FINAL REPORT

AIC 07-1002

Airlink Ltd

P2-ALU

Embraer-Empressa Brasileria De Aeronautica

EMB-110P1 Bandeirante

27 km East of Kandrian, West New Britain Province

PAPUA NEW GUINEA

30 March 2007

The former Papua New Guinea Air Safety Investigation Branch (ASIB), now the Papua New Guinea Accident Investigation Commission (AIC), was informed of the accident by the Operator, Airlink Ltd., 30 March 2007. As the only available AIC investigator was out of the country at the time of the accident, the investigation commencement was delayed until 4 April 2007. This coincided with the arrival, of the aircraft manufacturer's investigation team from Australia and Brazil.

The investigation was commenced as ASIB investigation number AS 07–1002 and completed as AIC investigation number AIC 07–1002.

This Report, made publicly available on 10 November 2014, was produced by the AIC, PO Box 1706, Boroko, NCD, Papua New Guinea.

The report is based upon the investigation carried out by the AIC, in accordance with Annex 13 to the Convention on International Civil Aviation, Papua New Guinea (PNG) Civil Aviation Act 2000 (As Amended), Civil Aviation Rules, and the Commissions of Inquiry Act 1951. It contains factual information, analysis of that information, findings and recommendations.

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David INAU
Acting CEO
PNG Accident Investigation Commission

10 November 2014

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INTRODUCTION

The Embraer Bandeirante aircraft, registered P2-ALU, was being operated on a freight flight from Port Moresby to Hoskins, West New Britain Province. The pilot in command (PIC) was woken at 0100 to be told he was required to crew the flight with a 0400 departure. However, there were no reports of the PIC mentioning that he was not rested and fit to operate the aircraft.

The aircraft departed Port Moresby at 0402, and the flight apparently progressed normally until it passed the en-route reporting point Maran, which is about 58 NM (107 km) from the accident site. That position report from the crew at 0506 was the last transmission heard from the aircraft by Air Traffic Services. They reported cruising at 11,000 ft. The aircraft did not arrive at Hoskins, and a search was commenced 70 minutes after the estimated time of arrival at Hoskins. There was no evidence that the crew reported descending below 11,000ft, or that they declared an emergency.

The crash site was located in the area of Atuvo and Senekaul villages, at an elevation of 780 ft, approximately 27 km to the east of Kandrian, inland of the southern coast of West New Britain. The aircraft struck tree tops at high speed, on gentle sloping terrain, on a magnetic heading of 315 degrees, resulting in the wreckage being dispersed along a 500 m wreckage trail.

The former Papua New Guinea Air Safety Investigation Branch (ASIB) commenced the investigation. Following the creation of the Papua New Guinea Accident Investigation Commission (AIC), all ASIB functions have been conducted by the AIC.

The AIC investigation determined that the right engine was not operating at impact. There was no evidence of fire. The right fuel lever was in the cut-off position, the fuel shut-off switch was switched off, and the fire extinguisher “T” handle had been activated. The examination of flight and maintenance records did not reveal any anomalies, and sufficient fuel was being carried for the flight.

The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR); neither was required by regulation. The absence of flight recorders deprived the AIC of a factual understanding of the circumstances of the accident, and ultimately possible safety information for the aviation industry worldwide.

The manner in which the cargo/freight manifest documents were completed rendered them confusing; the actual cargo weight could not be determined with accuracy. The operator’s *Load and Trim Sheet* listed a maximum allowable take-off weight that was heavier than the aircraft manufacturer’s aircraft type certification maximum allowable take-off weight.

The AIC was unable to determine why the right engine was not operating. The reason the crew were unable to control the aircraft maintaining level flight above the en-route lowest safe altitude with one engine inoperative, and subsequently impacted terrain, could not be determined.

The pilot’s family members obtained their own warrants for autopsy before the then ASIB’s autopsy warrants were issued. That resulted in limited autopsies and

subsequent embalming being carried out, prior to the ASIB being able to have official (State) autopsies carried out. This prevented the ASIB from having timely autopsies, for aviation health and safety purposes.

Compensation demands from local landowners during, and subsequent to, the on-site phase of the investigation prevented removal of wreckage from the site, and significantly interfered with the AIC's investigation activities.

This AIC report contains recommendations to the Papua New Guinea State Coroner, and the Minister for Civil Aviation recommending that action should be taken to address these issues.

1 FACTUAL INFORMATION

1.1 History of the flight

On 30 March 2007, a Embraer-Empresa Brasileira De Aeronautica Bandeirante EMB-110 P1 aircraft, registered P2-ALU was refueled with 640 litres (L) of Jet-A1 (AVTUR) in preparation for an early morning departure to Hoskins, New Britain, on 30 March.

On 30 March, the crew lodged a flight plan (See Appendix 1), which stated that the total fuel on board was 2,100 pounds (lbs) (1,208 L). The first sector of the planed route was from Port Moresby to Hoskins. The pilot-in-command (PIC) obtained an area forecast for the flight, which indicated that there were areas of rain and scattered cloud from 1500-5000 feet (ft), with deteriorating conditions forecast for the period between 0400[1]-0800 hours (hrs); for their arrival at Hoskins. The forecast required 30 minutes holding fuel in addition to the flight and statutory fuel requirements. These conditions were normal for their destination at this time of the year.

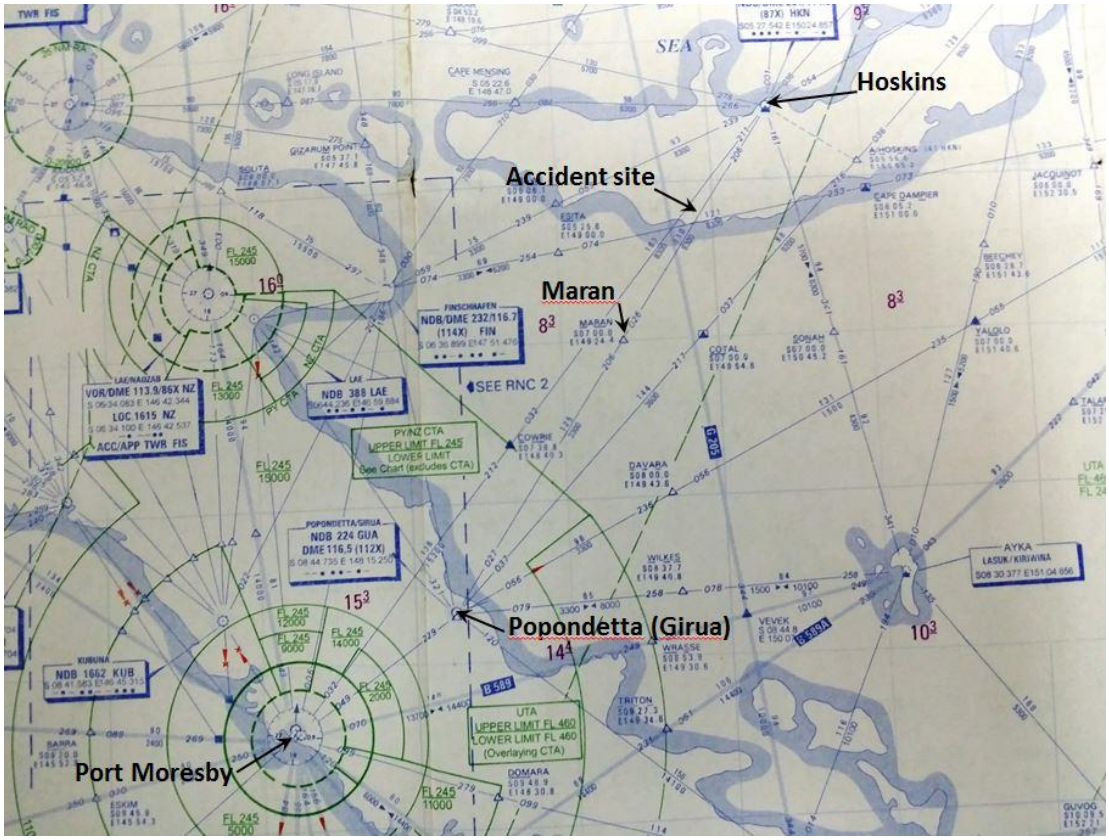


Figure 1: RNC chart showing the route Port Moresby to Hoskins

1 The 24-hour clock, in Coordinated Universal Time (UTC), is used in this report to describe the local time as specific events occurred. Local time in the area of the accident, Papua New Guinea Time (Pacific/Port Moresby Time) is UTC + 10 hours.

The aircraft departed Port Moresby at 0402, as flight number ND-304 for Hoskins. It initially climbed to the planned Flight Level (FL) 140 (14,000 ft), which was 300 ft above the lowest safe altitude (LSA) on the initial RNC[2] track between Port Moresby and Girua, an Instrument Flight Rules (IFR) reporting point on the north coast of the PNG mainland. The LSA for the sector between Girua and the en-route reporting point Maran was 3,300 ft, and the PIC had planned to cruise at 9,000 ft. The sector between Maran and Hoskins was planned at 9,000 ft, with a LSA of 8,300 ft.

The purpose of the flight was to transport newspapers and general freight to Hoskins and Rabaul.

Flight Information Area (FIA) communications with Nadzab Flight Service[3] used High Frequency (HF) radio, and a Very High Frequency (127.1 MHz[4]) repeater transceiver located near the township of Popondetta. This service was usually monitored by Nadzab Flight Service during their normal hours of operation[5], for aircraft operating on the Girua to Hoskins track. One of the functions of the Nadzab Flight Service Unit was to record all transmissions received via the Girua repeater site.

The crew made a position report, intercepted by Port Moresby Flight Service, advising that they were overhead Maran at 0506, cruising at FL 110 (11,000 ft), and gave an estimated time of arrival (ETA) Hoskins at 0540. That was 2,000 ft higher than the planned level. The position report was received by Port Moresby Flight Service, because Nadzab Flight Service had not commenced operations. It subsequently commenced operations for the day at 0540. Because Nadzab was responsible for the airspace in which ALU was operating, Port Moresby Flight Service advised Nadzab of ALU's position report, once Nadzab opened.

The Maran position report was the last recorded radio contact with the aircraft. No transmission declaring the intention to descend below FL110 was heard from the crew of ALU. No MAYDAY[6] transmission was reported by ATS or other aircrew.

When the crew of ALU failed to report their arrival at Hoskins, a search was commenced of the Hoskins aerodrome. At 0650 a DISTRESFA[7] Search and Rescue Phase (SAR) was declared indicating the degree of apprehension held for the safety of the aircraft and its occupants.

Later that morning verbal reports were received from a coastal logging company in an area east of Kandrian, that an aircraft had crashed. The wreckage of ALU was found 27 km east of Kandrian, at an elevation of 780 ft above sea level. Both crew members had not survived the impact. The wreckage was located at position 06° 11′ 39.8″ S, 149° 52′ 58.9″ E, and was dispersed along a 500 m wreckage trail after

2 RNC: The Radio Navigation Chart is used for instrument flight rules flights and provides track and lowest safe altitude information for specific routes.

3 Nadzab Flight Service provided flight information services to en-route aircraft. At the time of the accident flight Nadzab Flight Information Service (Nadzab Flight Service) was physically located at Nadzab. Some time after the accident the facility was moved to Port Moresby.

4 MHz: Megahertz 106 cycles per second.

5 The normal operating hours for Nadzab Flight Service were from 0500 – 1900 hrs

6 MAYDAY: International call for urgent assistance, from French "m'aidez!

7 DISTRESFA: Distress phase of a search/and rescue operation.

colliding with numerous trees and impacting the terrain. The investigation[8] estimated the time of the accident to be about 0523.

1.2 Injuries to persons

Table 1: Injuries to persons

Injuries	Flight crew	Passengers	Total in Aircraft	Others
Fatal	2	-	2	-
Serious	-	-	-	-
Minor	-	-	-	Not applicable
Nil Injuries	-	-	-	Not applicable
TOTAL	2	-	2	-

The Pilot in Command was a citizen of Papua New Guinea. The co-pilot was a citizen of Kiribati.

1.3 Damage to aircraft

The aircraft was destroyed during the impact sequence after striking numerous trees and impacting the terrain.

Figure 2: Aerial view of crash site

8 The former Papua New Guinea Air Safety Investigation Branch (ASIB) commenced the investigation. With the creation of the Papua New Guinea Accident Investigation Commission (AIC), all ASIB functions were conducted by the AIC. For the purpose of this investigation report, the AIC will be used throughout.

Figure 3: Main wreckage site

1.4 Other damage

The wreckage was confined to an area of forest, with no damage to other property or the environment.

1.5 Personnel information

1.5.1 Pilot in command

Age	: 28 years
Gender	: male
Type of licence	: Airline Transport Pilot Licence (Aeroplane)
Valid to	: perpetual, based on medical validity.
Rating	: EMB-110
Total flying time	: 4,653.5 hours
Total on this type	: 1,253.7 hours
Total last 30 days	: 37.5 hours
Total on type last 30 days	: 37.5 hours
Total last 7 days	: 6.1 hours
Total on type last 7 days	: 6.1 hours
Total flying time at night	: 206.6 hours
Last competency check	: 7 January 2007
Route competency check	: 8 January 2007
Aerodrome competency check	: 8 January 2007
Command Instrument rating renewal	: 7 January 2007
Medical class	: One
Valid to	: 8 March 2008

Medical limitation	: no limitations

On 8 January 2007, the pilot in command passed a *Flight Competency Check Part 125 Line Check*, flying as pilot in command of a EMB 110 aircraft. The route flown was the same as the accident flight route. The Check Pilot remarks stated *"Good Standard. A Bit more reading of Route Guide."*

The PIC's partner informed the investigation that the PIC had been woken at about 0100 to be told he was required to crew the flight with a 0400 departure. However, he did not report being unfit for duty.

1.5.2 Co-pilot

Age	: 32 years
Gender	: male
Type of licence	: Commercial (Aeroplane)
Valid to	: perpetual, based on medical validity.
Rating	: EMB-110 First Officer (co-pilot)
Total flying time	: 4,235.0 hours
Total on this type	: 610.0 hours
Total last 30 days	: 77.6 hours
Total on type last 30 days	: 77.6 hours
Total last 7 days	: 10.6 hours
Total on type last 7 days	: 10.6 hours
Total flying time at night	: 71.3 hours
Last competency check	: 15 February 2007
Route competency check	: 8 January 2007
Aerodrome competency check	: 6 July 2006
Command Instrument rating renewal	: 9 July 2006
Medical class	: One
Valid to	: 8 March 2008
Medical limitation	: no limitations

On 6 July 2006, the co-pilot passed a *Flight Competency Check Part 125 Line Check*, flying as pilot in command of a EMB 110 aircraft. The route flown was different from the accident flight route. The Check Pilot remarks indicated a satisfactory standard.

1.6 Aircraft information

The EMB-110 P1 Bandeirante, P2-ALU, was a twin-engine turbo-propeller aircraft, with a low wing and conventional tail (See Appendix 5).

The Pilot's Operating Handbook (page 5-36, figure 5-15) indicated that, for a hypothetical condition of maximum structural take-off weight and ISA[9]+10, the service ceiling with one engine inoperative would be about 9,000 ft of pressure altitude.

1.6.1 Aircraft data

Aircraft manufacturer	: Embraer-Empresa Brasileira De Aeronautica
Model	: Bandeirante EMB-110 P1
Serial number	: 110-232
Year of manufacture	: 1980
Nationality and registration mark	: Papua New Guinea, P2-ALU
Name of the owner	: Airlink Ltd
Name of the operator	: Airlink Ltd
Certificate of Airworthiness number	: 950
Issue Date	: 14 December 2001
Certificate of Registration number	: 950
Issue date to Airlink Ltd	: 1 October 2002
Total hours since new	: 36,962 hours
Total cycles since new	: 43,756 cycles
Total hours at last "A" inspection	: 36,941.7 hours
Total cycles at last "A" inspection	: 43,748 cycles
Total hours since last "A" Inspection	: 6.5 hours
Total cycles since last "A" Inspection	: 8 cycles

The investigation found that substantial maintenance was carried out during the week prior to the accident. Specifically, on 28 March 2007, "A" and "B2 Phase 2" inspections were carried out. No deficiencies were noted. These inspections covered airframe, engine, and propeller systems.

The Airlink *Daily Flight Record (DFR)* for 29 March 2007 contained a signed certification of completion of a daily inspection of the aircraft. It also detailed flight sectors flown, engine trend monitoring, fuel uplift and fuel used during that day. The recorded engine trend details were normal, and no aircraft defects were recorded. There were no reports of defects.

[9] International Standard Atmosphere, ISA: That agreed by ICAO and still used as common standard; defines pressure (1013.25 mb at MSL, about 29.92 in Hg), temperature (15°C at MSL) and relative density up to tropopause. Hence, Standard Day.

1.6.2 Engine data

The engines were removed from the accident site about 2 years after the accident. The delay was due to a number of factors, including local land owner compensation issues that were unable to be resolved for a protracted period, preventing the removal of the engines from the accident site. The engines were examined at the Pratt and Whitney factory in Canada.

Engine Type	: Turbo propeller
Manufacturer	: Pratt & Whitney Canada
Type	: PT6A-34

Engine number one (Left)

Gas generator serial number	: 56744
Gas generator total time since new	: 24,246 hours
Gas generator total cycles since new	: 33,719 cycles
Gas generator total time since overhaul	: 1,832 hours
Gas generator total cycles since overhaul	: 2,504 cycles
Power section generator serial number	: 56602
Power section total time since new	: 28,187 hours
Power section total cycles since new	: 51,452 cycles
Power section total time since overhaul	: 20 hours
Power section total cycles since overhaul	: 32 cycles

The maintenance documents supplied by the operator to the PNG Accident Investigation Commission showed that on 25 March 2007 the left engine's power section was removed and replaced, because it was due for routine overhaul. The manufacturer's examination report stated that the left engine displayed contact signatures to its internal components characteristic of the engine producing power at the time of impact, likely in a high power range.

Engine number two (Right)

Gas generator Serial Number	: 56541
Gas generator total time since new	: 26,418 hours
Gas generator total cycles since new	: 39,347 cycles
Gas generator total time since overhaul	: 3,947 hours
Gas generator total cycles since overhaul	: 5,514 cycles
Power section generator serial number	: 57040
Power section total time since new	: 24,805 hours
Power section total cycles since new	: 32,026 cycles
Power section total time since overhaul	: 7,969 hours
Power section total cycles since overhaul	: 7,995 cycles

The manufacturer's engine examination report stated that the right engine displayed

contact signatures to its internal components that were characteristic of the engine's gas generator operating in a very low power range, or being unpowered and rotating under air-loads at the time of impact. The contact signatures of the power section were characteristic of the propeller rotating out of feather[10] at the time of impact.

1.6.3 Propeller data

Propeller Type	: Variable Pitch Propeller
Manufacturer	: Hartzell
Type	: HCB 3TN3C

Propeller number one (Left)

Serial Number	: BUA 26048
Total Time Since New	: Not recorded in Maintenance Log
Total Time Since Overhaul	: 1,898.8 hours

Propeller number two (Right)

Serial Number	: BUA 26761
Total Time Since New	: Not recorded in Maintenance Log
Total Time Since Overhaul	: 216.1 hours

There was no evidence that a propeller defect contributed to this accident.

1.6.4 Weight and balance data

The Airlink Ltd., *Embraer EMB-110 P1 Load and Trim Sheet* (See Appendix 4) showed the distribution of the cargo within the aircraft as follows:

Row 3	150 kg
Row 4	200 kg
Row 5	157 kg
Row 6	152 kg
Aft baggage compartment	278 kg

Aircraft operating weight	3,872 kg (Basic Weight plus two pilots)
Maximum landing weight	4,809 kg
Fuel total weight	907 kg
Ramp Weight	5,716 kg
Max-aircraft weight at takeoff	5,700 kg (adjusted for pre-take-off fuel burn of 16 kg)

The Aircraft Flight Manual was not recovered from the accident site. The

10 When propeller blades are feathered, they are about 90º to the plane of rotation.

investigation determined that the Basic Operating Weight 3,872 kg as listed on the *Load and Trim Sheet*, was likely that of the passenger configuration and included the fitment of 18 seats (six single seats, and six double seats) in the cabin, weighing about 122 kg. Therefore, the Basic Operating Weight in the freight configuration was about 3,750 kg including two pilots.

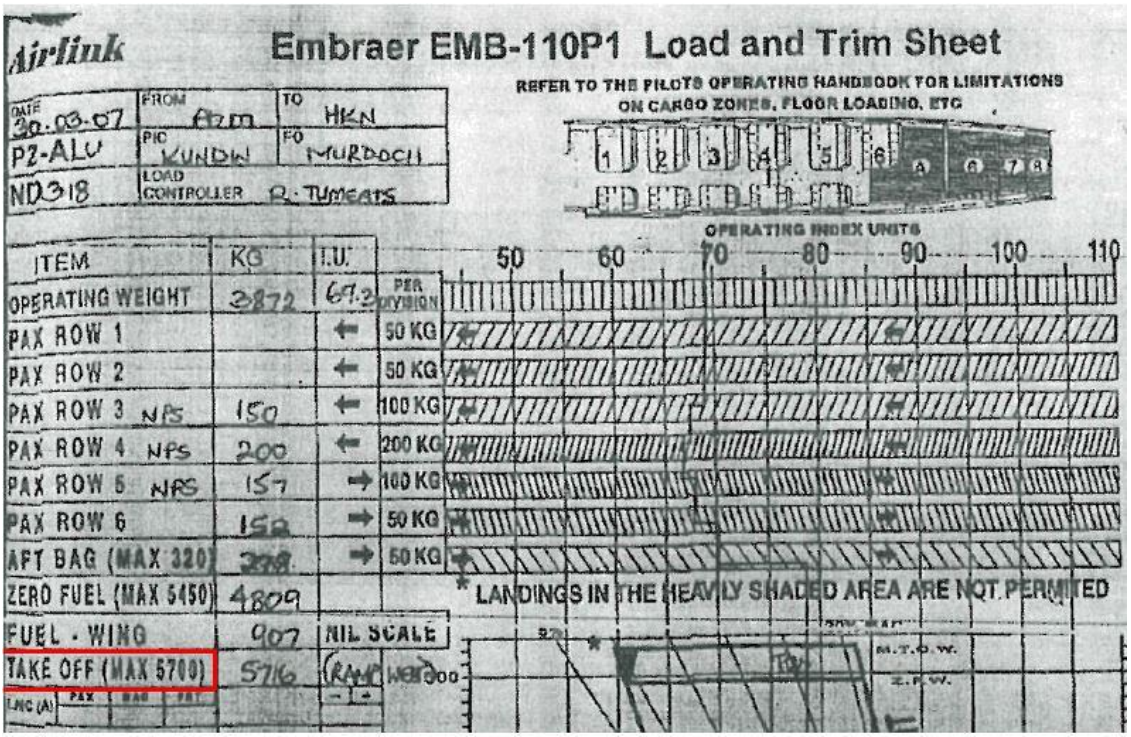


Figure 4: Section of P2-ALU *Load and Trim Sheet* for the accident flight
[red border added for clarity]

According to the EMB-110 P1 Pilot's Operating Handbook, on page 2-7:

- Maximum structural take-off weight is 5,670 kg
- Maximum ramp weight is 5,700 kg
- Maximum cargo for an EMB-110 P1 in cargo configuration is 1,813 kg.

The Airlink Ltd., *Embraer EMB-110 P1 Load and Trim Sheet* listed the Maximum [allowable] Take-off Weight (MTOW) as 5,700 kg. The Embraer investigators advised the PNG AIC that there was no record of Embraer (as the manufacturer of the aircraft type) having participated or supported Airlink Ltd., to create this *Load and Trim Sheet*.

They stated that "*it's Embraer policy to always use the published certified limitations on preparation of Balance Charts". "Embraer never produced any upgrade to allow the aircraft EMB-110 P1 a higher MTOW than the factory weight of 5670 kg."*

The operator advised that the ramp weight for the flight was 5,716 kg, and that 16 kg of fuel would be used for taxi before takeoff, resulting in a take-off weight of 5,700 kg.

The *Airlink General Cargo Manifest* number 88073 (See Appendix 3) had many

changes, making it difficult to be certain of the actual listed weight.

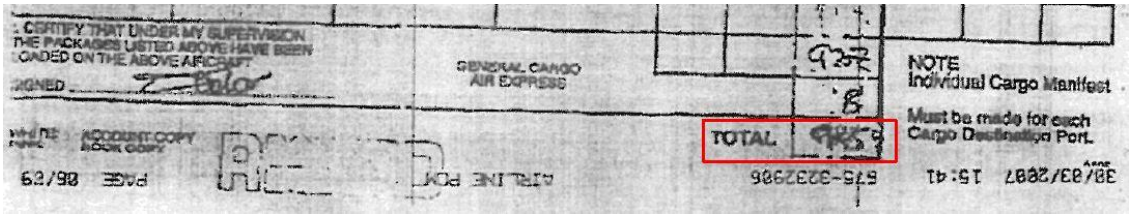


Figure 5: Section of *Airlink General Cargo Manifest* number 88073
[red border added for clarity]

Freight from Port Moresby to Hoskins was determined to be:

SP Post Newspapers	272 kg
TNT freight Consignment Note 314513	27 kg
TNT freight Consignment Note 314511	134 kg
Total Port Moresby to Hoskins	433 kg

Freight from Port Moresby to Rabual was determined to be:

SP Post Newspapers	223 kg
SP Post Newspapers	284 kg
TNT freight Consignment Note 314512	18 kg (marked as O/L (offloaded) but not crossed off on the manifest.)
Total Port Moresby to Rabual	507 kg

There was another total weight of 499 kg with the notation "(*actual wgt*)".

The *Airlink General Manifest* number 111092 (See Appendix 2) listed the total cargo weight as 937 kg. That manifest was listed as an "*Accountable Document".* The Port Moresby to Hoskins weight was listed as 438 kg, and the Port Moresby to Rabual weight was listed as 499 kg.

Total cargo weight listed on the *Load and Trim Sheet* was 937 kg. The *Load and Trim Sheet* listed NPS (newspapers) in row 2 (150kg), row 3 (200kg), and row 4 (157 kg); a total newspaper weight of 527kg. These weights did not accord with the manifest weights.

Compensation demands from the local landowners during the on-site phase of the investigation interfered with the AIC's investigation activities, and prevented the recovery of vital evidence, including the recovery and verification of aircraft operating documentation[11], including documentation of freight on board the aircraft. Therefore, the investigation was unable to conclusively determine the weight of freight on board, on departure from Port Moresby.

The fuel figure on the flight plan was 2,100 lbs (952.5 kg). However, fuel listed on the *Load and Trim Sheet* was 907 kg. Using the lower of the fuel and freight/cargo

11 Aircraft operational documents were copies obtained from the operator.

weights, and allowing for a 16 kg pre-take-off fuel burn, the aircraft appears to have been 59.5 kg in excess of the maximum structural weight at takeoff. However, if the weight of the passenger seats was removed from the Operating Weight, the aircraft may have been 62.5kg below the MTOW. It was not possible for the investigation to conclusively determine the actual MTOW on departure from Port Moresby.

1.6.5 Fuel information

The fuel used was Aviation Turbine Fuel Jet A-1(AVTUR).

The aircraft was last refuelled at Jacksons Airport, Port Moresby on the evening of 29 March 2007. A quantity of 640 L was uplifted. The *Aviation Sales Release Receipt Tax Invoice* completed by the airport refueller, did not indicate the quantity of fuel that went into each of the aircraft's tanks; only a total. The Airlink *DFR* for 29 March 2007 detailed flight sectors flown, and fuel uplift and fuel used during that day.

The "Finish Fuel" column on the DFR stated 568 L. Based on the *DFR* and the fuel company's *Aviation Sales Release Receipt Tax Invoice* documents, the 30 March 2007 total fuel load on board the aircraft would have been 1,208 L (2,103 lbs) at a specific gravity of 7.9 (0.79 kg / L). The flight plan lodged by the pilot stated a pre-taxi fuel of 2,100 lbs.

None of the operator's documents indicated the fuel distribution in the aircraft's tanks. The *Airlink Embraer EMB-110 P1 Load and Trim Sheet* signed by the PIC, showed a fuel load of 907 kg (1999.5 lbs). The *DFR* for the accident flight was not recovered from the accident site.

1.7 Meteorological information

The area forecast for the flight indicated that there were areas of rain and scattered cloud from 1500-5000 ft, with deteriorating conditions forecast for the period between 0400 and 0800, for their arrival at Hoskins. The forecast also indicated the possibility of reduced visibility at the time of their arrival, 0540.

The accident occurred at about 05:23.

According to www.timeanddate.com

Moonrise 29 March 2007

- Port Moresby 15:27, and Arawa, Bouganville at 1448, and the accident site estimated at 15.15

Moonset 30 March 2007

- Port Moresby 0325, and Arawa, Bouganville at 0254, and the accident site estimated at 0315

Sunrise 30 March 2007

- Port Moresby 0615, and Arawa, Bouganville at 0541, and the accident site estimated 0604.

According to www.suncalc.co.uk sunrise at Senekaul, near the accident site on 30 March 2007, was 6:03; (Gasmata 6:01 (about 62 km east of the accident site); Kandrian 6:04 (about 27 km west of the accident site); and Hoskins 6:01). Therefore, with no moon and no sun, it would have been a dark night at the time of the accident.

According to www.wunderground.com at 0400 on 30 March 2007 the Hoskins temperature was 23º C, and the mean sea level pressure was 1008.5 hPa.

The historical data recorded by www.geodata.us about the date of the accident was:

- 21 March minimum daily temperature 23ºC and maximum daily MSL pressure was 1010.2 hPa
- 4 April minimum daily temperature 25º C and maximum daily MSL pressure was 1009.6 hPa

The investigation estimated that the temperature and MSL pressure at the accident site, 780 ft above MSL, at the time of the accident, were 21.5º C and 1009 hPa respectively. Therefore, at cruising altitude 11,000 ft, the pressure altitude would have been 11,120 ft, and the density altitude 10,280 ft.

Witnesses on board a logging ship anchored off the coast adjacent to the accident site, reported that winds during the night were strong enough to drag the ships anchor. However, the villagers near the accident site reported that the weather was fine at the time of the accident, with no cloud or wind over their village. The village was about 20 km inland of the coast.

1.8 Aids to navigation

1.8.1 Aircraft navigation equipment

The aircraft was equipped with the following navigation instruments:

- Two automatic Direction Finder (ADF)
- One Distance Measuring Equipment (DME)
- One Global Positioning System (GPS)

In addition to these navigation aid instruments, the aircraft was also equipped with one Weather Radar receiver.

The aircraft was equipped and maintained to meet the IFR standards and was certified to operate under IFR conditions with two pilots. The aircraft was not fitted with an automatic pilot system.

1.8.2 Ground based navigation aids

The en-route ground-based navigation aids on the track between Port Moresby and Hoskins were as follows.

Port Moresby:

- Non Directional Beacon (NDB)
- Very High Frequency Omni-directional Radio Range (VOR)
- Distance Measuring Equipment (DME)

Girua:

- Non Directional Beacon (NDB)
- Distance Measuring Equipment (DME)

Hoskins:

- Non Directional Beacon (NDB)
- Distance Measuring Equipment (DME)

No reports of problems interrogating the navigation aids were received from the crew of ALU or any other aircrew on 30 March 2007. The ground-based and aircraft navigational equipment was not considered to be a contributing factor in this accident.

1.9 Communications

The aircraft was fitted the following communication equipment.

- Two Very High Frequency (VHF) transceivers
- One High Frequency (HF) transceiver
- One Transponder

The on-board communications equipment was maintained to meet the IFR standards and was certified to operate under IFR conditions.

All communications between ATS and the crew were recorded by ground based automatic voice recording equipment for the duration of the flight. Air Traffic Services reported that there were no difficulties communicating with the crew of ALU. The quality of the aircraft's transmissions was good.

Shortly after the accident, the investigating team requested the recorded ATS information from Nadzab Flight Service, in order to determine if the crew of ALU had made an in-flight emergency transmission on VHF, because nothing was heard on HF.

Nadzab Flight Service informed the AIC that the tapes were not available because ATS only had four recorder tapes, and those tapes were recycled or re-recorded every fourth day. The recorded data for the morning of 30 March 2007, covering ALU's flight, had been over-recorded and was no longer available.

1.10 Aerodrome information

Aerodrome information was not relevant to this investigation.

1.11 Flight recorders

The aircraft was not fitted with a flight data recorder or cockpit voice recorder. Neither recorder was required by current Papua New Guinea aviation regulations.

1.12 Wreckage and impact information

The on-site investigation team consisted of the AIC investigator, the manufacturer's representatives from Embraer in Australia and Brazil, Pratt and Whitney from Canada, and the operator Airlink.

The aircraft struck tree tops on gentle sloping terrain, on a magnetic heading of 315 degrees, resulting in the wreckage being dispersed along a 500 m wreckage trail.

The crash site was located at 06° 11′ 39.8″ S, 149° 52′ 58.9″ E in the area of Atuvo and Senekaul villages at an elevation of 780 ft; approximately 27 km to the east of Kandrian, inland of the southern coast of West New Britain.

This route was flown regularly by EMB-110 aircraft and routinely heard by villagers in the area of the accident. Witnesses in the nearby villages reported hearing a different sound from what they normally heard when aircraft crossed the south coast of New Britain Island. Witnesses at Atuvo Village reported seeing the aircraft flying low over their village school with lights illuminated. Shortly after, they heard two separate impact sounds.

The villagers ran to the area of the final impact sound and found the aircraft wreckage with both pilots fatally injured.

The wreckage was dispersed in a pattern that was consistent with the aircraft impacting terrain at high speed. The wreckage trail evidence indicated that the landing gear was extended, but the wing flaps were in the fully retracted position. The initial impact with trees was with the right main landing gear, which tore the landing gear out of the right wing and severed the wing from the fuselage. The narrow path through the trees provided evidence that, immediately after the initial impact, the aircraft rolled right, and was at a right bank angle of about 45º and a descent angle of approximately 70° until ground impact. Airframe empennage structure and components, the right engine, the right-main landing gear, and portions of the right wing separated during the initial impact. The left main landing gear was found partially extended, or may have collapsed during the impact sequence. The nose landing gear was determined to have been extended at impact.

Figure 6: The flight path of the aircraft cutting through the trees
(photo from the Embraer Air Safety Report)

The forward passenger access door, two nose avionics access doors, and the right emergency exit door were located with the main wreckage. The right emergency exit door was found on the under-side of the fuselage.

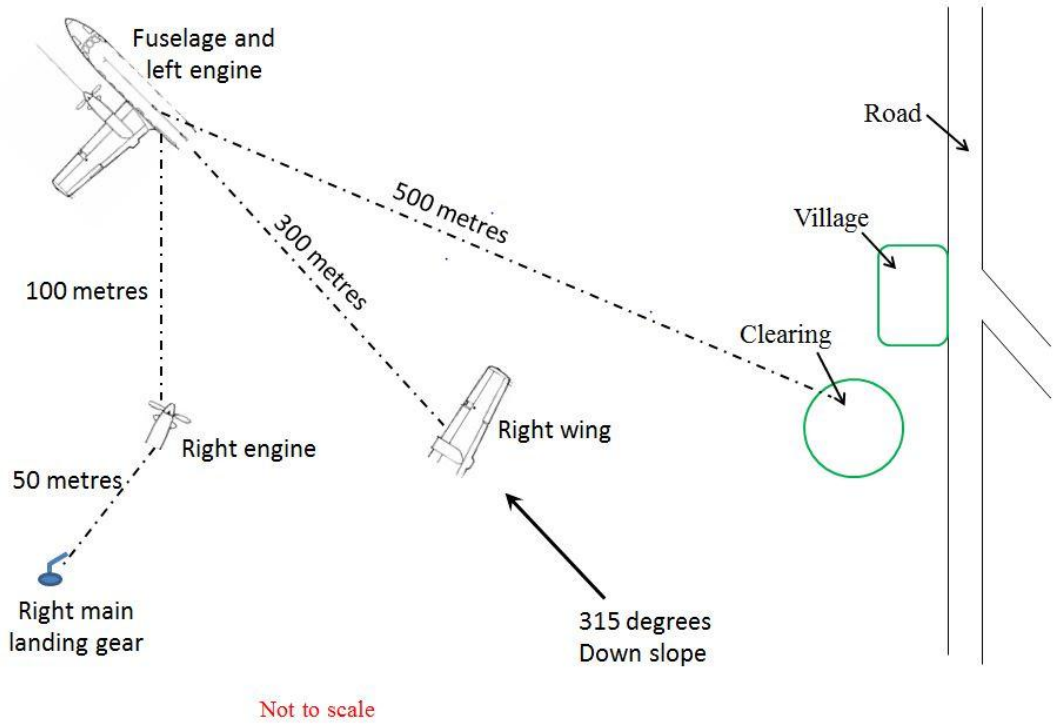


Figure 7: Sketch of wreckage distribution

Figure 8: Fuselage, left wing, left engine and lower portion of vertical stabilizer
(photo from the Embraer Air Safety Report)

1.12.1 Left wing

The left wing was still attached to the main fuselage wreckage, but had been displaced forward, allowing the left propeller to make contact with the fuselage. The out-board section of the left aileron was bent upwards, and the attached trim tab was trimmed /deflected downwards, indicating that it was trimmed to roll toward the left.

The outer left wing examination revealed a cord-wise overload failure of the upper wing-skin surface, which was consistent with the aircraft rolling violently toward the starboard side at a 45° angle at the moment of impact. The flaps were found in the retracted positioned.

Figure 9: Left wing
(photo from Embraer Air Safety Report)

1.12.2 Right Wing

The right wing failed around the right main landing gear nacelle area. At the failed section, both upper spar structures had the appearance of being crushed by compressive forces. The lower front spar structure had deformations of traction and bending upwards, while the lower rear spar structure had deformations of traction, bending upwards and torsion. In this area, two and a half ribs were missing. The ribs were found with the right main landing gear. Ribs six and seven were pulled from the front spar, with rivet holes on spar web deformed aft. The outer failed rib (rib eight) was also the wall of the outer fuel tank section. Most remaining fuel exited the wing tank during the impact. The right wing upper surface, at the failed section, showed upward bending.

Most of the right wing leading edge had separated from the wing, with only a small section attached near the wing tip. At the separated section of the leading edge on the upper wing surface, there were parallel semi-circular scratches, indicating a strike followed by a rotating drag. The right aileron separated from the wing and the remainder of the right flap was retracted.

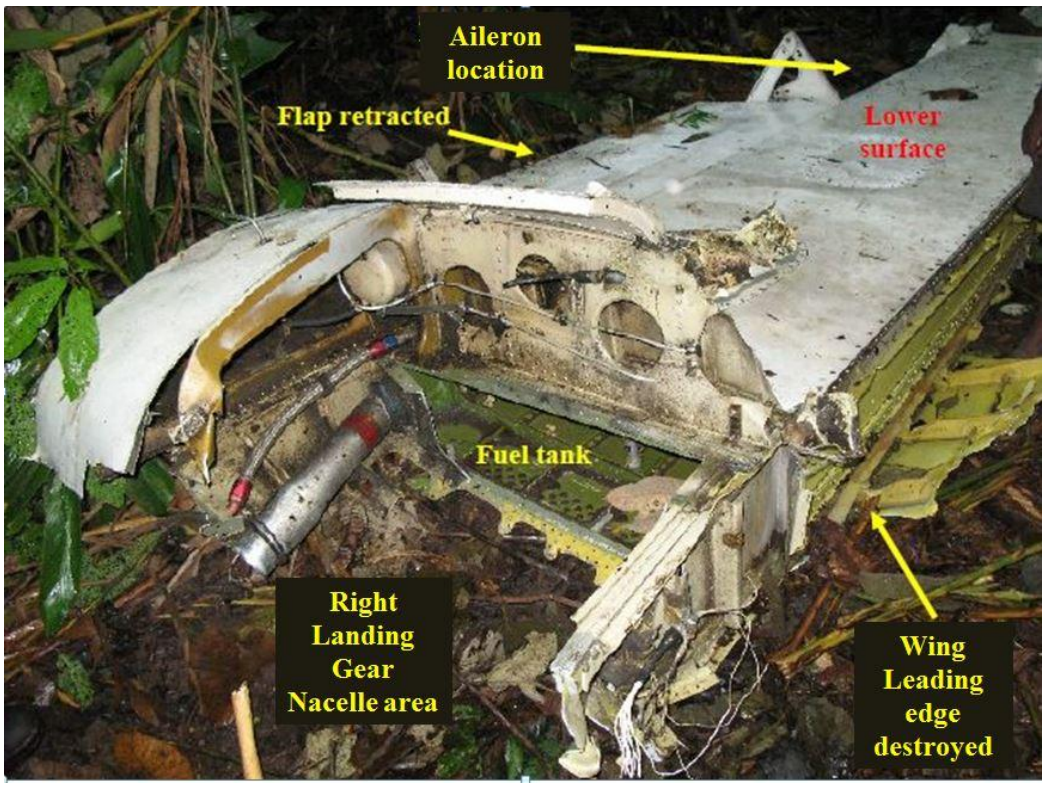


Figure 10: Inverted right wing
(photo from Embraer Air Safety Report)

1.12.3 Left main landing gear

The left main landing gear was partially extended, or may have collapsed during the impact, with the left opening door open, and the right closed.

Figure 11: Part of the left main landing gear attached to the wing structure
(photo from the Embraer Air Safety Report)

1.12.4 Right main landing gear

The right main landing gear was found in the fully extended position.

Figure 12: Part of the right main landing gear attached to the wing structure
(photo from Embraer Air Safety Report)

1.12.5 Empennage

The severely damaged and disrupted empennage section contained the vertical stabiliser rear spar, lower section of the vertical stabiliser, which was still attached to

the lower rudder hinge and a lower section of the rudder. The forward vertical stabiliser spar was severely disrupted along with the attached skin panels. The forward main attach points were found broken in over-load failure. The fractured surfaces had a clean metallic appearance, indicating that failure was not caused by corrosion or fatigue. All of the fracture surfaces were consistent with over-load failure. Due to the destruction of the empennage and associated controls by impact forces, the investigation was unable to determine the deflection of the rudder trim tab.

Figure 13: Section of vertical stabilizer and rear fuselage
(photo from the Embraer Air Safety Report)

Figure 14: Vertical stabilizer front spar
(photo from Embraer Air Safety Report)

1.12.6 Left engine and propeller

The left engine showed some evidence that it was developing power prior to impact. The propeller was found still attached to the engine, but only one blade was found at the site. An inspection of that blade revealed that it was bent forward, which was evidence that it was being driven under engine power.

Figure 15: Left engine and propeller
(photo from the Embraer Air Safety Report)

The propeller hub was fractured. The investigation determined that the fracture was likely to have been the result of ground impact, and/or striking the fuselage when the left wing was deflected forward on ground impact. Of the three blades, only one was visible; it was bent forward. The evidence of the propeller blade pitch angle and the forward bend were consistent with the engine developing power and driving the propeller at impact.

Figure 16: Left propeller blade and fuselage cuts
(photo from Embraer Air Safety Report)

The engine exhaust outlet exhibited clear evidence that it had been deformed while operating at high temperature; further indicating high power at the time of impact.

Figure 17: Left engine exhaust pipes showing hot deformation
(photo from the Embraer Air Safety Report)

1.12.7 Right engine and propeller

The right engine was found approximately 180m behind the main wreckage. The right propeller, engine nacelle, firewall, and engine supports were still attached to the engine. The right propeller blades were feathered[12], with damage only in the blade tips; the tips were bent in the direction of rotation. Some material was missing at the blade tips, probably due to impact. One of the blades was buried and showed more bending deformation.

The engine exhaust showed some deformation, but appeared to be cold deformation. The engine power turbine was jammed/locked. There was no evidence that it had failed due to excessive rotational speed. There was also no evidence of in-flight fire.

12 When propeller blades are feathered, they are about 90º to the plane of rotation.

Figure 18: Right engine and propeller
(photo from the Embraer Air Safety Report)

1.12.8 Cockpit

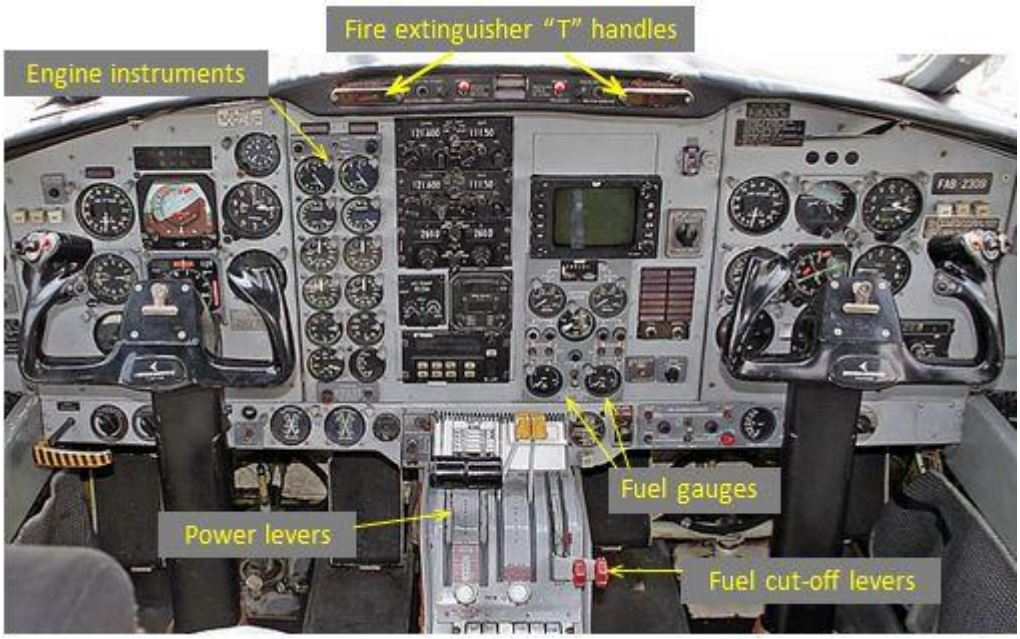


Figure 19: Typical EMB-110 Bandeirante cockpit

The Fire Extinguisher "T" Handle for the right engine had been activated. The safety "witness" lockwire was broken, confirming activation. The left "T" handle "witness" lockwire was unbroken/secure.

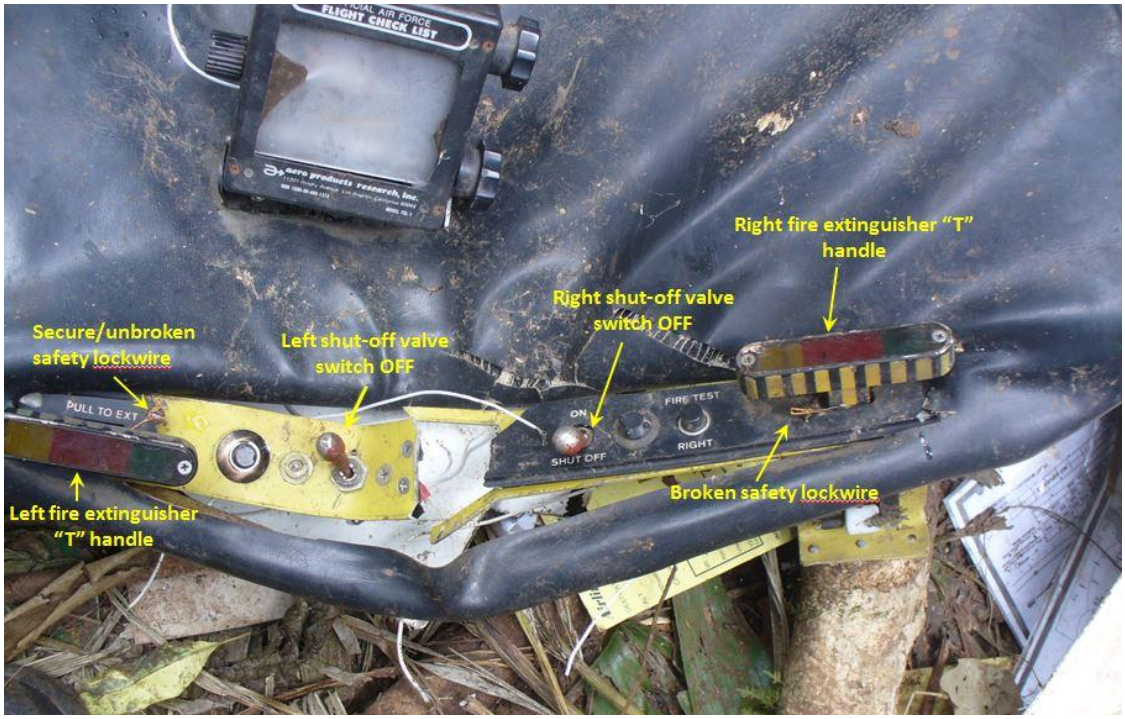


Figure 20: Activated right engine fire extinguisher "T" handle
(photo from the Embraer Safety Investigation files)

The engine controls were damaged and may have been moved forward by any of the following: impact forces, including cable movement as the airframe was disrupted, loose objects during impact sequence, or from the rescue team workers actions. The position of the propeller levers was not an indicator of the propeller blades' positions at impact. However, the propellers' blades will move to the feathered position when the PT6A-34 engine is shut down.

The fuel levers have a locking device at the cut-off position to prevent movement from that position. The right engine fuel lever was found in the cut-off position.

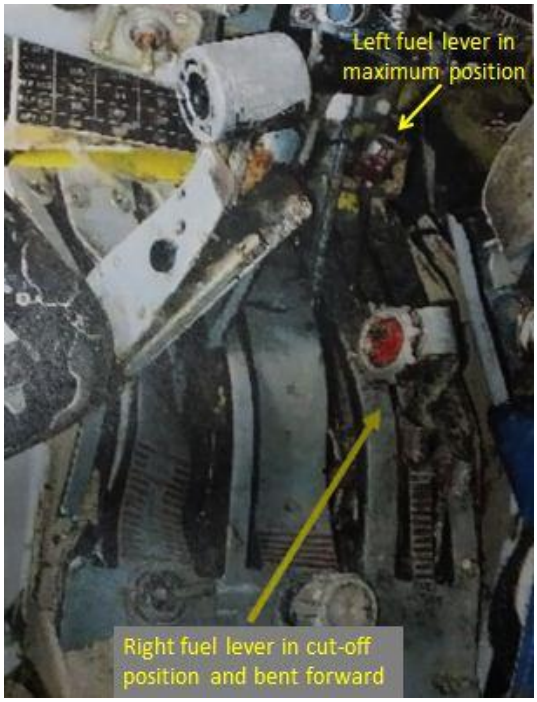


Figure 21: Fuel cut-off levers
(photo from the Embraer Air Safety Report)

The right engine and fuel instruments, "frozen" / jammed at impact, had significantly lower readings than the left engine instruments. Specifically: torque, oil pressure, and T5 readings. The left fuel gauge was damaged and the needle was bent and showing about 1,300 lbs in the needle tip bent position or 1,500 lbs taken in a straight line from the needle pin before the bend. The right gauge was jammed at 100 lb.

Table 2: Instruments - Fuel panel readings

P2-ALU	LEFT ENGINE	RIGHT ENGINE
Fuel Flow	180 lbs/hr	0 lbs/hr
Fuel Pressure	34 psi	25 psi
Fuel Quantity	1,500 lbs	100 lbs

Table 3: Engine instrument readings

P2-ALU	LEFT ENGINE	RIGHT ENGINE
Engine Torque	350 ft/ lb	0 ft/ lb.
Propeller Speed	instrument missing	needle missing
Oil Pressure	120 psi	5 psi
N2 % RPM	0 %	0 %
T5	550 deg C	100 deg C

Table 4: Fuel switch positions at impact

Left Main switch “ON” (Fig 22)	Right Main switch “ON” (Fig 22)
Left Aux switch “OFF” (Fig 22)	Right Aux switch “AUTO” (Fig 22)
Crossfeed “OFF” (Fig 22)	
Left Shut-off[13] “ON” (Fig 21)	Right Shut-off “OFF” (Fig 21)

Figure 22: LEFT: ALU fuel gauges. RIGHT: ALU engine gauges

(photo from the Embraer Air Safety Report)

1.13 Medical and pathological information

Both pilots, the sole occupants, were fatally injured.

The process of organising forensic autopsies of the occupants required the accident investigators to contact the Waigani Coroners Court to have warrants for autopsy and burial issued by the Coroner.

These procedures were completed, however the family members had earlier obtained their own warrants, which prevented the investigation team from having timely autopsies, for aviation health and safety purposes, conducted.

Pathologists from the NSW Forensic Institute of Science subsequently conducted autopsies in Port Moresby on 7 April 2007, at the request of the investigation team.

13 Shut-off valve switches. When moved to the OFF position, they energise the shut-off valves, located in the engine nacelle firewalls, thus closing the fuel supply to the engines. The same switch also controls the hydraulic and air-conditioning shut-off valves

1.13.1 Pilot - Extract from post-mortem report

The Pathologist's report stated that the body of the pilot had been subjected to a previous limited autopsy, and had also been embalmed. The disturbance to the body associated with these procedures severely limited the information available at autopsy, and rendered toxicological analysis near meaningless. An assessment as to whether there was any underlying potentially incapacitating pathological factor was therefore not possible. Despite some evidence of narrowing of the coronary arteries the effect of this finding was inconclusive.

It was not possible to test for carbon monoxide and cannabinoid substances. Further testing for a range of drugs of abuse and prescribed medications were negative.

The Pathologist concluded that "this death cannot be regarded as natural".

1.13.2 Co-Pilot - Extract from Post Mortem

The Pathologist's report stated that prior to this post mortem examination the body of the co-pilot had previously undergone a limited autopsy and subsequent embalming. Both of these procedures had limited the information available at autopsy, which markedly hampered meaningful assessment and toxicological analyses.

The co-pilot had sustained multiple recent blunt force injuries, consistent with injuries sustained in the impact. Focal haemorrhage was identified in association with these injuries, in keeping with the injuries having been sustained whilst the co-pilot still had a heartbeat. In view of the circumstances in which the body was discovered, it is consistent with death as a consequence of multiple blunt force injuries.

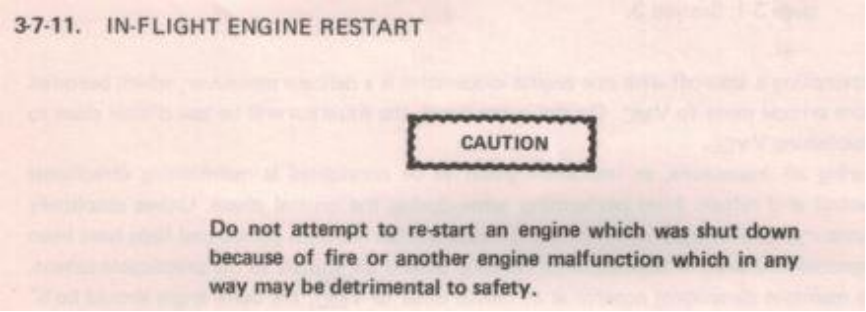
The disturbance to the body associated with the prior autopsy and subsequent embalming severely limited the information available at autopsy, and rendered toxicological analysis near meaningless. There was evidence of potentially significant atherosclerotic narrowing of the coronary arteries, but due to the prior autopsy process, this finding was not considered conclusive. No further significant pathological conditions were identified in this limited examination.

The Pathologist concluded that "this death cannot be regarded as normal".

1.14 Fire

Although the cockpit fire extinguisher "T" handle had been activated, there was no evidence of fire in flight or after the aircraft impacted terrain.

The Embraer EMB-110 P1 Fire Detection and Extinguishing system description does not detail a physical or electrical impediment that could prevent the crew from trying to relight an engine in flight. However, the aircraft's Emergency Procedures Section 3.7.11 cautions against relighting an engine that has been shut down because of in-flight fire.



3-7-11. IN-FLIGHT ENGINE RESTART

CAUTION

Do not attempt to re-start an engine which was shut down because of fire or another engine malfunction which in any way may be detrimental to safety.

Figure 23: EMB-110 P1 *Emergency Procedures* Section 3.7.11

1.15 Survival Aspects

The accident was not survivable.

1.16 Tests and research

Apart from engine examinations conducted in Canada at the Pratt and Whitney factory, no other tests or research were required to be conducted as a result of this accident.

1.17 Organisational and Management Information

1.17.1 The Operator

Airlink Ltd
PO Box 1208
Madang

The operator was an aviation company that conducted scheduled third level regular public transport (RPT) flights from a network of base stations around PNG, utilizing a fleet of aircraft that included the EMB110. The operator went into liquidation on the 3 October 2007, about 6 months after the accident.

The Company conducted an internal audit report on 28 Feb 2007 on their maintenance control and maintenance records. (Audit Module-MC07-01) The following are quotes from that report.

1.17.2 Manufacturer's Engine Overhaul Requirements

Most countries accept the engine manufacturer as the most knowledgeable authority on the overhaul requirements for their products. As a result, the manufacturers write detailed Specifications or Service Bulletins for what engine components must be replaced at every overhaul. The process involved standards that are to be met and how often the engine must undergo overhaul.

These inspections include midlife inspections and are normally accepted by the Regulatory Authorities.

1.17.3 Summary of audit

Carl Healy and Associates were asked to review Airlink's engineering and operational practices, due to a series of engines failures over a period of 12 months. Heightened concern resulted from the failure of a PT6 engine Power Section, Serial Number 56700-100, and feed-back from the manufacturer. The PT6 series engine type had been known globally for its reliability.

The prime recommendation was that the Airlink Ltd.,"On Condition Maintenance Program", which had not been supported by the engine manufacturer for about ten years, be discontinued and replaced with a hard-time overhaul life.

Because the operator's PT6 engine records were contradictory and incomplete, it was further recommended that the Airlink Ltd., supply department and maintenance control staff responsible for initiating and updating records be re-trained, and steps taken to have a third party independently review and correct all PT6 engine records.

1.18 Additional Information

1.18.1 Terrain on track over West New Britain

The terrain on West New Britain along the aircraft's track had ridges varying in height to about 1,500 m, with one peak 32 km west abeam the flight planned track 1,951 m high. That mountain was 42 km northwest of the accident site.

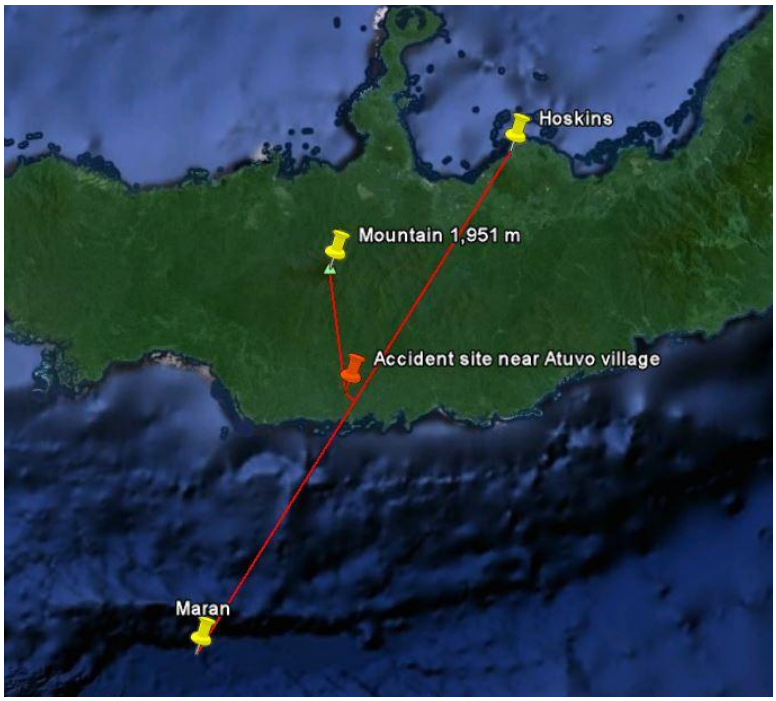


Figure 24: Map of accident site in relation to mountains

1.18.2 Coronial investigation

The family members obtained their own warrants for autopsy, and limited autopsy and subsequent embalming were carried out, prior to the AIC being able to have official (State) autopsies carried out. This prevented the AIC from having timely autopsies, for aviation health and safety purposes.

The Coroners Act 1953 states:

9. NOTICE OF SUDDEN DEATH, ETC., TO BE GIVEN

(1) Where a dead body is found or a case of sudden death or death attended with suspicious or unusual circumstances occurs, a person knowing, or becoming acquainted with, the death or the finding of the body must immediately give notice to the nearest Coroner or commissioned officer of the Police Force.

Penalty: A fine not exceeding K20.00.

(2) A member of the Police Force who receives notice or otherwise becomes aware of–

(*a*) a death referred to in Subsection (1); or

(*b*) a dead body being found, must without delay give to a Coroner such information as he can obtain concerning the death or the dead body.

14. POST-MORTEM EXAMINATIONS

(1) Subject to Subsection (2), in a summons referred to in Section 13 or by a written order a Coroner may, at any time before the termination of the inquest, direct a medical practitioner to make a post-mortem examination of the body of the deceased person, with or without an analysis of the contents of the stomach, intestines or other organs.

(2) Where it appears to the Coroner that the death of the deceased person was or might have been caused partly or wholly by improper treatment by a medical practitioner or other person, the medical practitioner or other person must not be allowed to perform or assist at the post-mortem examination or analysis.

(3) Where it appears to the Coroner that the cause of death has not been satisfactorily explained by the evidence of the medical practitioner or other witnesses brought before him, he may summon as a witness some other medical practitioner and direct a post-mortem examination of the deceased person to be made by him, whether any such examination has already been performed or not.

(4) Where a Coroner considers it advisable to have a post-mortem examination made of–

> (*a*) the body of a person who has died and the cause of whose death is unknown or in doubt; or
>
> (*b*) a body respecting which a doubt exists as to whether it is that of a still-born child,

to assist him in deciding whether or not an inquest ought to be held, he may, at any time and without holding an inquest, by written order direct a medical practitioner to make a post-mortem examination of the body and report on the examination to the Coroner.

1.18.3 Powers of Accident Investigation Commission

Compensation demands from local landowners following this and other accidents have interfered with the AIC's investigation activities.

In recent years these demands have disrupted, and even prevented, the progress of obtaining or recovering vital evidence to be analysed by the AIC, or to be sent

overseas to a manufacturer or a reputable facility for examination and report of its analysis. At the time of this accident the Air Safety Investigation Branch (ASIB) was responsible for accident investigation in Papua New Guinea. The ASIB was not a Commission, and although the ASIB had primacy of investigation of aircraft accidents and serious incidents, it was more difficult to enforce powers than it should now be as the AIC is a Commission.

The Civil Aviation Act 2000 (As Amended), and the Commissions of Inquiry Act 1951, together provide the legislative base upon which the AIC has custody of an aircraft once an accident occurs in Papua New Guinea. It is an offence to wilfully interrupt the proceedings of an AIC investigation.

Land owner activities as described above constitute wilfully interrupting an AIC investigation.

The Civil Aviation Act 2000 (As Amended) Part XIII, Division 5, Section 245

245. INVESTIGATIVE POWERS OF COMMISSION

(1) For the purposes of carrying out its functions and duties under this Act, the Commission shall have the same powers as are conferred on a Commission of Inquiry by the *Commissions of Inquiry Act (Chapter 31)* and subject to the provisions of this Part, all the provisions of that Act, shall apply accordingly.

(2) In addition the Commission shall have all such powers as may be conferred on it by this or by any other Act, and as may be reasonably necessary or expedient to enable it to carry out its functions.

246. POWERS OF ENTRY AND INVESTIGATION

(1) Subject to Subsection (2), where an accident occurs to an aircraft in Papua New Guinea, the aircraft (including the contents and parts thereof) shall be deemed to be in the custody of the Commission for such period as the Commission considers necessary for the purposes of an accident inquiry, and shall not be removed or otherwise interfered with except with the permission of the Chief Commissioner, the Deputy Chief Commissioner or the Chief Executive.

(6) A person exercising the power of entry conferred by Subsection (3) or Subsection (4) shall –

(a) carry a warrant of authority issued by the Chief Commissioner specifying -

(i) the name and the office or offices held by the person; and

(ii) that the person is authorized by the Chief Commissioner to exercise the power conferred by Subsections (3) and (4) to enter aircraft, aerodromes, buildings, and places, and to carry out such inspection; and

(b) produce the warrant of authority and evidence of identity -

(i) if practicable on first entering the aircraft, aerodrome, building, or place; and

(ii) whenever subsequently reasonably required to do so.

Commissions of Inquiry Act 1951

11. CONTEMPT OF COMMISSION

A person who–

(*a*) wilfully insults the Commission; or

(*b*) wilfully interrupts the proceedings of the Commission; or

(*c*) is in any manner guilty of wilful contempt of the Commission,

is guilty of an offence.

Penalty: A fine not exceeding K5,000.00 or imprisonment for a term not exceeding two years, or both.

There was no other factual information that was relevant to the circumstances leading up to the accident.

1.19 Useful or Effective Investigation Techniques

The investigation was conducted in accordance with the Papua New Guinea (PNG) Civil Aviation Act 2000 (As Amended), Civil Aviation Rules, and the Commissions of Inquiry Act 1951, and the PNG Accident Investigation Commission's approved policies and procedures, The report is based upon the investigation carried out by the AIC, which was in accordance with Annex 13 to the Convention on International Civil Aviation

2 ANALYSIS

The Embraer Bandeirante aircraft, registered P2-ALU, was being operated on a freight flight from Port Moresby to Hoskins. The pilot in command (PIC) had been woken at 0100 to be told that he was required to crew the flight with a 0400 departure. However, there were no reports of the PIC subsequently mentioning that he was not rested and fit to operate the aircraft.

The last transmission heard by Air Traffic Services was the crew's position report at Maran when they reported cruising at FL110 (11,000 ft). Maran is about 58 NM (107 km) from the accident site.

The impact of the crash was not survivable.

The investigation team found the right main landing gear and right engine torn from the wing, with the propeller assembly still attached to the engine. The propeller blades were in the feathered position. The landing gear had been extended prior to impact. The right main landing gear and right engine had been torn from the wing during the initial impact with trees. The wing flaps were in the fully retracted position.

The engine controls were damaged and may have been moved by impact forces or loose objects during the impact sequence, or from the rescue team workers' actions. However, the fuel levers have a locking device at the cut-off position to prevent movement from that position. The left engine's fuel lever was in the maximum position. The right engine's fuel lever was found in the cut-off position, with the lever significantly bent forward.

The left engine exhaust pipes showed evidence of heat deformation. There was no such evidence for the right engine.

The right engine's fire extinguisher "T" handle had been activated; it was no longer secured with the copper witness wire. It is extremely unlikely for this to have occurred due to impact forces. It is therefore likely that the right engine was not operating at the time of impact. There was no evidence of in-flight or post-impact fire. The left "T" handle witness wire was still secure.

The readings taken from the engine and fuel instruments at the accident site are recorded in section 1.12 of this report. From these readings and the physical evidence of the feathered right propeller blades and their damage signatures, the investigation determined that the right engine was not operating at the time of impact.

The right engine and fuel instruments, "frozen" / jammed at impact, had significantly lower readings than the left engine instruments. Specifically, torque, oil pressure, and T5 readings.

The aircraft's pre-taxi fuel at Port Moresby was 2,100 lbs. This was confirmed from the documentary evidence obtained by the investigation. The pilot's flight plan listed taxi, climb, and cruise fuel to Hoskins as 1,165 lbs. The investigation was unable to conclusively determine the weight of the aircraft at takeoff from Port Moresby. The aircraft crashed about 52 NM (96 km) short of the destination, Hoskins. In normal two-engine operations the 52 NM would have taken about 16 minutes and consumed about 160L of fuel. The investigation was unable to determine when the right engine

failed, or was shut down by the crew. However, it was considered likely that the fuel burn from Port Moresby to the accident site was about 1,005 lbs. That would have left 1,095 lbs on board at the time of the accident.

The left fuel gauge was damaged and the needle was bent and showing about 1,300 lbs in the needle tip bent position, or 1,500 lbs taken in a straight line from the needle pin before the tip bend. The right gauge needle did not appear to be damaged and was jammed at 100 lb. The investigation determined that because of the observed damage to the left fuel gauge, the left fuel gauge reading could not be considered reliable. Furthermore, the known fuel on board pre-taxi from Port Moresby, and the calculated fuel burn to the accident site confirmed the investigation's finding.

The investigation was unable to determine why the right engine was not operating, or why the right fuel lever was in the cut-off position, and the fire extinguisher "T" handle activated.

Based on the right fuel gauge reading, if accurate, there was minimal fuel remaining in the right tank. There was no evidence available to permit a determination of the quantity of fuel in each (left and right) fuel tank prior to departure from Port Moresby. The possibility that the aircraft departed Port Moresby with a fuel load imbalance could not be discounted. If that had occurred, it is likely that the crew would have commenced cross-feeding to balance the wing fuel load early in the flight.

Given the right fuel tank quantity shown on the gauge, it is possible that the crew were using fuel from the right tank to feed both engines during the cross-feed operation, and may have neglected to stop the cross-feeding until after the engine flamed out. At the time of impact the fuel tank cross-feed switch was off.

The out-board section of the left aileron was bent in upwards, and the attached trim tab was trimmed / deflected downwards, indicating that it was trimmed to roll toward the left. This is a further indication that the crew may have been controlling the aircraft with the right engine not operating. Due to the destruction of the rudder, and rudder trim tab and associated mechanism, the position of the rudder trim tab could not be determined. The possibility of aerodynamic imbalance due to crossed controls[14] during attempted level flight with one-engine inoperative, could not be discounted.

There was no evidence that the crew had transmitted a broadcast that they were descending from Flight Level 110 (11,000 ft), or that they had declared an emergency or transmitted a MAYDAY[15] message.

In the area of the accident, the moon had set at about 0315, and sunrise was not until about 0604. The accident occurred at about 0523. Witnesses near the crash site reported seeing the aircraft lights just before the impact with trees. The investigation concluded that other than the aircraft lights (which may have been the landing lights) the aircraft crashed during total darkness.

The investigation determined that once the aircraft had descended below the en-route

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14 Crossed controls is the term for an application of aircraft flight-control movements in the opposite sense to those used for normal manoeuvres, e.g. left aileron and right rudder; rarely required.

15 MAYDAY: International call for urgent assistance, from French "m'aidez!

lowest safe altitude of 8,300 ft, the pilot would have been unable to continue flight in instrument conditions without risking a collision with terrain in the centre of West New Britain. It appears that as the aircraft continued to descend, the crew may have turned away from the planned track, and attempted to fly north-west, away from the high terrain.

The investigation was not able to determine how long the aircraft was flown with one engine inoperative, or if there were any other abnormalities that caused descent below the en-route lowest safe altitude (LSA).

If the aircraft was at or below maximum allowable take-off weight, it should have been able to be safely flown with one engine inoperative above the en-route LSA.

The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR); neither was required by regulation. The absence of flight recorders deprived the AIC of a factual understanding of the circumstances of the accident, and ultimately possible safety information for the aviation industry worldwide.

Limited autopsy and subsequent embalming were carried out under warrant, prior to the AIC being able to have official (State) autopsies carried out. This prevented the AIC from having timely autopsies, for aviation health and safety purposes.

In accordance with the PNG Coroners Act 1953 (See Section 1.18 of this report) it is essential that a post-mortem examination and analysis be carried out in support of the AIC investigation as soon as possible after an accident. Coroners should give primacy to the AIC to avoid the possibility of other autopsies on the person disturbing evidence, and thereby potentially being in breach of the Commissions of Inquiry Act 1951; specifically, interrupting the proceedings of the Commission. (See Section 1.18 of this report.)

Land owner demands disrupted the on-site investigation, and prevented vital evidence being recovered for further analysis.

The investigation was unable to determine the reason for the accident.

3 CONCLUSIONS

3.1 Findings[16]

3.1.1 Aircraft

1. The aircraft was certified, equipped and maintained in accordance with existing regulations and approved Civil Aviation Safety Authority procedures.
2. The aircraft was certified as being airworthy when dispatched for the flight.
3. The maximum take-off weight was not able to be determined. However, it is likely that the centre of gravity of the aircraft was within the prescribed limits.
4. There was no evidence of any defect or malfunction in the aircraft that could have contributed to the accident.
5. There was no evidence of airframe failure or airframe system malfunction prior to the accident.
6. The aircraft was structurally intact prior to impact.
7. All control surfaces were accounted for, and all damage to the aircraft was attributable to the severe impact forces.
8. The position of the rudder trim could not be determined.
9. The aircraft was destroyed by impact forces.
10. There was no evidence of pre- or post-impact fire.
11. The left propeller blade damage and twist was consistent with the engine producing power at impact.
12. The right propeller blade damage and twist was consistent with the engine not producing power at impact.
13. The accident occurred at about 0523.

3.1.2 Crew / Pilots

1. The pilot in command was licensed and qualified for the flight in accordance with existing Papua New Guinea regulations.
2. The co-pilot was licensed and qualified for the flight in accordance with existing Papua New Guinea regulations.
3. The pilot in command had broken sleep during the rest period prior to the flight, but did not report being unfit for duty.

16 Findings: The order in which the findings are presented does not denote a degree of significance.

3.1.3 Flight operations

1. The flight was planned in accordance with the procedures in the company Operations Manual.
2. The flight crew carried out normal radio communications with the relevant ATC units.

3.1.4 Operator

1. The operator's internal audit had identified maintenance record keeping deficiencies.
2. The operator's internal audit found that the operator's "On Condition Maintenance Program" was not supported by the engine manufacturer.
3. The *Load and Trim Sheet* was likely for the passenger configuration; the operating weight listed appeared to be for an aircraft with passenger seats installed.
4. The *Load and Trim Sheet* listed the Maximum Take-off Weight (MTOW) as 5,700kg; this was not supported by the aircraft manufacturer.
5. The EMB-110 P1 Type Certification structural MTOW was 5,670kg.
6. The manner in which the cargo/freight manifest documents were completed rendered them confusing; the actual cargo weight could not be determined with accuracy.

3.1.5 Air Traffic Services

1. The Nadzab Flight Service Unit opened 40 minutes late, and did not receive the aircraft's Maran position report at the time of the report.
2. The aircraft's Maran position report was received by Port Moresby Flight Service.
3. No MAYDAY transmission was reported by ATS or other flight crew.
4. A DISTRESFA Search and Rescue Phase was declared at 0650.
5. ATS had insufficient tapes available for retaining recorded data.
6. The recorded data for the morning of 30 March 2007, covering ALU's flight, had been over-recorded and was not available.

3.1.6 Flight recorders

1. The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR); neither was required by Papua New Guinea regulation.

3.1.7 Medical

1. There was no evidence that incapacitation or physiological factors affected the flight crew performance.
2. There was no evidence that the pilot suffered any sudden illness or incapacity which might have affected his/her ability to control the aircraft.
3. The bodies of the pilot and co-pilot had been subjected to a previous limited autopsy and also been embalmed. The disturbance to the bodies associated with these procedures severely limited the information available at autopsy, and rendered toxicological analysis meaningless.

3.1.8 Survivability

1. The accident was not survivable due to the impact forces.

3.1.9 Safety oversight

1. The Civil Aviation Safety Authority's safety oversight of the operator's maintenance procedures did not detect the record keeping deficiencies.
2. The Civil Aviation Safety Authority's safety oversight of the operator's maintenance procedures did not detect that the operator's "On Condition Maintenance Program" was not supported by the engine manufacturer.
3. The Civil Aviation Safety Authority's safety oversight of the operator's Load System did not detect the anomalies in the *Load and Trim Sheet* with respect to MTOW and aircraft Operating Weight.

3.2 Contributing factors

The reason the crew were unable to maintain level flight above the en-route lowest safe altitude with one engine inoperative, and subsequently impacted terrain, could not be determined.

3.2.1 Other factors

The following concerns were identified during the course of the investigation. While not causal to the accident, they are addressed with the aim of safety improvement.

The pilot in command's family obtained their own warrants for autopsy, which prevented the investigation team from having timely autopsies conducted, for aviation health and safety purposes.

Compensation demands from local landowners following this and other accidents have interfered with the AIC's investigation activities. In recent years these demands have disrupted, and even prevented, the progress of obtaining or recovering vital evidence to be analysed by the AIC, or to be sent overseas to a manufacturer or a reputable facility for examination and report of its analysis.

4 SAFETY ACTIONS AND RECOMMENDATIONS

4.1 Recommendations

As a result of the investigation into the accident involving Embraer-Empresa Brasileira De Aeronautica Bandeirante EMB-110 P1 aircraft, registered P2-ALU, about 52 NM (96 Kms) south west of Hoskins, West New Britain Province, on 30 March 2007, the Papua New Guinea Accident Investigation Commission issues the following recommendations to address safety concerns identified in this report.

4.1.1 Recommendation to the State Coroner

The pilot in command's family obtained their own warrant for autopsy, which resulted in the autopsy being undertaken on behalf of the family of the deceased rather than by the State.

4.1.1.1 ***The Papua New Guinea Accident Investigation Commission (AIC) recommends that the Papua New Guinea State Coroner liaise with the Accident Investigation Commission at the time of being notified of an aircraft accident involving fatalities, to ensure primacy of the autopsy process to the State.***

4.1.2 Recommendation to the Minister for Civil Aviation

Compensation demands from local landowners following this and other accidents have interfered with the AIC's investigation activities. In recent years these demands have disrupted, and even prevented, the progress of obtaining or recovering vital evidence to be analysed by the AIC, or to be sent overseas to a manufacturer or a reputable facility for examination and report of its analysis.

The Civil Aviation Act 2000 (As Amended), and the Commissions of Inquiry Act 1951, together provide the legislative base upon which the AIC has custody of an aircraft once an accident occurs in Papua New Guinea. It is an offence to wilfully interrupt the proceedings of an AIC investigation

4.1.2.1 ***The Papua New Guinea Accident Investigation Commission (AIC) recommends that the the Minister for Civil Aviation liaise with the Minister for Police, with the aim of educating police on the legislated requirement to protect aircraft wreckage following an accident. This should also ensure that the Police understand that aircraft wreckage is in the custody of the AIC, and may not be interfered with, or withheld by landowners or other parties anywhere in Papua New Guinea.***

APPENDICES

Appendix 1: Flight Plan filed at 291736Z (30 March at 0336)

CHG ALU VICE ALW

Airlink DOMESTIC FLIGHT PLAN

Filing Time 291736Z

FF QYPMYHYX QYTZZTZX QYMZYSQX

Originator

Addresses

	Aircraft Ident	Flight Cat	Class of Operation	Aircraft Type	Wake turb cat	PER
PLN	ALW	I	E 304	E110	L	B

COM (Vx2) H
NAV D (Fx2) G (Ox2) W
SSR C

Departure Point AYPY FOR Landing Points AYHK - AYTK

ETD (Date / Time) 18:15 ATD

Route Segments	LSALT	FL or ALT	TAS	TR MAG	Wind	HDG MAG	G S	Dist.	ETI	PLN ETA	ATA	G S	ETA next Posn	Flt Proc. Etc
▲ GUA	13700	A140		049				75	25					
▲ MRA	3300	A090		027				125	38					
AYHK	8300	A090		026				110	33					
AYTK	9300	A090		054				136	43					V

INDICATE ▲ AGAINST REPORTING POINTS

ALTN
FOR
FOR
FOR

Remarks

CLIAS 140 IAS Mach

STAGE	AYPY - AYHK		AYHK - AYTK										SURVIVAL EQUIPMENT
	Min	lbs	Min	lbs	Min	lbs	Min	lbs	Min	lbs	Min	lbs	
Climb		140		40									STD
Cruise	96	960	43	430									
Altn													PERSONS ON BOARD
SUB-TOTAL	96	1100	43	470									TBA
Variable Reserve	17	170	7	70									PILOT IN COMMAND
Fixed Reserve	45	450	45	450									P. Thomas
Holding (if req'd)													COMPANY
Taxi		65		35									Airlink
Fuel Required	178	2000	125	1225									
Margin (cruise)													FLIGHT PLAN ACCEPTED
TOTAL ENDCE		2160		1760									

REMEMBER TO CANCEL SARWATCH AND OBTAIN ACKNOWLEDGEMENT

Appendix 2: Airlink General Manifest 111092

30/03/2007 16:07 675-8522725 AIRLINK HQ MADANG PAGE 07/08

Airlink

Head Office
PO Box 1208, Madang
Phone (675) 852-2933 Fax (675) 852-2722

ACCOUNTABLE DOCUMENT

GENERAL MANIFEST 111092 AL208 ISSUE 2

AIRCRAFT P2-ALU DATE 30 03 07 COSTING COPY

FROM POM TO HKN

	Passenger Details						Baggage Details				Freight Details			Mail Wt
	Name	Seat	Ticket #	Wt	From	To	Pcs	Wt	Excess	Excess Tkt #	Orig	Manifest #	Wt	
1					POM	MKN					POM	88073		
2													455	
3														
4														
5														
6														
7														
8														
9														
10														
11													499	
12					POM	RAB					POM	88073		
13														
14														
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25														
26														
27														
28														
29														
30													957	
				KGS —			KGS —						KGS	

All weights must be shown in Kilograms

I HEREBY AGREE WITH THE CONDITIONS OF CARRIAGE AS SHOWN ON THE REVERSE.

FLIGHT NO ND 304

CASH

CHANGE

FLYING TIME ____ HRS ____ MINS

SERVICE CHARTER TICKET NUMBER

CHARTER ACCOUNT NO

CHARTER WARRANT NO

PRICE OF: K

QUOTE K

CHARTERING SIGNATURE ____ DATE ____

LOAD CONTROL SIGNATURE ____ DATE 30/3/07

CAPTAIN KUNDIN/MURDOCH

White: Costing with coupons Green: Uncraft (charterer if req'd Blue: Gate check & Port file Pink: Book copy

Received 30/3/07

30/03/2007 15:41 675-8232906 AIRLINE POM PAGE 07/07

Appendix 3: Airlink General Cargo manifest 88073

30/03/2007 16:07 675-8522725 AIRLINK HQ MADANG PAGE 06/08

Airlink

GENERAL CARGO MANIFEST

P.O. Box 1208, Madang 511, Papua New Guinea.
Ph: (675) 852 2933 Fax: (675) 852 2725

Nº: 88073

AIR MANIFEST NO. 111092	FLT NO. NS304	A/C P2-ALU					DATE: 30.03.07		
FROM: POM	TO: HKN				NO. OF PIECES		TRANSHIPMENT		
FROM CONSIGNOR	CONSIGNEE TO	CONTENTS	CON-NOTE NUMBER	GEN	AIR EXP	WEIGHT	PORT	NO. OF PIECES	WEIGHT
SP POST	SP POST	NEWSPAPERS		16	HKN	272/ 270	OTHER WEIGHT		
TNT	TNT	PLASTIC BAG	314513	1		27			
~~DHL~~	~~DHL~~	~~PALLET~~	~~36785~~	~~+~~		~~56~~	~~O/L~~		
TNT	TNT	CONSOL	314511	1	HKN	134	RAR & COM		
						438			
	FOM RAR								
SP POST	SP POST	NEWSPAPERS		32	RAB	220 223 224			
✓	✓	✓			✓				
TNT	TNT	EXPRESS BAG	314512	1	✓	18	O/L		
						499	(actual wgt)		
						507			
THRUS									
NUKU DUARO		Box:	317796	(EX MAG)			HKG	1	17 O/L
	UNU		308488	(EX MAG)			LUV	1	~~30~~ O/L
	UKA MAD		316297	(EX MAG)				1	~~22~~ O/L
						937			
						8			
					TOTAL	945			

Received
30/03/07

I CERTIFY THAT UNDER MY SUPERVISION THE PACKAGES LISTED ABOVE HAVE BEEN LOADED ON THE ABOVE AIRCRAFT

SIGNED

GENERAL CARGO
AIR EXPRESS

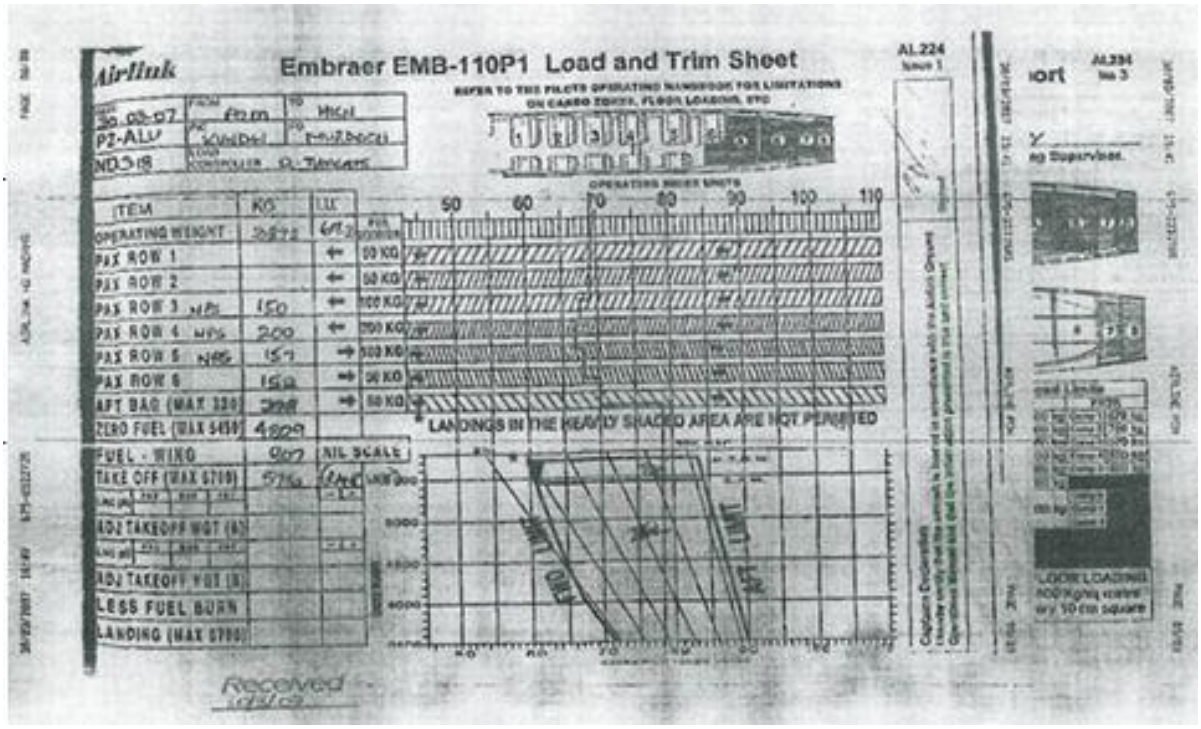
NOTE
Individual Cargo Manifest
Must be made for each Cargo Destination Port.

WHITE: ACCOUNT COPY
PINK: BOOK COPY

AIRLINE POM

675-8232986 30/03/2007 15:41 PAGE 06/09

Appendix 4: Airlink Embraer EMB-110 P1 Load and Trim Sheet



Appendix 5: Three-view drawing of the Embraer EMB-110 P1 Bandeirante