seats for 1 set) of passenger seats kept intact on seat tracks located in the aft fuselage, as shown in Figure 1.3-10. 28 sets of passenger seats were dislocated from their positions due to the impact (about 5 sets) or rescue effort (about 23 sets), as shown in Figure 1.3-11. Their original positions could not be identified.

Two cabin crew seats (FWD and AFT) have been located. Flight crew and observer seats were badly damaged. Most of seat structures were damaged badly as twisted, deformed, and cracked. Most of seat shackles and belts were still in workable condition. Some of the life vests were recovered.

Figure 1.3-10 Passenger seats intact on seat track

Figure 1.3-11 Passenger seats dislocated from its position

1.13 Medical and Pathological Information

1.13.1 Medical Treatment of Injured

In this occurrence, there were 14 out of 15 survivors onboard who suffered mostly front impact and serious injuries including skull, sternum and lumbar bone fractures, abrasion, contusion and lacerations. The medical records of the injuries can be referred to Attachment 7-3.

The injuries were initially transported to 6 local hospitals around Taipei City and New Taipei City.

1.13.2 Toxicology information of Flight crews

The Institute of Forensic Medicine, Ministry of Justice conducted toxicology examinations on the 3 flight crew. The test items included alcohol content, poisons, sedatives, hypnotics, carbon monoxide hemoglobin and the basic drugs screen (about one thousand items).

Toxicology report of Captain A shows no evidence of drugs or toxin.

Toxicology report of Captain B shows doxycycline in blood and urine, no other drug or toxin was found.

Toxicology report of the first officer shows amlodipine in blood and urine, no other drug or toxin was found.

The toxicology examination report of flight crew can be referred to Attachment 7-4.

1.13.3 Forensic inspection and autopsy

Shi-Lin District Prosecutors, Institute of Forensic Medicine and Aviation Safety Council had a coordination meeting to make sure the agencies jointly collected all required information before performing victim forensic inspection. The forensic pathologists from IFM performed the autopsy of three flight crew. Locations where victims were retrieved were not recorded before they were arranged and centralized by firefighters or rescuers.

1.13.3.1 Victim Inspection

Based on the abstract of inspection report by IFM, which can be referred to Attachment 7-5, most causes of the death were multiple traumatic injuries and drowning. The direction of the fatal impact force was predominately from front to back.

The main findings of the external examination on the victims were multiple fractures of skull and extremities. Some victims showed not only multiple traumatic injuries, but also possible drowning.

The forensic autopsy report showed the three flight crew had the same cause of death that was ring fracture of skull base, and severe comminuted skull fracture with severe brain crush and separation, referred to Attachment 7-6.

1.13.3.2 Injury patterns

The injury patterns included skull bone fracture, extremities bone fracture, multiple traumatic injuries, and drowning. Their descriptions related to cabin distribution was drawn by using "Injury Database and 3-D Analysis Software[1] ", as shown in Attachment 7-7.

1.14 Fire

No fire

1.15 Survival Aspects

1.15.1 Emergency Evacuation

According to the interview notes of passengers and a cabin crewmember (referred to Attachment 7-8), pilot in command performed briefing with cabin crew before this flight. The content of the briefing included the terminal and en-route weather, turbulence alert signal, hijacking signal and fire procedure review etc. After pushing back, cabin crew played safety video and carried out life vest demonstration. The aircraft then started to take-off rolling when cabin crew completed cabin safety check and announced to flight crew.

The survivors heard the no.1 engine noise became smaller and saw it stop rotating during takeoff/ initial climb phase. The aircraft sank a while,

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[1] produced by ASC and Institute of Forensic Medicine in 2009

then was pulled up and then rapidly fell down in a left roll. During falling down, there was no striking noise or feeling in cabin and the aircraft directly into the water. Some of the passengers saw the aircraft was very close to the surrounding buildings.

All of the 15 survivors were seated after row 10. After the aircraft crashed into water, the middle-aft fuselage was separated from the forward fuselage, and was rotated nearly 160 degrees in counterclockwise direction and upside down. The cabin environment became dark and full of fuel odor. Some of passengers were upside down and unconscious immediately after the impact. Then they woke up due to choke from water. Most survivors were still in their seats and unbuckled their seat belts by themselves or assisted by other passengers. Most passengers described that the cabin at that time was very silent without any movement.

There was a break/hole at the aircraft right hand side fuselage around row 14~15 seats. Survivors described they saw sunlight from outside through this hole and they decided to escape from this hole. There were some objects obstructing survivors' escape way including seats, luggage, and other debris. One survivor who escaped from this hole stated her watch showed 11:05am at that time. A total of 10 survivors escaped from this hole and stood on the aircraft wing. The first batch of rescue boats arrived at scene at about 11:35am.

There were five survivors seated closed to aft-cabin escaped from service door. They had late recovery from coma. When the first one of these 5 survivors woke up, he could observe other survivors' condition and location and he described that in addition to these five people, there were no other survivors. He tried to comfort and took care of other survivors when waiting for rescuers and trying to knock the window for help. The rescuers opened the service door and rescued these five passengers around 11:35am through this service door.

1.15.2 Rescue

According to interview notes of local rescuers (referred to Attachment 7-9) and official rescue report (referred to Attachment 7-10), the first 9 rescue vehicles with about 15 fire fighters from Taipei City and New Taipei City rushed to crash site about 11:05~11:15 am after receiving the notice from their firefighting command centers. Three of the fire fighters tried to swim to aircraft main wreckage in the river. Two of them failed to reach due to strong current. Two powered rubber boats successively reached to aircraft main wreckage area and send rescuers to climb on tail fuselage. The other rescuers stayed on boat and began to rescue the 10 survivors who escaped by themselves from cabin and stood close to wing section about 11:30 am. The rescuers on tail fuselage then opened the service door and went into cabin. They rescued five survivors from cabin through the service door.

According to rescuer interview notes, the cabin was full of gas odor and dark when they went into cabin. Therefore they tried to find out and use appropriate tools to rescue people such as the explosion-proof lights and the hydraulic cutters. TransAsia maintenance staffs and the fire fighter from Taipei Songshan Airport arrived on the initial phase and provided the advisory of aircraft's information regarding exit position and door operation, gas tank position, cutting area, hanging points and so on. For rescue purpose, the rescuer ever cut off several seats and portion of right fuselage skin. Most of victims in cabin were sitting on their seats with seat belt fasten and they were upside down in water.

IV. Appendices

NIL

V. Attachment List

No	Item
7-1	The wreckage site survey report
7-2	The seat status report
7-3	The medical records of the injuries
7-4	The toxicology examination report of flight crew
7-5	The abstract of victim inspection report
7-6	The forensic autopsy report
7-7	The injury pattern
7-8	The interview records of cabin survivors
7-9	The interview records of rescuers
7-10	The rescue and emergency response report from CAA