Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2008-072
Final

Missing aircraft
Buckingham Bay, Northern Territory
16 October 2008
VH-WRT, GA-8 Airvan

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CONTENTS

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Abstract

On the morning of 16 October 2008, a Gippsland Aeronautics GA-8 Airvan, registered VH-WRT, was being operated on a freight charter flight from Elcho Island and return, Northern Territory. At about 1230, it was realised that the aircraft was missing. A witness reported seeing the aircraft during the early stages of the flight and, shortly afterwards, a column of dark black smoke rising from the eastern side of the Napier Peninsula. On 17 October 2008, items of wreckage from the aircraft were found in the south-western part of Buckingham Bay. The pilot, who was the sole occupant of the aircraft, and the main wreckage of the aircraft have not been found. After consideration of the available evidence, the investigation was unable to identify any factor that contributed to the accident.

Although the investigation did not identify any issues that had the potential to adversely affect the safety of future operations, the operator took proactive safety action in response to the accident. That action included changed procedures in the areas of cargo restraint and the carriage of dangerous goods, the supervision and oversight of flights, and to the operator's flight following requirements. In addition, the operator has acted to reduce pilot workload.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: The ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

FACTUAL INFORMATION

Sequence of events

On 16 October 2008, the pilot of a Gippsland Aeronautics GA-8 Airvan (Airvan) aircraft, registered VH-WRT (WRT), was conducting a freight charter flight from Elcho Island and return, Northern Territory, under the visual flight rules (VFR). The flight route was intended via three aboriginal communities (MataMata, Rurruwuy, and Nyinyikay) about 80 km east of Elcho Island Aerodrome (Figures 1 and 2).

Figure 1: General area of the intended flight (red rectangle)

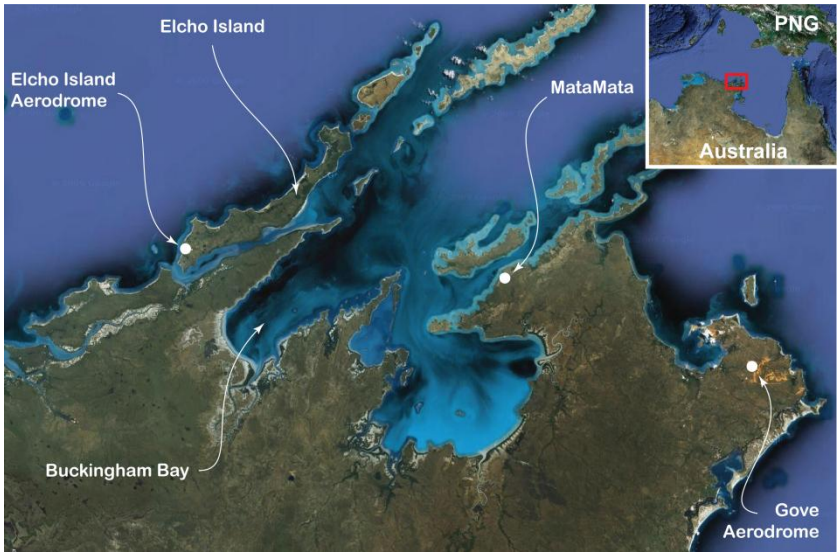
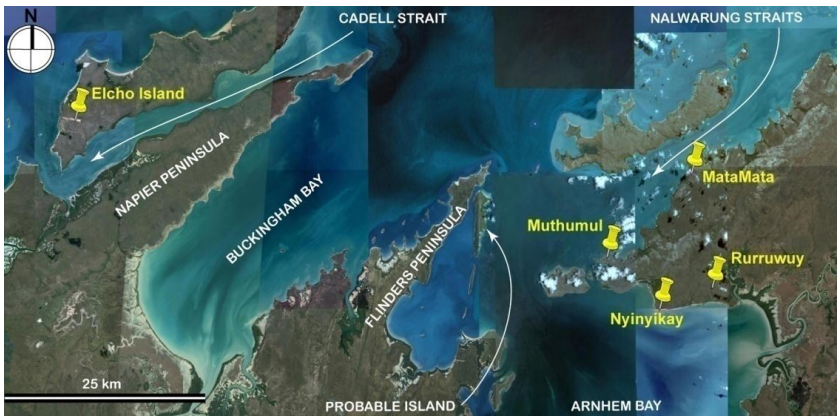


Figure 2: Location of airfields on the intended route



The aircraft, carrying a cargo consisting mainly of fuel in 20 L jerry cans and some school stationery, took off from runway 10 at Elcho Island at about 0930 Central Standard Time[1]. One of the operator's ground staff reported that he watched the takeoff and that it had appeared 'normal'.

[1] The 24-hour clock is used in this report to describe the local time of day, Central Standard Time (CST), as particular events occurred. Central Standard Time was Coordinated Universal Time (UTC) + 9.5 hours.

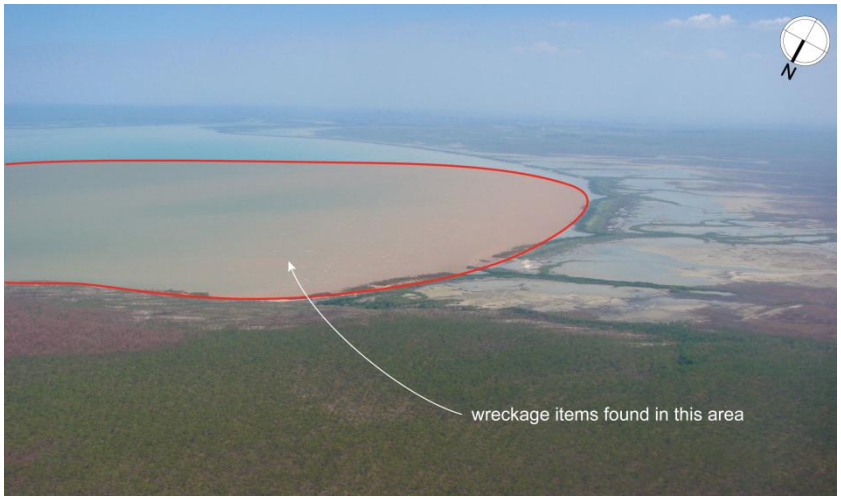
A second witness reported observing the aircraft from the airfield about 2 to 3 minutes later, when the aircraft was about 6 km east of the airfield. He reported that he saw the aircraft fly away from him, bank to the right, and then descend. He could not hear any engine noise from the aircraft. Once the aircraft disappeared from view, he drove to the barge landing on the south-eastern coast of Elcho Island from where he saw a column of 'dark black' smoke coming from the eastern side of the Napier Peninsula. He drove quickly into Galiwinku (the Elcho Island community) and told one of the staff at the Marthakal Homeland Resource Centre that he was concerned about the aircraft. The Resource Centre staff member was preoccupied at the time, and the matter was not followed up. The second witness reported that he drove back to the barge landing to find that the dark black smoke had gone.

At about 1330, a member of the community at Rurruwuy rang the operator's Elcho Island office because the aircraft had not arrived as expected. The staff in the office realised that the aircraft was overdue for return at Elcho Island, and a search was initiated.

The following day, items of wreckage (cargo and a number of aircraft parts) were found floating or beached in the south-western part of Buckingham Bay (Figures 3 and 4).

Despite an extensive search by Australian Search and Rescue (AusSAR)[2], the Northern Territory Police and Australian Transport Safety Bureau (ATSB), and the Elcho Island community, neither the pilot nor the main aircraft wreckage have been located. Details outlining the nature of the search undertaken by the ATSB are at Appendix A.

Figure 3: Aerial view of the south-western part of Buckingham Bay



[2] AusSAR is the Australian search and rescue agency.

Figure 4: Location of wreckage items retrieved from Buckingham Bay

1. Black jerry can and aircraft wheel.
2. Seat cushion.
3. Unspecified floating debris.
4. Small school whiteboards.
5. Eight jerry cans and other debris.

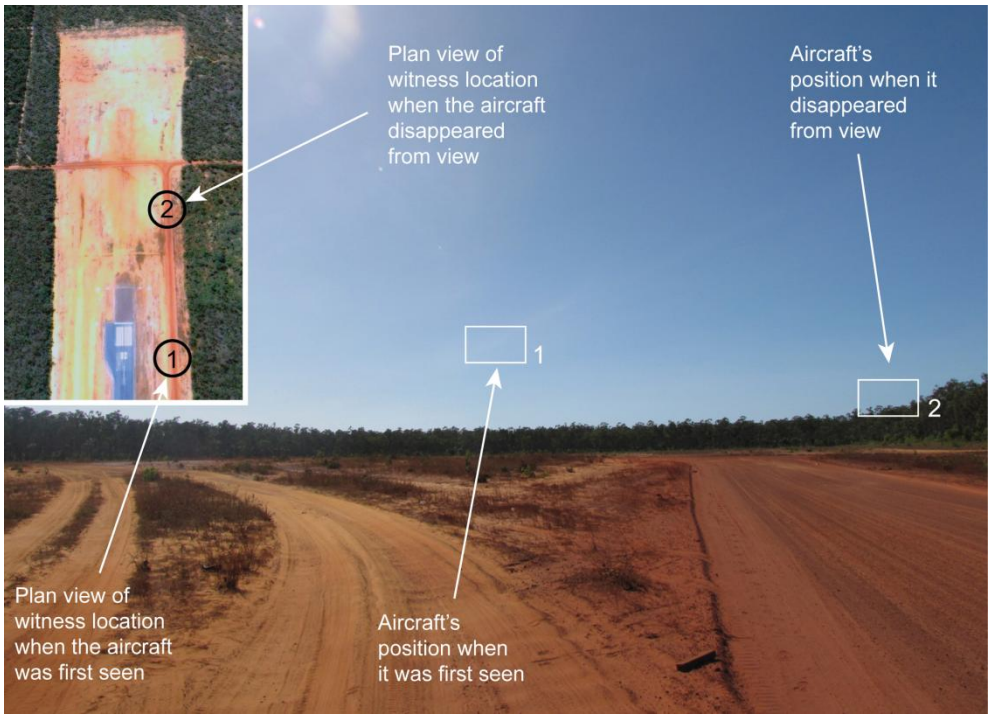
Witness information

Witness information can be an important source of information in all investigations. However, it is well established that people may be unreliable as observers, particularly when asked to recall the details of significant events that may have occurred an extended time previously. In addition, the effect of other sources of information on witnesses' recollections as time passes should not be underestimated.

There are two accounts of the initial stages of the accident flight. The first is from one of the ground staff who helped the pilot load the aircraft and then reported that he watched the takeoff, which was reported as 'normal'. That witness did not wear a wristwatch and stated that he was not sure of the exact time of the takeoff.

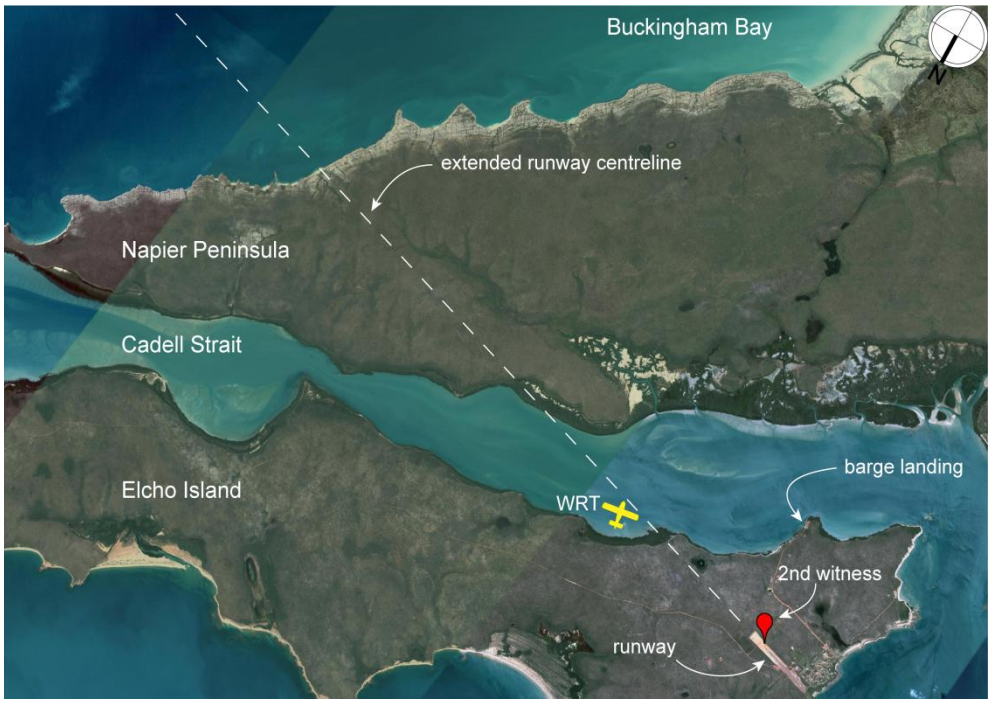
The second account is from a member of the Galiwinku community who reported that he was driving east with two companions along the dirt road on the airfield shortly after the pilot took off. The road ran parallel to and to the south of the runway. The witness reported getting out of the vehicle to watch the aircraft’s departure (Figure 5). The second witness's information was provided to the ATSB several months after the accident, after knowledge of the accident, the accident flight's intended destination, and the location of wreckage was well known in the local community.

Figure 5: Second witness's view from the aerodrome



The second witness recalled watching the aircraft fly away from him as it climbed, before turning to the right (Figure 6), with an angle of bank sufficient for him to see the left wing above the fuselage. It then descended quite steeply until it disappeared behind the trees at the eastern end of the airfield. The witness reported being concerned by an apparent lack of engine noise, and thinking that the aircraft was not operating normally.

Figure 6: Location of the second witness on the aerodrome and of the aircraft when it turned right and began to descend[3]



Smoke seen across the Napier Peninsula

Once the second witness could no longer see the aircraft from the airfield, he drove quickly to the Elcho Island barge landing from where he had an unobstructed view to the east. He reported that he saw a plume of 'dark black' smoke on the eastern side of the Napier Peninsula[4], and described the plume as 'thin [with a] big round ... top'. Although he was unable to estimate the height of the plume, he said that it 'kept climbing and then disappeared into the sky'.

The accuracy of the second witness's estimate of the position of the smoke was aided by the location of a number of creeks on the north-western side of the Napier Peninsula: his line-of-sight crossed the second most northerly of the creeks (Figures 7 and 8).

After driving to the Marthakal Community Office in Galiwinku to report the matter, the second witness returned to the barge landing about 9 or 10 minutes later to find that the dark black smoke had gone.

People with local knowledge stated that, at the time of the accident, there was no-one on the eastern side of the Napier Peninsula in the area where the second witness reported seeing the dark black smoke. However, intentional burning, a practice of the traditional landowners, is normal in that area.

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[3] Appendix B explains how the position of the aircraft as it turned was determined.

[4] Smoke that is dark or black generally contains a high proportion of soot, and the incomplete combustion of fuel with a high calorific value, such as a petroleum product, typically produces large amounts of black smoke.

Figure 7: The second witness's view east across Cadell Strait showing the creek above which he saw the plume of smoke

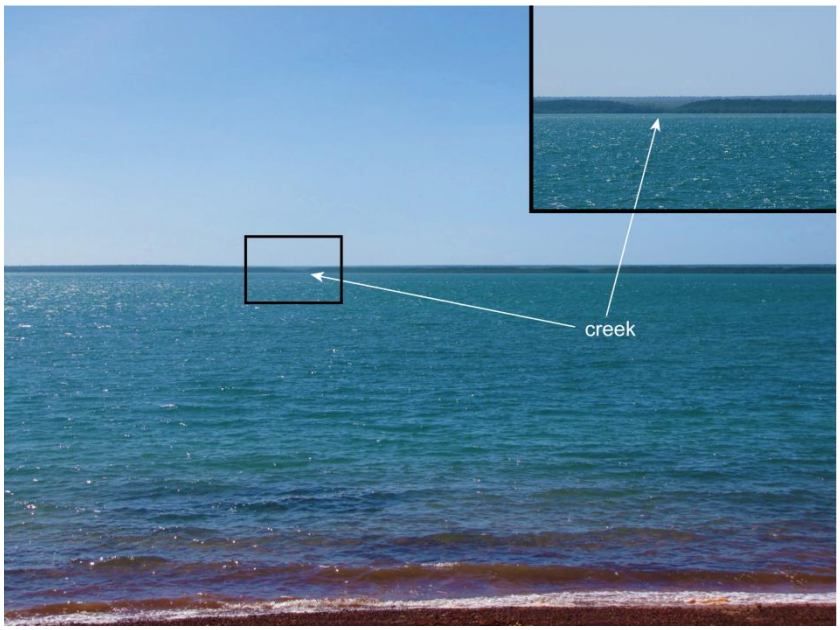
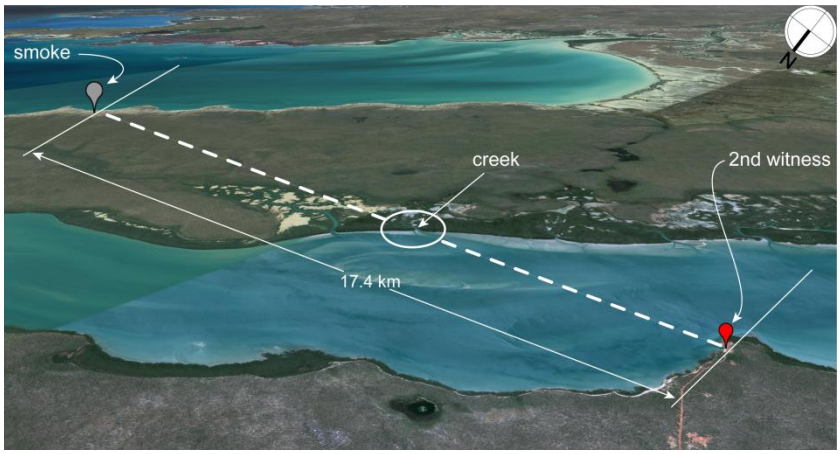


Figure 8: Location of the second witness at the barge landing and his line of sight to the smoke he recalled seeing



NOTE: The distance from the Elcho Island barge landing to the south-eastern side of the Napier Peninsula is 17.4 km, measured along the witness's line of sight. The exact distance from the witness to the smoke is not known.

Timeline of the second witness's account

Several months after the accident, the second witness estimated the time that he spent watching the aircraft from the airfield, the time spent at the barge landing, and the time spent at the Marthakal Community Office (Table 1). The estimated time taken to drive between the airfield, the barge landing, and the Marthakal Community Office was based on actual times taken to drive these distances, recorded some time after the accident by the second witness and an observer. Those times have been combined and are presented at Table 1.

Table 1: Timeline of the second witness's account

Event	Duration min:sec	Total time elapsed since takeoff min:sec
Takeoff	---	0
Begins watching the aircraft	---	3:00
Watches aircraft from the airfield	3:00	6:00
Drives from the airfield to the barge landing – observes plume of black smoke	3:45	9:45
Remains at the barge landing	1:30	11:15
Drives to the Marthakal Community Office	3:30	14:45
Remains at the Marthakal Community Office	2:00	16:45
Drives from the Marthakal Community Office back to the barge landing	4:00	20:45

The standard climb and cruise speeds for the Airvan were applied to the forecast wind and the aircraft's approximate track to derive an estimate of the duration of the accident flight. On this basis, it would have taken the aircraft 9 to 10 minutes to:

- climb to the point at which it was reportedly seen to turn,
- descend until it reportedly disappeared behind trees, and
- cross the Napier Peninsula.

That was consistent with the time elapsed before the second witness observed the plume of dark smoke (Table 1, line four).

Pilot information

The pilot held a Commercial Pilot (Aeroplane) Licence that was issued in June 2005. His Class 1 Medical Certificate was valid until February 2009.

The pilot's flying logbook and the operator's records indicated that he had a total aeronautical experience of about 1,300 flying hours, of which about 300 flying hours were on the Airvan. The pilot's training records as well as anecdotal evidence indicated he had a good standard of aircraft handling.

The pilot had been based at Elcho Island since April 2008. During that time, he had conducted passenger and freight charter flights in both the Airvan and Cessna 206 aircraft types, and had crossed Buckingham and Arnhem Bays regularly when flying between Elcho Island and the communities of MataMata, Muthamul, Rurruwuy, and Nyinyikay. His logbook indicated that he had flown between Elcho Island and the most northerly community of MataMata 18 times, and between Elcho Island and the three more southerly communities of Muthumul, Rurruwuy, and Nyinyikay 50 times. All but one of those 68 flights were in the Airvan. In addition, he had flown between Elcho Island and Gove Aerodrome[5] (tracking generally overhead those four communities) 45 times.

The pilot's flight and duty times were kept by the operator as computerised records. A review of those records indicated that in the 72 hours before the accident, the pilot was free of duty on 13 and 14 October 2008 and worked on 15 October 2008. The pilot was on duty on 15 October for 10 hours, of which 3.8 were flight hours. The pilot's duty times for the 4 weeks preceding the accident were analysed using a fatigue modelling tool. That analysis indicated that the pilot ought not to have been fatigued as a result of his work during the period before the accident.

On the evening of 15 October 2008, the pilot attended a meeting at a colleague's house. Although it was reported that he had appeared unusually tired that evening and had fallen asleep, he was also reported to have been behaving in character and to have appeared 'really positive'.

A review of telephone records indicated that the pilot was awake until at least 0010 on the morning of 16 October 2008 and was awake again not later than 0645, leaving a maximum of 6 hours and 35 minutes during which he could have slept. A systematic picture of the amount and quality of sleep obtained by the pilot in the weeks leading up to the accident, and of his off-duty activities during that period, could not be ascertained.

The pilot arrived at work at the Elcho Island Aerodrome some time before 0800 on 16 October 2008. At around 0800, he drove a company vehicle into Galiwinku in response to a call from one of the operator's office staff who requested a lift to the aerodrome. According to that staff member, the pilot appeared to be 'happy and normal'.

Aircraft information

The aircraft was manufactured in Australia and was first registered on 9 February 2001. It was registered to the current owner on 15 May 2006.

The aircraft was powered by a Lycoming IO-540-K1A5 six-cylinder engine and fitted with a constant-speed, two-blade, Hartzell HC-C2YR-1BF propeller. The engine was fitted to the aircraft after overhaul on 3 October 2007 at 3,905.3 total airframe hours. The propeller was fitted new to the aircraft on 8 February 2001 at zero airframe hours and had, at the time of the accident, accumulated about 2,260 hours since overhaul.

The aircraft was equipped with two very high frequency (VHF) radios. The communications control panel permitted the independent selection of the transmission and reception functions on one or both radios. There was a portable

[5] Operated by the Nhulunbuy Corporation.

emergency locator transmitter (ELT) model GME MT310 on board the aircraft that was capable of transmitting on frequencies 121.5 and 243 MHz[6] simultaneously when activated. No ELT signal was detected following the accident.

Maintenance history

The most recent maintenance on the aircraft was a 200-hourly or 'Check 3'[7] that was conducted on 30 September 2008 at 4,705.6 hours in service. The inspection was conducted at a Civil Aviation Safety Authority (CASA)-approved maintenance provider in Nhulunbuy (Gove). An inspection of the horizontal stabiliser, as required by Airworthiness Directive AD/GA8/5, was also carried out at the time and no defects were found. The current maintenance release for the aircraft was not recovered. There were no reports of any maintenance issues entered on the maintenance release in the 50 hours between the Check 3 inspection and the accident, and no reports of any mechanical issues during the operation of the aircraft in the days before the accident.

The aircraft had flown 45.3 hours since the Check 3 and its total time in service before the accident flight was 4,750.9 hours.

Fuel on board

Other aircraft used fuel from the bulk aviation gasoline (AVGAS) tank on Elcho Island in the days before and after the accident, and no fuel-related problems were reported. The records that would indicate exactly when the bulk AVGAS tank was last replenished were incomplete, although it was probably refilled on or soon after 6 October 2008.

The fuel pump printout showed that the aircraft was last refuelled on the afternoon of 15 October 2008, when 133.6 L of AVGAS were added. After this refuelling, the pilot recorded 158 kg of fuel (equivalent to 220 L) on the Manifest Load Sheet. The aircraft was then flown to Milingimbi, Ramingining, and back to Elcho Island, a 61-minute round trip and the last flight by the aircraft on 15 October 2008. The pilot dipped the tanks after that flight and recorded 160 L of fuel remaining (equivalent to 115 kg of fuel).

On the morning of the accident, the pilot did not make an entry on the Manifest Load Sheet in the AM DIP box (where the fuel quantity in litres should be recorded after the tanks have been dipped before the first flight of the day). However, he entered a fuel weight of 107 kg on the Manifest Load Sheet, which was equivalent to 149 L. That corresponds closely with the estimated 153 L of fuel remaining after the 61 minutes of flying after the aircraft was refuelled the previous afternoon, given a fuel consumption of 65 L/hr[8].

The reason for the discrepancy of 11 L between the previous night's tank dip of 160 L remaining and the volumetric equivalent of the recorded fuel weight on board

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[6] Subsequently, the approved ELT frequency has changed to 406 MHz.

[7] A 'Check 3' inspection, conducted every 200 flight hours, comprised an inspection of the engine, fuselage structure, landing gear, electrical system, and instruments.

[8] The operator's Operations Manual instructed pilots to use a fuel flow of 65 L/hr when flight planning.

the aircraft of 149 L could not be determined. It may have been a consequence of the fuel being warmer at the end of the day or the increased rate of evaporation of the fuel making it more difficult for the pilot to read the dip-stick.

Aircraft and fuel weight and cargo weight

Aircraft and fuel weight

The Aircraft Operating Weight[9] (AOW) published in the Operations Manual for the aircraft was 1,196 kg, which included a survival kit (including 10 L of water in a jerry can), a first aid kit, and a basic tool kit. Pilots adjusted the AOW figure in accordance with known weight variations in either the aircraft's Empty Weight or the weight of additional equipment carried on normal operations, but not included in the AOW (for example water, cargo restraints, and emergency equipment).

On the accident flight, the pilot used:

- an AOW of 1,185 kg
- a fuel figure of 107 kg, which was equivalent to 149 L.

The weight of the 19 jerry cans of fuel on board was 380 kg. A summary of the aircraft and other fuel on board is at Table 2.

Table 2: Summary of the aircraft fuel and other fuel on board

AVGAS	149 L
diesel/ opal[10] (19x 20 L jerry cans)	380 L
total	**529 L**
diesel/opal in jerry cans which were intact or punctured after impact	160 L
diesel/opal in jerry cans which were ruptured after impact	220 L
AVGAS in the wing tanks on impact[11]	up to 141 L

Cargo weight

In addition to the black 20 L fuel jerry cans, a single yellow 20 L fuel jerry can (Figures 12 and 14) was retrieved from Buckingham Bay among the other items of floating debris. No-one on Elcho Island recalled filling a yellow 20 L jerry can with fuel at the time that the black jerry cans were filled and no-one remembered seeing it among the other cargo that was loaded onto the aircraft. Nevertheless, this jerry can exhibited the same type of long, fresh rupture (indicative of failure under very high internal pressure) as 11 of the black jerry cans, and was therefore probably aboard the aircraft and filled with fuel.

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9 Aircraft Operating Weight = Empty Weight + full oil + unusable fuel + 86 kg (pilot) + 10 kg (equipment).

10 A form of petrol.

11 Based on a fuel consumed during the flight of 11 L.

The only entry made by the pilot in the box on the Manifest Load Sheet marked 'Freight' was 'fuel', but the operator's ground staff recalled that a large, probably empty, green plastic rubbish bin and a box of food were also loaded. In addition, items of stationery that were intended for the community at Rurruwuy, some of which were retrieved from Buckingham Bay, were also loaded.

A summary of the cargo that was known to have been loaded onto the aircraft is at Table 3.

Table 3: Summary of the cargo known to have been loaded onto the aircraft

Item	weight (kg)	quantity	total weight (kg)
Black 20 L jerry can	20	18	360
Yellow 20 L jerry can	20	1	20[12]
Green plastic rubbish bin	2	1	2[13]
Box of food	10	1	10[13]
School stationery	10	not known	10[13]
Total	–	–	**402**

Estimated take-off weight

The aircraft's estimated take-off weight was 1,694 kg (Table 4).

Table 4: Estimated take-off weight

Item	weight (kg)
Aircraft Operating Weight	1,185
Cargo	402
Fuel weight	107
Take-off weight	**1,694**

Pilot's load sheet and take-off weight calculation

The actual cargo weight, on the basis of the estimates in Table 3, was 402 kg.

The pilot entered 440 kg of freight on the Manifest Load Sheet (Table 5), which represented the weight of the 22 black 20 L jerry cans he had originally planned to carry (including the four jerry cans that were destined for Muthamul, but that he subsequently decided to leave behind). He did not, therefore, include the box of food, the green plastic rubbish bin, the school stationery, or the yellow 20 L jerry can in his freight figure.

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[12] The operator used a weight of 20 kg for a full jerry can of fuel.

[13] Estimated weight. The actual weights of these items are unknown.

Table 5: Manifest Load Sheet as completed by the pilot

Item	weight / kg
Freight	440
Payload[14]	540
Fuel weight	107
Operating weight	1,185
Take-off weight	**1,832**
Last min ON/OFF (accounting for the four jerry cans that were removed by the pilot)	80
Amended take-off weight	**1,772**

The pilot made a transcription error in entering a payload of 540 kg instead of 440 kg, and an arithmetic error when subtracting the 'Last min ON/OFF' line from the 'Take-off weight' line, to arrive at an 'Amended take-off weight' of 1,772 kg. The application of that incorrect take-off weight to the aircraft's centre of gravity (c.g) moment chart (Appendix C) would have resulted in the derivation of an incorrect trim value[15] by the pilot. The pilot entered a trim value of 2.8 on the Manifest Load Sheet.

Meteorological information

The weather on the morning of the accident was reported to have been fine. In Nhulunbuy, which was about 130 km east of Elcho Island, the surface wind was easterly at 8 kts and the maximum temperature was 32.6 °C.

The Bureau of Meteorology (BoM) reported that the wind speed in north-east Arnhem Land on 16 October 2008 was about 20 kts at 5,000 ft above mean sea level (AMSL). Data from Gove Aerodrome at 0830 on 16 October 2008 indicated easterly winds of 10 kts from the surface to 5,000 ft, and south-easterly winds of 20 kts to 28 kts between 5,000 and 10,000 ft. The BoM reported that any associated windshear (3 kts per 1,000 ft) would have produced nil to light turbulence.

Visual satellite imagery indicated nearly clear conditions in the vicinity of Elcho Island and Buckingham Bay at around 0930. That was corroborated by the fine conditions reported by a pilot flying an aircraft between Gove and Milingimbi that morning. At about the time of the accident, that aircraft was approaching the southern part of the Flinders Peninsula and a passenger took a photograph looking north-west across the Flinders Peninsula to the part of Buckingham Bay over which the Airvan was expected to track. That photograph indicated benign conditions (Figure 9).

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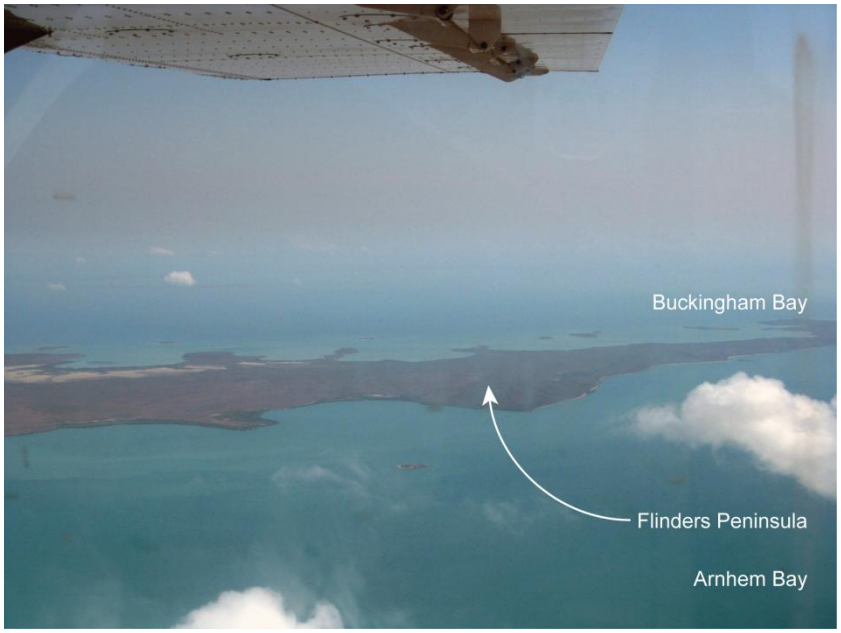
[14] That part of an aircraft's useful load from which revenue can be derived.

[15] A value derived from the Centre-of-gravity moment chart. This value determines the position in which the elevator trim wheel must be placed before takeoff in order to remove any pitch moment about the aircraft's centre of gravity.

Gove radar imagery indicated that an isolated rain shower moved west across Buckingham Bay between 0830 and 1110 on 16 October 2008. The shower weakened before it reached Elcho Island.

Figure 9: Photograph taken at about the time of the accident from the aircraft flying between Gove and Milingimbi



Wreckage and accident site information

Items of wreckage were recovered from the south-western part of Buckingham Bay by parties from Elcho Island and by the Australian Customs Vessel *Roebuck Bay*. The wreckage included the left main wheel (Figure 10), the nosewheel (Figure 11), nineteen 20 L jerry cans, one 10 L jerry can, six seat bases, one seat back, a lamb's wool seat cover, fragments of a green plastic rubbish bin, and miscellaneous school stationery (Figure 12).

Figure 10: Left main wheel

Figure 11: Nosewheel

A fracture of the left main landing gear wheel had occurred transversely through the welded transition between the stub axle and landing gear leg (Figure 10). The fracture surfaces were typical of a ductile shear mechanism and their form was consistent with failure occurring under bending overstress conditions. The nosewheel yoke had separated from the oleo at the bolted connection between the two components. Both the left main wheel and the nosewheel components showed significant levels of corrosion and associated metal-loss as a result of their immersion in salt water.

Fragments of the green plastic rubbish bin were retrieved from Buckingham Bay (Figure 12). No trace of the box or the food it contained was found, and the items of stationery that were retrieved from the bay were mainly small whiteboards and whiteboard markers.

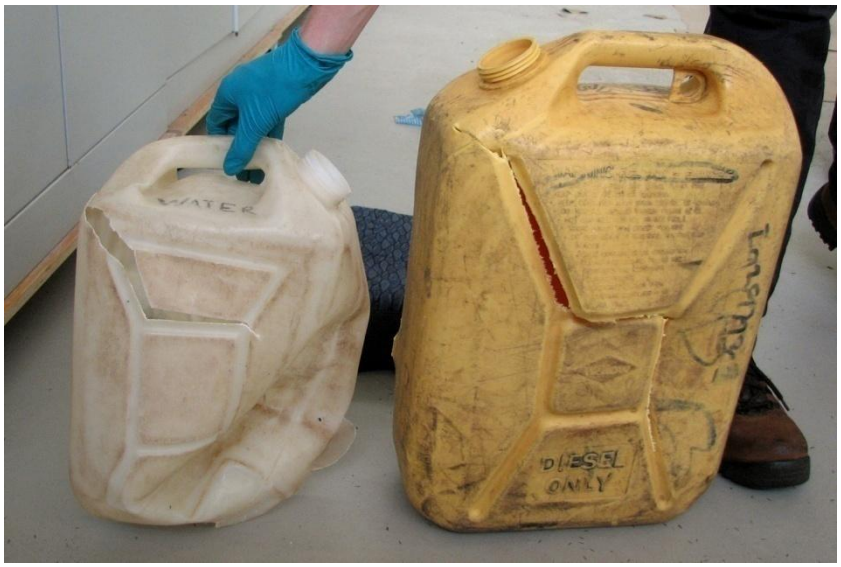
Eleven of the 20 L jerry cans recovered had ruptured in a manner consistent with their exposure to the abrupt hydraulic pressure effects created within the internal liquid when the aircraft impacted the water (Figures 13 and 14). The remaining eight jerry cans were either wholly or largely intact (two of them exhibited punctures). The handles of the jerry cans were undamaged and showed no sign of distortion.

None of the wreckage items that were recovered showed any sign of fire.

Figure 12: Cargo and wreckage items recovered from Buckingham Bay

Figure 13: Fuel jerry cans showing evidence of bursting under internal pressure

Figure 14: Fuel and water jerry cans showing evidence of bursting under internal pressure



Operator's procedures

Flight over water

The operator's procedures required pilots flying west over water between Gove and Elcho Island to remain within gliding distance of land and to cross Buckingham Bay at 4,500 ft or above. The Aeronautical Information Publication Australia (AIP) ENR 1.7 Altimeter Setting Procedures, Section 5 *Tables of Cruising Levels* required that, for a VFR aircraft flying east below 10,000 ft the preferred altitude was 1,500 ft, 3,500 ft, 5,500 ft and so on. In that case, the company's minimum altitude requirement for crossing Buckingham Bay would have meant that the pilot should have planned to climb to a minimum of 5,500 ft.

Flight notification

The operator did not, and was not required by regulation, to maintain a company flight-following procedure. The operator required its pilots to pass details of a company flight to an appropriate flight-following body. Those details were normally submitted to Airservices Australia (Airservices) by telephone, facsimile, internet (using the National Aeronautical Information Processing System (NAIPS)), or by high frequency (HF) radio. It was also possible to lodge flight details using the aircraft's radio once airborne.

Airservices reported that they had no record of the intended flight.

Radio settings on departure

The operator's policy was that, after takeoff, only operational frequencies should be monitored until an aircraft was clear of the circuit area.

When departing from an aerodrome, a pilot should set the Common Traffic Advisory Frequency (CTAF)[16] on one of their aircraft's two very high frequency (VHF) radios and make the standard, mandatory calls when taxiing, when entering the runway, and once airborne. The aircraft's other VHF radio could be set to another operational frequency at the pilot's discretion. On any flight climbing above 3,500 ft, the other frequency used would normally have been 123.4 MHz (Brisbane Centre) to monitor any aircraft operating under the instrument flight rules in the area.

Load security

The aircraft operator's Operations Manual Part B stated that cargo carried in the Airvan must be carried in accordance with Section 6 of the Aircraft Flight Manual (AFM) and that:

> All cargo carried in the cabin of Company aircraft is to be restrained and contained using cargo nets [main vertical net and the throwover net], ropes and/or suitable cargo restraint straps.

The Airvan has three removable nets and one fixed net to restrain cargo within the cabin, on the cabin baggage shelf, and in the aft luggage bin (Appendix D). The installation of the main vertical net would have necessitated removing at least the first row of passenger seats.

It was reported that preferably all of the passenger seats should have been removed so that the throwover net could have been pulled taut over the load. It became apparent during discussion after the accident that some company pilots were reluctant to remove aircraft seats before loading cargo into the cabin.

The operator provided each base with one set of Airvan cargo nets. The main vertical net and the throwover net from the Elcho Island base were both found in the Elcho Island hangar after the accident.

Dangerous goods

The company's operating procedures permitted the carriage of dangerous goods in the passenger compartment on cargo flights. For the purposes of the flight on 16 October 2008, petrol was classified as dangerous goods while diesel was not. The pilot may not have been aware that two of the 20 L jerry cans on board contained Opal, because they may not have been marked to distinguish them from those containing diesel.

[16] Pilots use these frequencies to arrange separation from other aircraft and to self-regulate traffic flow. Pilots must broadcast on the relevant CTAF when arriving at and departing from CTAF aerodromes. The Elcho Island CTAF(R) frequency was 127.15 MHz.

Additional information

Aircraft loading

Background

The pilot entered his destination as MataMata on the Manifest Load Sheet, which indicated it was to have been his first port of call.

Initially, the flight was to take fuel to MataMata, Muthumul, Rurruwuy, and Nyinyikay (Figure 2). Twenty-two black 20 L jerry cans had been filled in preparation for the flight, of which 19 contained diesel and three contained Opal.

The pilot telephoned the Elcho Island base manager to discuss the aircraft's loading and during the conversation, the pilot decided not to carry the four jerry cans destined for Muthamul. In consequence, of the original complement of 22 black jerry cans, four were left behind on Elcho Island (one of which contained Opal) and 18 were loaded onto the aircraft. Of those, 16 contained diesel and two contained Opal. That was consistent with the retrieval of 18 black jerry cans from Buckingham Bay after the accident.

The pilot also telephoned the Lake Evella base manager during his preparation for the flight. A consequence of those telephone conversations was that the flight, which was initially scheduled to leave at 0900, departed at about 0930.

Load distribution

The operator’s ground staff reported that they assisted with the aircraft loading but that the pilot finished this task himself. The ground staff returned to the hangar when several of the fuel jerry cans were still to be loaded and the green plastic rubbish bin was still on the loading trolley. As a result, the witness accounts below give an incomplete picture of the distribution of the load in the aircraft before departure.

The ground staff recalled that four fuel jerry cans were loaded into the forward cargo pod, four into the rear pod (Figure 15), and that three were placed on the cabin baggage shelf in the cabin (Figure 16). Two fuel jerry cans were placed in the aisle, although their exact position in the aisle is not known. The box of food was placed on the cabin baggage shelf. In addition, the ground staff recalled that the left seat in row 4 had been removed.

The left seat from row 4 was not left on Elcho Island and was therefore probably placed in the aft luggage bin. Together with the other items already stowed in the aft luggage bin[17] that made the total weight in this compartment 27 kg, although the maximum permissible weight in the aft luggage bin was 22 kg. Despite the 5 kg overload, the addition of the seat from row 4 to the other items in the aft luggage bin would have been consistent with standard practice by the operator's pilots at that time.

No other seats were reported as being removed from the aircraft.

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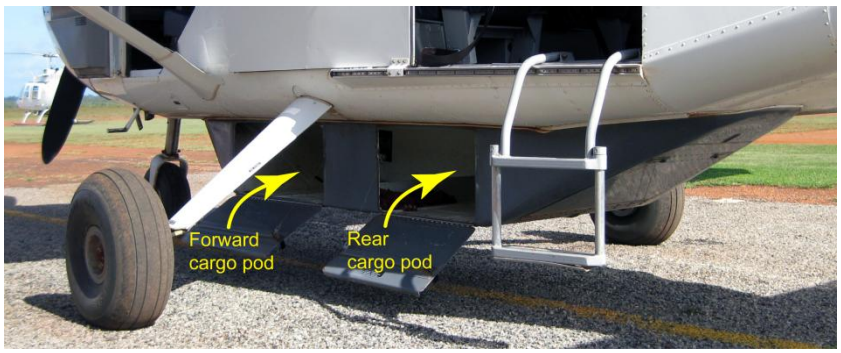
[17] First aid kit 2 kg, basic tool kit 2 kg, survival kit 7 kg, water 10 kg, seat 6 kg.

Figure 15: Airvan forward and rear cargo pods



There is no information on where the remaining six fuel jerry cans, the green plastic rubbish bin, and the school stationery were placed within the aircraft. The reported distribution of the aircraft's load for the flight is illustrated in Figure 17, although the exact position of the two jerry cans reported to have been in the aisle is not known.

Figure 16: Main cargo area, cabin baggage shelf, and aft luggage bin in the Airvan

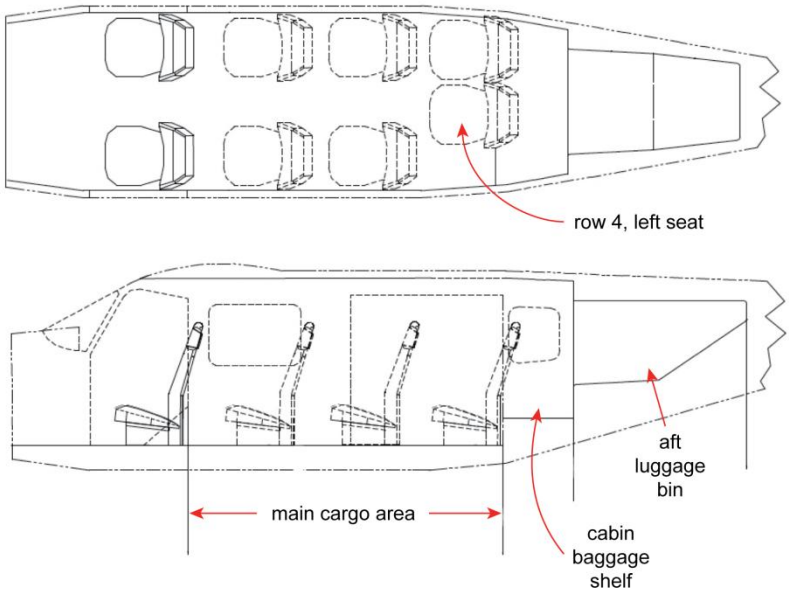
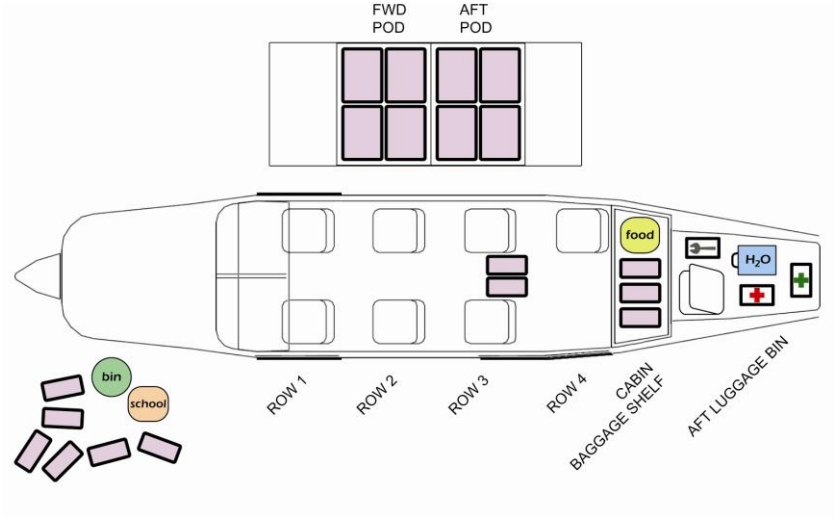


Figure 17: Reported distribution of the items of cargo



NOTE: The exact position of the two jerry cans reported to have been in the aisle is not known.

Alternate loading method

An alternate, informal and unapproved loading method that was used on Elcho Island by a number of the operator's pilots came to light during discussions after the accident. The method involved placing fuel jerry cans in an aircraft's aisle and/or in the spaces between the rows of cabin seats. The seat belts were then looped through the jerry can handles to restrain them.

Centre of gravity and controllability of the Airvan

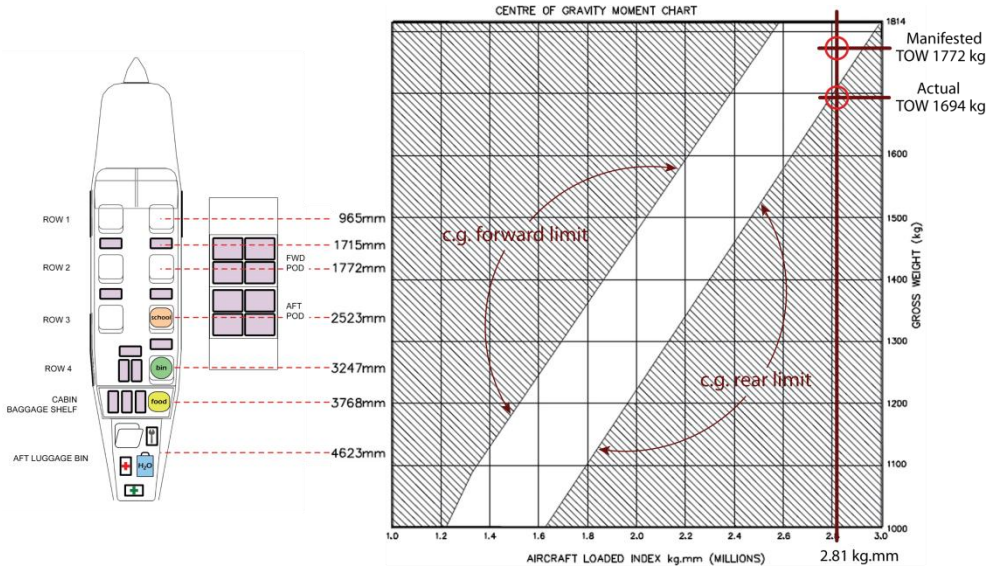
Aircraft centre of gravity

The accident flight probably lasted about 9 to 10 minutes during which the aircraft would have burned about 10 L of fuel. This would have reduced its weight by about 7 kg and caused the c.g to move slightly rearwards.

On the basis of the distribution of cargo reported by the operator's ground staff, two possible pre-flight load distributions – Scenario 1 and Scenario 2 – were considered in terms of their effect on aircraft weight and balance. A third case – Scenario 3 – was considered to help determine whether or not the aircraft would have been controllable if all the cargo in the cabin had moved back into row 4 during flight.

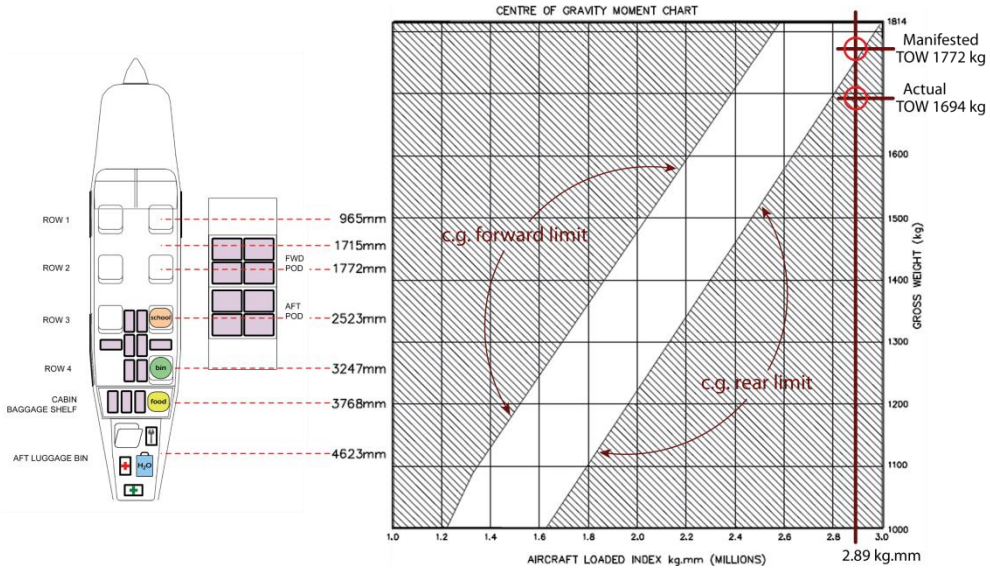
Scenario 1 - Cargo distribution corresponding to the manifested trim value of 2.8. The distribution of cargo depicted in Figure 18 corresponds to the trim value of 2.8 that was entered on the Manifest Load Sheet by the pilot. The actual c.g (on the basis of a take-off weight of 1,694 kg) would have been slightly to the rear of the aircraft's rear c.g limit.

Figure 18: Scenario 1, reflecting the pilot-recorded trim value



Scenario 2 – Cargo distribution resulting in the most rearward permissible c.g. If the pilot had placed all of the cargo close to the rear door to make loading and unloading easier, the situation would have been similar to that depicted in Figure 19. If the take-off weight had been 1,772 kg[18] as the pilot calculated, this distribution would have resulted in a c.g close to the rear limit, and a trim figure of 2.89. The actual c.g (on the basis of a take-off weight of 1,694 kg) would have been to the rear of the aircraft's rear c.g limit.

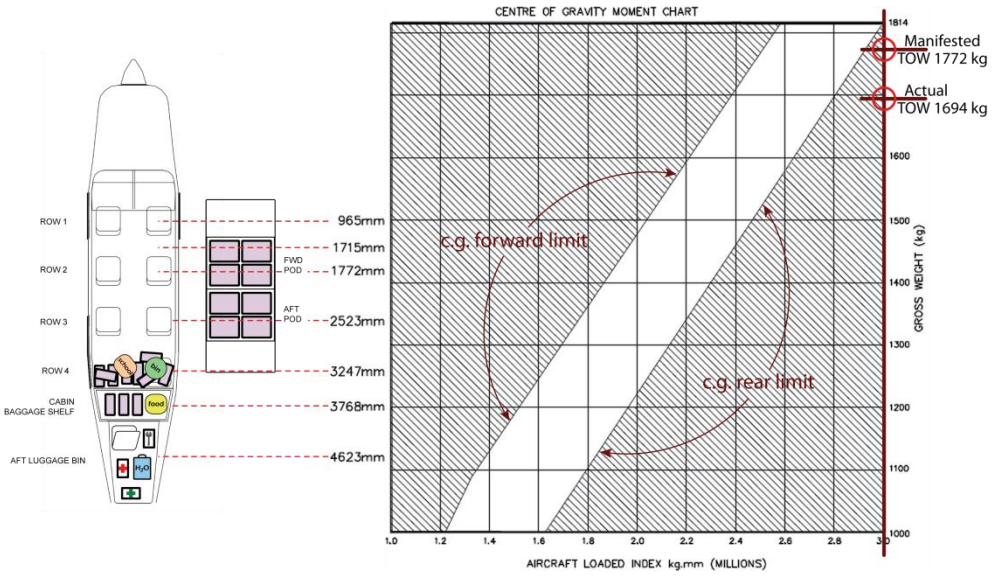
Figure 19: Scenario 2, most rearward c.g



[18] The pilot would have obtained an incorrect plot of the aircraft's c.g on the *Centre of gravity moment chart* because of his errors on the *Manifest Load Sheet* which led to an incorrect take-off weight figure of 1,772 kg (instead of 1,694 kg). The heavier take-off weight figure would have given the impression that the c.g was further forward than it really was.

Scenario 3 – All cabin cargo in row 4. Figure 20 illustrates the situation if all the cargo had moved to the rear of the cabin during flight, and illustrates the c.g for both the pilot's (incorrect) calculated take-off weight (1,772 kg) and the estimated take-off weight (1,694 kg).

Figure 20: Scenario 3 - All cabin cargo in row 4

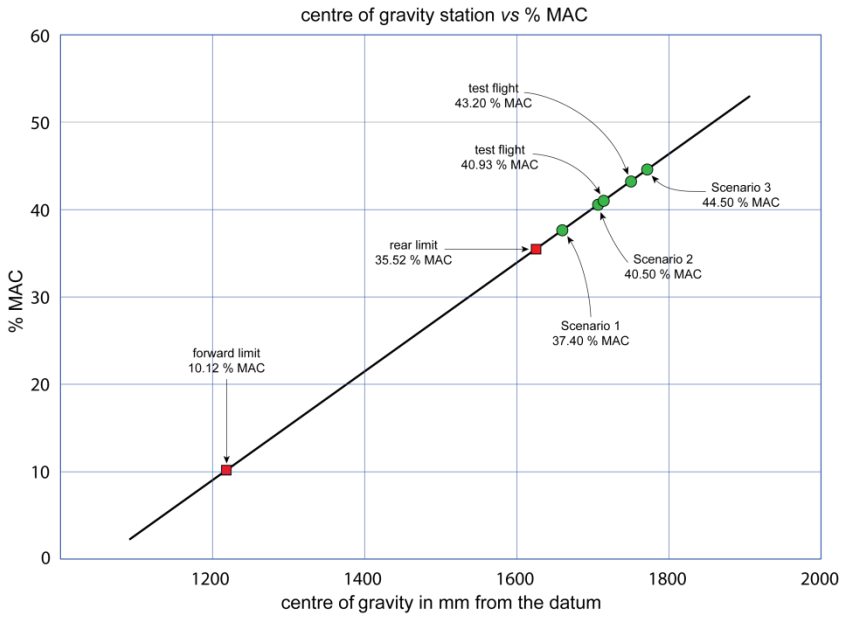


Controllability of the GA-8 Airvan with a rearward c.g

An aircraft's c.g may be expressed as a 'percentage of mean aerodynamic chord' (% MAC) by measuring the c.g in terms of the aerodynamic properties of the wing. The black diagonal line in Figure 21 shows the c.g for the Airvan in terms of the relationship between % MAC and the distance from the aircraft's datum[19]. The points plotted on the diagonal line represent the forward and rear c.g limits, the c.g in Scenarios 1 to 3, and the c.g on two flights conducted during the Airvan's certification program.

[19] The datum is a reference point on the aircraft.

Figure 21: Airvan c.g vs % MAC



When the Airvan was test flown with the c.g as far to the rear as 43.20 % MAC, the aircraft was demonstrated to be controllable in all flight configurations. With that c.g, the aircraft was unstable in the take-off configuration, and unable to be trimmed in the landing configuration. It did not, however, require excessive force or exceptional piloting ability in that configuration, and responded at all times to conventional control inputs.

To determine the potential effect on the controllability of the aircraft if all of the cargo had moved to the rear of the cabin during flight (Scenario 3), expert opinion was sought on the flight characteristics of the Airvan with a c.g position of 44.5% MAC at a weight of about 1,700 kg. The expert advice was that, unless the aircraft was flying slowly and with a high angle of attack, it would have been controllable with conventional control inputs and the pilot would have been able to lower the nose.

Departure information and radio calls

The aircraft's exact departure time from Elcho Island was not known. The AvData equipment[20] at Elcho Island recorded radio transmissions made by pilots on the local area frequency of 127.15 MHz, but it was not operating on the morning of 16 October 2008.

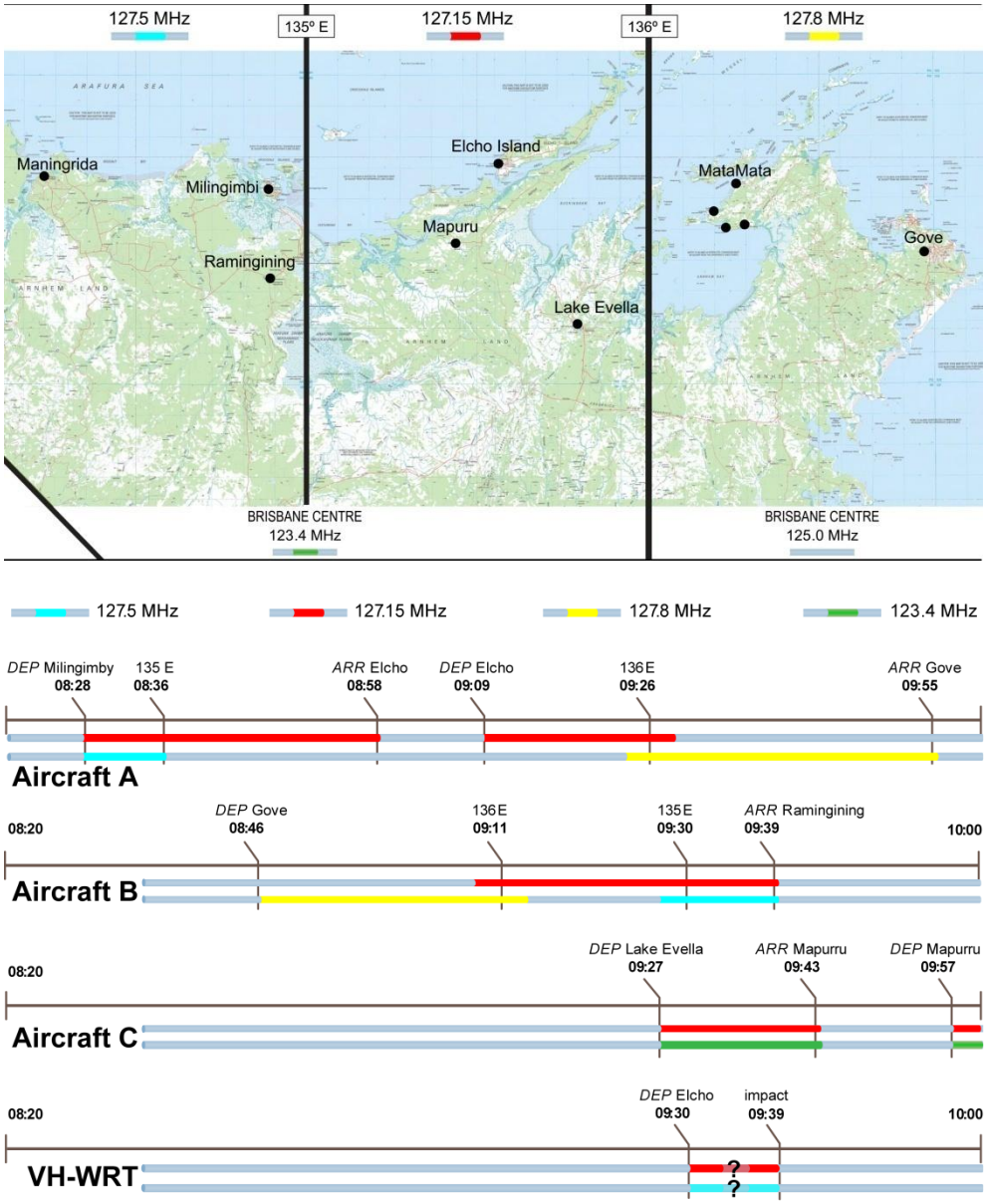
The AvData recorder at Gove Aerodrome did not record any transmissions from the aircraft on 16 October 2008, and no distress call or any other transmissions from the aircraft were reported on any frequency that day.

[20] AvData equipment records the radio transmissions made by pilots as they arrive at and depart from uncontrolled aerodromes. The information is used to calculate an aircraft operator's landing fees.

Figure 22 shows the aviation radio frequency boundaries in eastern Arnhem Land and the:

- timelines of flights involving three aircraft known to have been flying over eastern Arnhem Land at the time of the accident
- estimated timeline of the accident flight
- radio frequencies being monitored by the pilots of the three other aircraft (Aircraft A, B, and C) during their respective flights.

Figure 22: Radio frequency boundaries in eastern Arnhem Land and the frequencies monitored by other pilots at the time of the accident



The pilot of Aircraft A left Elcho Island for Gove about 20 minutes before WRT and would not have been monitoring 127.15 MHz at 0930. He reported that he did not hear any transmissions from the pilot of WRT.

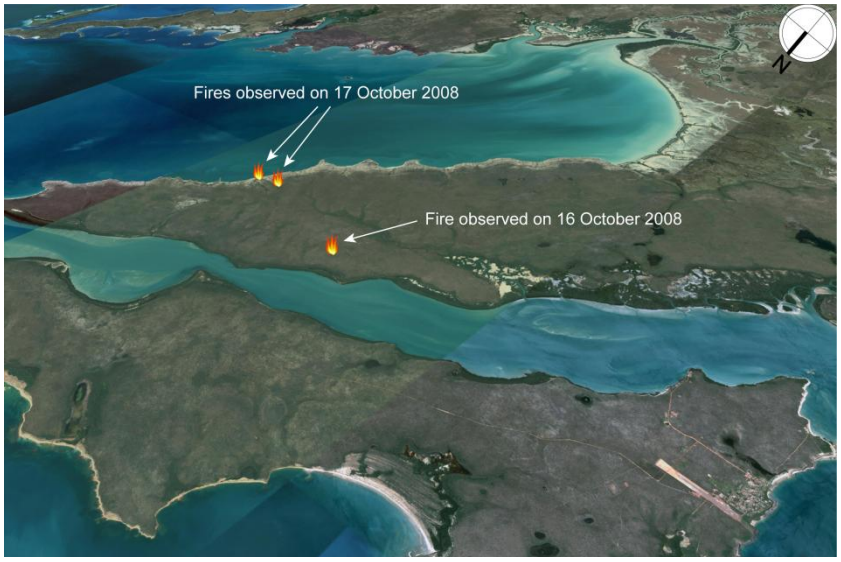
Several days after the accident, a pilot who was flying from Gove to Ramingining on the morning of the accident (Aircraft B) recalled having heard a departure call from the pilot of WRT while he was monitoring both 127.15 MHz and 127.5 MHz. He remembered the intent of the transmission had been that an aircraft was departing Elcho Island for MataMata and climbing to 5,500 ft.

The pilots of another aircraft (Aircraft C), who were airborne at the time WRT is believed to have departed Elcho Island, reported they were monitoring 127.15 MHz and 123.4 MHz at that time but heard no transmissions from the pilot of WRT.

Bush fires on the Napier Peninsula

A number of bush fires on the Napier Peninsula were seen from aircraft involved in the search for WRT (Figure 23). Those fires were investigated on the ground by Northern Territory Police on 17 October 2008, and were judged to have been burning for more than 1 week.

Figure 23: Location of fires on the Napier Peninsula seen from search aircraft after the accident



Reconstruction flights

Two reconstruction flights were conducted by the operator in an Airvan from Elcho Island on 15 May 2009 to help determine the location and height of the aircraft when the second witness saw it make a right turn before it began to descend (see Appendix B).

ANALYSIS

A routine cargo charter in a GA-8 Airvan (Airvan), conducted by a pilot who was familiar with the aircraft type and the route, ended with a collision with water in Buckingham Bay probably about 9 or 10 minutes after takeoff.

The timeline of events reported by a witness is consistent with the time an Airvan would have taken to depart Elcho Island, manoeuvre as witnessed, and then cross the Napier Peninsula. The plume of dark black smoke that the witness reported seeing at a position on the east of the Napier Peninsula was consistent with the smoke that would be produced by a brief, fuel-fed fire that could be expected following an aircraft collision with terrain.

Aircraft debris was recovered the day after the accident from the south-west of Buckingham Bay but, despite extensive searching, neither the main wreckage of the aircraft nor the pilot has been found. Had there been an active flight notification recorded by Airservices Australia, this may have helped initiate the search effort more quickly.

The benign weather at the time, the pilot's familiarity with both the aircraft type and the route, and the pilot's handling competence suggest that neither the weather nor the handling of the aircraft were factors in the development of the accident.

Sequence of events

The consistency of the estimated flight time with the timeline of the second witness's movements and observations suggests that the second witness may have observed the aircraft and that the dark black smoke to the east of the Napier Peninsula may have been from a fire following the aircraft's impact with terrain. The recovery of aircraft wreckage and cargo from Buckingham Bay indicates that the aircraft impacted the water.

Further, the reported south-easterly direction of flight when the aircraft disappeared from view at the aerodrome, and the reported position of the dark black smoke, implies that some manoeuvring under power occurred after the aircraft disappeared from view: the aircraft would have had to fly east from the position in which it was last seen, and it would not have been able to cross the Napier Peninsula without power.

Pilot fatigue

The pilot's duty times for the 4 weeks preceding the accident were analysed using a fatigue modelling tool. This indicated that the pilot ought not to have been fatigued as a result of his work during the period before the accident.

The quality of the pilot's sleep on the night before the occurrence could not be determined and it was not possible to ascertain a broader picture of the pilot's sleep or of his activities in the time leading up to the occurrence. It was not possible, therefore, to determine the pilot's fatigue level objectively, or to comment on any influence it may have had on the occurrence.

Airworthiness and maintenance

The aircraft was reportedly airworthy and all appropriate maintenance had been conducted. The nature of the wheel fractures and the way in which eleven of the jerry cans failed suggest that the impact with water occurred at high speed. The damage to the wheels was consistent with that impact, and not a result of a mechanical failure of any kind. There was no evidence that the airworthiness or maintenance of the aircraft contributed to the occurrence.

Aircraft fuel

The amount of aircraft fuel on board before the flight and the absence of any fuel-related problems reported by other pilots using fuel from the main AVGAS tank on Elcho Island suggest that the aircraft fuel on board was not a factor in the occurrence.

Restraint of cargo in the cabin and aircraft centre of gravity

The decision by the pilot not to remove the seats in the cabin and not to use the cargo nets to secure the cargo in the cabin was consistent with both a reluctance on the part of some of the operator's pilots to remove aircraft seats, and a reported informal loading procedure at Elcho Island. Although not meeting the operator's Operating Manual requirements, the informal loading procedure would nevertheless have provided a degree of restraint to jerry cans that were stowed between the seats. However, the lack of any damage or distortion of the handles of the jerry cans that were recovered from Buckingham Bay suggested that, if they were stowed on the accident flight between the seats according to this informal loading procedure, they were not restrained with the aircraft's seat belts.

The reported normality of the takeoff and the controlled manner in which the aircraft was observed to fly make it unlikely that the cargo moved during the initial stages of the flight. Nevertheless, if all of the cargo had somehow moved into row 4 at any time during the flight, the aircraft's centre of gravity (c.g) would have been a maximum of 44.5% mean aerodynamic chord (MAC). The certification trials for the Airvan indicated that the aircraft was controllable at that % MAC. It is therefore unlikely that a shift of any or all the cargo in the cabin to row 4 could have altered the aircraft's flight characteristics to the extent that the pilot experienced difficulty controlling the aircraft, and any change in the c.g due to cargo movement is unlikely to have contributed to the accident.

Radio calls

In accordance with the operator's procedures, the pilot could be expected to have set his very high frequency radios to frequencies 127.15 MHz and 123.4 MHz for the flight east from Elcho Island to MataMata, and to have monitored and broadcast only on 127.15 MHz until clear of the circuit area. Although 127.5 MHz would have been the wrong frequency to use when departing Elcho Island, it is possible it was set on one of the two radios because the aircraft's previous flight had been from Milingimbi to Elcho Island – so the aircraft might have landed at Elcho Island with

the radios set to 127.5 MHz and 127.15 MHz (the two common traffic advisory frequencies that were applicable at Milingimbi and Elcho Island respectively).

The aircraft's radio selector switch had two positions, and it is not uncommon for a pilot to inadvertently select the wrong position until the error is detected. If, on the morning of the accident flight, one radio was set to 127.5 MHz and the pilot inadvertently selected that radio, he would have broadcast on 127.5 MHz instead of 127.15 MHz. That might explain how the pilot approaching Ramingining could have heard a departure call from the pilot of WRT, but the pilots flying from Lake Evella to Mapuru did not.

Observation of 'dark black smoke'

The locations of the bushfires on the Napier Peninsula were well to the north of the reported location of the plume of dark black smoke. Further, bushfire smoke is generally grey or white, so it is unlikely that bushfires were responsible for the reported dark black smoke. Instead, any plume of dark black smoke would probably have been produced by a fuel-rich, petroleum product-based fire.

Eleven of the 19 jerry cans were ruptured during the impact, and this would have released 220 L of fuel in addition to any released from the aircraft's fuel tanks. The other eight jerry cans either remained intact or had punctures which were relatively small, so that the 160 L of fuel within them would have been either contained or would have leaked out slowly over time. The amount of fuel on the surface of the water in the immediate aftermath of the impact, and therefore the amount of smoke which could be expected from any fuel-fed fire, is not known.

The lack of any fire damage on any of the recovered items of wreckage does not support the hypothesis that a fuel-fed fire followed the aircraft's impact with water. However, unburnt items of wreckage have been recovered after other accidents where a fuel-fed fire followed an aircraft's impact with water; see, for example, the Bureau of Air Safety Investigation report 199402804 involving a Rockwell Commander 690B aircraft, registered VH-SVQ (available at www.atsb.gov.au). In that instance, some of the recovered items of wreckage exhibited fire damage, while others did not.

In the case of WRT, none of the wreckage showed any fire damage. In addition, the witness report of dark black smoke was made several months after the accident, and after knowledge that the accident occurred in Buckingham Bay was widespread in the local community. On that basis, it is not possible to determine whether there was a fuel-fed fire after the aircraft impacted the water.

Summary

Following a review of the available evidence covering:

- witness information,
- the pilot's fatigue and health,
- the airworthiness of the aircraft,
- aircraft fuel,
- the weather affecting the flight, and
- the aircraft’s loading and weight and balance

the investigation was unable to identify any factors that may have contributed to the accident.

FINDINGS

From the evidence available, the following findings are made with respect to the missing aircraft at Buckingham Bay, Northern Territory on 16 October 2008 involving Gippsland Aeronautics GA-8 Airvan aircraft, registered VH-WRT. They should not be read as apportioning blame or liability to any organisation or individual.

Contributing safety factors

No contributing safety factors were identified.

Other safety factors

- The main vertical net and the throwover net were not used to restrain the cargo.
- The full jerry cans were not secured in the aircraft cabin.
- At the time of departure, the aircraft's centre of gravity (c.g) was probably to the rear of the permitted c.g limit that was published in the Aircraft Flight Manual.
- There was no record that the pilot lodged a flight notification for the flight with Airservices Australia.

SAFETY ACTION

Any safety issues identified during the conduct of an investigation are listed in the Findings and Safety Actions sections of the report. However, whereas an investigation may not identify any particular safety issues, relevant organisation(s) may proactively initiate safety action in order to further reduce their safety risk.

All of the relevant organisations identified during this investigation were given a draft report and invited to provide submissions. Although no safety issues were identified during this investigation, the following proactive safety action was submitted by those organisations.

Aircraft operator

Loading and cargo restraint

In respect of loading and cargo restraint in its Airvan aircraft, the operator has advised the following:

- The correct technique for loading and restraining cargo has been reviewed and demonstrated to all pilots.
- In May 2009, the company training manual was revised and a new module included on the restraint of cargo and the carriage of dangerous goods. Pilots under training are now required to demonstrate competency before the module is completed.
- New pilots are not authorised to conduct cargo flights until they have demonstrated to the Chief Pilot their ability to properly load and secure the cargo.
- All pilots have been reminded of the:
  - importance of careful weight and balance determination in accordance with the company loading system on every flight; and
  - requirement to record weight and balance calculations neatly on the manifest.
- An external audit of the operator's operations was carried out from 5 to 13 May 2009 to determine conformance to company operations documentation, including cargo restraint.
- The water container in the survival kit in Airvan aircraft has been moved from the aft luggage bin to the forward pod to reduce the weight in the baggage bay extension area. This will maintain the aft luggage bin weight within the 22 kg maximum, even when a seat, which has been removed from the cabin, is placed in this area.

Flight-following

In an effort to enhance the flight-following of company aircraft, the operator has undertaken the following:

- Reminded all pilots of the importance of nominating a realistic SARTIME.
- Introduced a SARTIME limitation of either 2 hours or two flight sectors. Pilots may only operate for more than two sectors on a single SARTIME if the total flying time for all the sectors is less than 1 hour.
- Commenced action to install a 3G mobile telephone-based system for en route flight tracking of company aircraft in the Arnhem Land, Northern Territory fleet by the end of May 2010. To enable this installation, the operator's design organisation has produced an approved modification to permit the installation of a power receptacle in aircraft that did not already have one.
- Commenced trialling a combination tracking system using both the 3G mobile telephone network and the Iridium satellite system (because the 3G mobile telephone-based system does not give complete coverage in all parts of Arnhem Land).
- Prior to the accident, the operator had commenced installing fixed 406 MHz emergency locator transmitters (ELTs) in all of its aircraft in Arnhem Land, including leased aircraft. That installation program was completed by the end of 2008.

Carriage of dangerous goods

In respect of the carriage of dangerous goods, the operator has taken the following actions:

- Suspended the carriage of dangerous goods (DGs) from the operator's Elcho Island base until an internal audit could verify that procedures and equipment were in place to meet the operator's existing DG requirements.
- Arranged for an external audit of the operator's operations that was carried out from 5 to 13 May 2009 to determine conformance to company operations documentation, including procedures for the carriage of DGs.
- Presented a proposal for a simplified DG acceptance and carriage system to the Civil Aviation Safety Authority (CASA) for their approval (because existing DG requirements were complex and not suited to remote operating environments such as in Arnhem Land). CASA approved this proposal in early April 2009, and a new company DG manual has been produced and distributed. Training and competency testing has since been carried out for all flight crew members.

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[21] The time nominated by a pilot for the initiation of search and rescue action if a report has not been received by the nominated unit.

Management supervision and oversight

To enhance the supervision and oversight of its pilots, the operator has taken the following actions:

- Relocated an experienced flight instructor pilot from the company's operation in Papua New Guinea to Arnhem Land in early January 2009. That pilot mentored the Chief Pilot and assisted with checking and training tasks.
- Appointed an Executive Officer in February 2009 to provide more effective staff management capacity for the operator's Program Manager in Arnhem Land.
- Held a number of management training seminars in May 2009, covering revised procedures and instruction on time and resource management.
- Arranged for an external safety and organisational audit that was carried out in April 2009.
- Arranged for an external audit of the operator's maintenance control, which was carried out from 5 to 13 May 2009. The aim of that audit was to determine conformance to company documentation.

Reduction of pilot workload

In order to reduce pilot workload, the operator has taken the following actions:

- In February 2009, a fourth pilot was added to the complement of flight crew at the Elcho Island base.
- During March 2009, the operator ceased being responsible for fuel and other agency duties at the Elcho Island base.

Other actions

A number of pilot training seminars were held from 8 to 11 May 2009 for all of the operator's pilots. Those seminars included the following:

- Training by a CASA Aviation Safety advisor on air safety and human factors, the responsibilities of the pilot in command, and airmanship.
- An introduction to the 'Share your experience' program, a peer accountability and occurrence sharing program, which is functioning successfully in other regions served by the operator.
- A seminar on threat and error management theory and practice.
- Demonstrations and instruction on load restraint and security on the operator's aircraft types.

APPENDIX A: Search information

This appendix deals mainly with the 7-day search that was conducted by the Northern Territory Police and Australian Transport Safety Bureau (ATSB), from 5 to 11 November 2008 inclusive, using side-scan sonar, a remotely-operated underwater vehicle (ROV), and police divers. A search by the Elcho Island community is also discussed. It does not describe the search effort immediately following the accident, which was directed by the Rescue Coordination Centre (RCC) – Australia, from 1540 on 16 October 2008 until responsibility was transferred to the Northern Territory Police at 1200 on 18 October 2008.

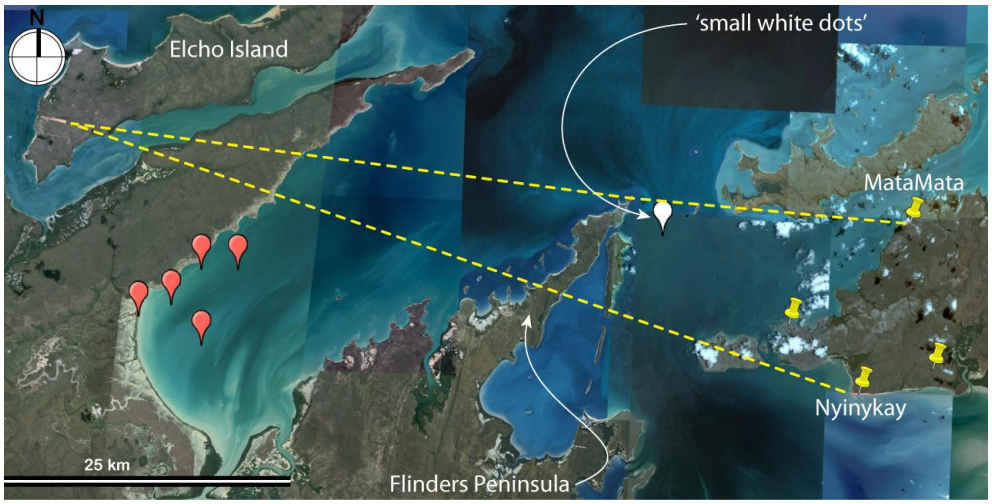
Northern Territory Police/ATSB search effort

During the initial search operation, the information that was subsequently provided by the second witness was unknown to the RCC or to the aircraft operator. The first party to learn of that information was the aircraft operator in mid-February 2009, about 4 months after the accident. In the absence of that information, the Northern Territory Police/ATSB search activity was based on:

- the tracks that the pilot was expected to have taken outbound from, and inbound to Elcho Island
- the position of debris that was recovered from or sighted in the sea as a result of the RCC-Australia search
- a submerged target that was identified by parties from Elcho Island.

The tracks to and from Elcho Island were predicated on the operator's requirement for pilots to remain within gliding distance of land in case of engine failure. A flight from Elcho Island to MataMata, given the weather on the day of the accident, would have been conducted as follows. After takeoff, the pilot would maintain runway heading until 500 ft above ground level (AGL). At 500 ft AGL he would commence a 9° left turn to track direct to the northern tip of the Flinders Peninsula and climb to at least 4,500 ft across Buckingham Bay. From the tip of the Flinders Peninsula, he would track direct to MataMata. A flight from Nyinyikay to Elcho Island would track direct between the two airfields, climbing to at least 4,500 ft (Figure A-1).

Figure A-1: Location of small white dots east of the Flinders Peninsula



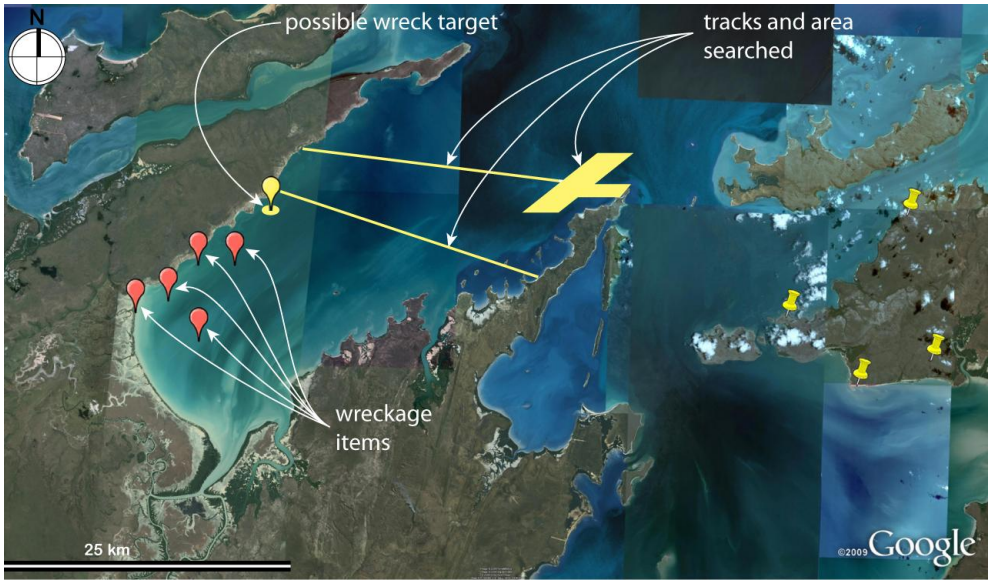
In addition to the debris that was recovered from Buckingham Bay by the RCC-Australia search, and which was positively identified as coming from the aircraft, a number of 'small white dots' within a 1 NM (2 km) radius of position 12° 05.64' S 136° 04.27' E (Figure A-1, white balloon) were seen from a search aircraft at 0806 on 17 October 2008, almost 24 hours after the accident. It was possible that these may have been school whiteboards like those found in Buckingham Bay, although none were retrieved from the sea and positively identified. The following information was considered in order to conduct the search:

- the outbound track from Elcho Island to MataMata passed over the northern tip of the Flinders Peninsula
- the apparent existence of debris from the aircraft both in Buckingham Bay and to the east of the Flinders Peninsula
- information on the tides and wind in the hours after the accident.

That consideration led to the selection of the area to the west and north of the tip of the Flinders Peninsula (marked in yellow on Figure A-2) as the principal search area, in which nothing was found. The sections of the direct tracks between Elcho Island and MataMata, and Elcho Island and Nyinyikay falling within Buckingham Bay (Figure A-2, yellow lines) were also searched using side-scan sonar but nothing was found.

The target on the sea bed on the western side of Buckingham Bay, which had been 'located' by parties from Elcho Island using a side-scan sonar, was interpreted and reported by those parties to be the aircraft. Northern Territory Police divers searched this location (marked by a white ellipse beneath a yellow balloon in Figure A-2) but found nothing.

Figure A-2: Areas and tracks searched by the Northern Territory Police and ATSB and a possible wreck target on the western side of Buckingham Bay



Elcho Island community search

In addition to supporting the Northern Territory Police/ATSB search, a Queensland-based commercial salvage operator was subsequently engaged by the Elcho Island community to search for the aircraft wreckage. That operation took place between 8 and 14 August 2009, using a magnetometer and two side-scan sonars. No wreckage was found.

APPENDIX B: RECONSTRUCTION FLIGHTS

On 15 May 2009, the operator flew two reconstruction flights in an Airvan. During this exercise, the second witness was positioned at the same place on the airfield from where he reported he had seen the aircraft turn on the day of the accident. During the reconstruction, the witness was able to communicate with the pilots via a handheld radio. The surface wind at Elcho Island at that time was south-easterly at 10 to 15 knots, similar to the conditions on the day of the accident.

The positions at which the right turn commenced on the first and second reconstruction flights are marked on Figure B-1 by the red and white pins respectively.[22] The yellow aircraft icon is the mid-point between them.

Figure B-1: Estimated position of the aircraft when the second witness saw it turn right

First reconstruction flight

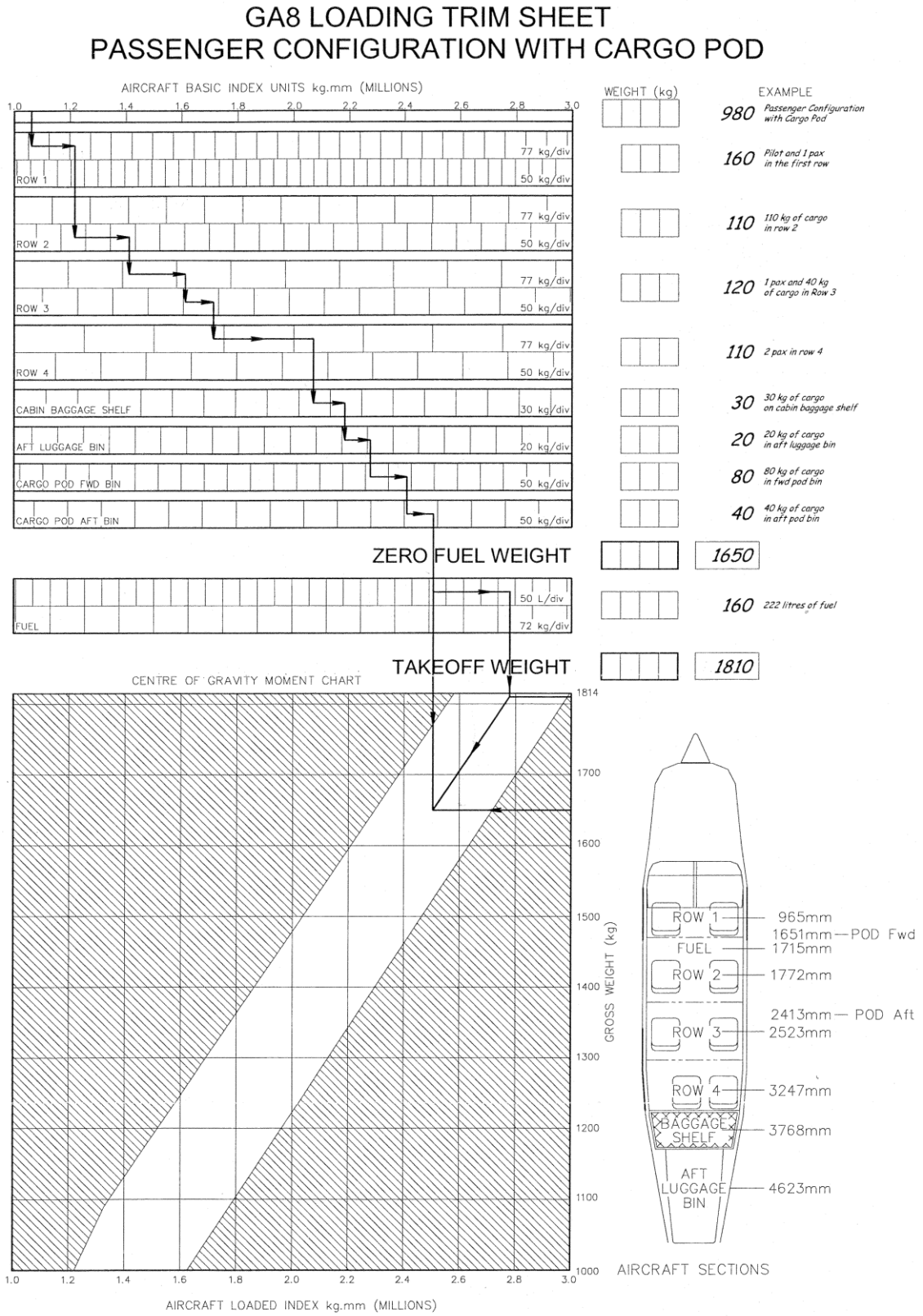
On the first flight, the aircraft tracked the upwind centreline of runway 10 at Elcho Island. The second witness instructed the pilots to track further left, or to the north heading about 085° to 090°, to more closely approximate the position in which he recalled seeing the aircraft turn. He instructed them to begin their right turn when the aircraft was about 1 km left of the runway centreline and at around 1,250 ft above ground level (AGL). The aircraft was turned onto a heading of 160° and descended at 500 ft/min, which the second witness judged was not as steep as the descent he recalled witnessing.

[22] A transcription error occurred during the second flight when the coordinates of this position were taken. The position marked by the white pin is an estimate made on the basis of the recollection of one of the reconstruction flight pilots. The estimate is referenced to the coordinates marked by the red pin, which were transcribed correctly from the aircraft's Global Positioning System during the first flight.

Second reconstruction flight

On the second flight, the aircraft was directed onto about the same initial heading, but proceeded slightly further from the airfield before the second witness directed it to make the right turn. The turn and the descent were performed more steeply, with a rate of descent of about 800 ft/min, which the second witness judged to be much closer to the profile that was observed on the day of the accident.

APPENDIX C: GA-8 AIRVAN LOADING TRIM SHEET



APPENDIX D: GA-8 AIRVAN CARGO NETS

The removable nets in the Airvan include the:

- main vertical cargo net
- throwover net
- cabin baggage shelf net.

Main vertical cargo net

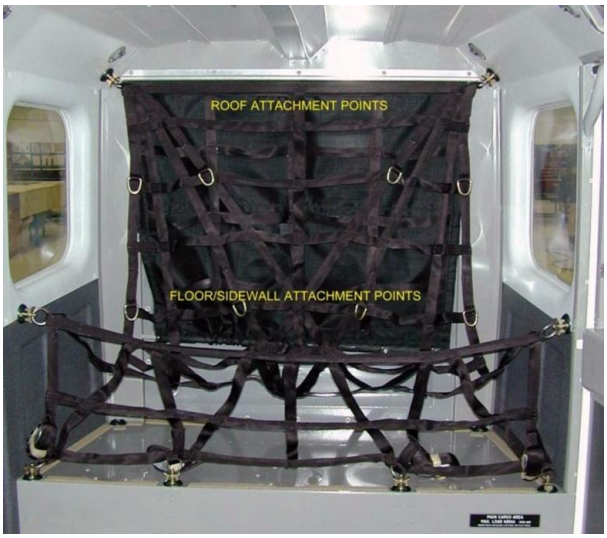
The main vertical cargo net is attached to the cabin floor and ceiling behind the pilots' seats (Figure D-1). Either of the two rows of floor anchor plates in row 1 may be used to secure the net, so the first row of passenger seats must be removed before the main vertical cargo net can be installed.

Figure D-1: Main vertical cargo net, looking forward

Baggage shelf net

The cabin baggage shelf net prevents cargo on the cabin baggage shelf from moving forwards (Figure D-2). The forward, lower edge of the net can be attached either to the four attachment points on the forward edge of the shelf (as in Figure D-2) or, after removing the seats in row 4, to the row 4 floor mounts.

Figure D-2: Cabin baggage shelf net, looking rearwards (note aft luggage bin net behind the cabin baggage shelf net)



Throwover net

The forward edge of the throwover net attaches to one of two rows of D-rings on the main vertical cargo net, and its rearward edge attaches to any row of the floor anchor plates (depending on the size of the cargo). The throwover net is then tightened with adjustable straps.

Aft luggage bin net

The aft luggage bin net is fixed (Figures D-2 and D-3). It prevents items in the aft luggage bin from moving forwards, and items on the cabin baggage shelf from moving rearwards into the aft luggage bin.

Figure D-3: Aft luggage bin net, looking rearwards

APPENDIX E: SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

- the aircraft operator
- the aircraft manufacturer
- the operator's flight crew
- the Bureau of Meteorology
- the Rescue Coordination Centre – Australia
- the captain of the Australian Customs Vessel Roebuck Bay
- the Northern Territory Police
- members of the Galiwinku community.

References

- Hayward, B., 1998. Witness interviewing techniques in aircraft accident investigation. In *Aviation psychology: a science and a profession.* Ashgate. Aldershot, UK.
- Loftus, E.F., Greene, E.L., and Doyle, J.M., 1989. The psychology of eyewitness testimony. In *Psychological methods in criminal investigation and evidence.* Springer. New York, USA.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the aircraft operator, the operator's chief pilot at the time of the accident, the Office of the Northern Territory Coroner, the Northern Territory Police, and the Civil Aviation Safety Authority.

Submissions were received from the aircraft operator and the operator's chief pilot at the time of the accident. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Missing aircraft Buckingham Bay, Northern Territory, 16 October 2008, VH-WRT, GA-8 Airvan