Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Aviation Occurrence Investigation AO-2006-001

Final

Loss of control – 9 km SE Raglan, Qld

31 October 2006

VH-ZGZ

Piper Aircraft Corporation PA-31-350

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Abstract

On 31 October 2006, a Piper Aircraft Corporation PA-31-350 Chieftain aircraft, registered VH-ZGZ, was being operated on a private category instrument flight rules (IFR) flight from Emerald to Gladstone, Qld. On board the aircraft were the pilot in command and two passengers. After departing Emerald at 1807 Eastern Standard Time, the flight proceeded apparently normally until the aircraft disappeared from radar while passing about 4,500 ft on descent into Gladstone. It was subsequently determined that the aircraft had crashed 9 km SE of Raglan, approximately 39 km west of Gladstone. The aircraft occupants received fatal injuries.

Conditions in the area of the accident were dark with some rain. Thunderstorms had been forecast but there was no thunderstorm or lightning activity in the area where radar contact was lost. Recorded radar and voice transmission information indicated that the aircraft was performing normally before it suddenly diverged left from a steady descending flight path and entered a spiral dive.

On-site examination confirmed that the aircraft impacted the ground at high speed in a steep, left spiral descent. The aircraft structure was complete at impact. It was established that at impact, both engines were operating at between 2,200 and 2,400 RPM and both propellers were in the normal operating pitch range. There was evidence that the gyroscopic instruments were functioning. The destruction to the wreckage precluded examination of the electrical and fuel systems, the flight controls, and the autopilot.

A series of maintenance issues involving the aircraft's engines occurred in the period before the accident. However, there was evidence that these had been resolved before the accident flight.

The pilot's experience on the aircraft type was limited, as was his night and instrument flight experience. The dark and very likely cloudy conditions that existed in the area where the aircraft suddenly diverged from its flight path meant that recovery to normal flight could only have been achieved by sole reference to the aircraft's flight instruments. The difficulty associated with such a task when the aircraft was in a steep descent was likely to have been significant.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external organisations.

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 enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, 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 proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au.

FACTUAL INFORMATION

1.1 History of flight

On 31 October 2006, a Piper Aircraft Corporation PA-31-350 (Chieftain) aircraft, registered VH-ZGZ (ZGZ), was being operated on a private category instrument flight rules (IFR) flight from Emerald to Gladstone, Qld. On board the aircraft were the pilot in command and two passengers. One of the passengers was a qualified pilot, but who was not endorsed on the aircraft type.

After departing Emerald at 1807 Eastern Standard Time[1], the pilot contacted air traffic control and reported climbing to 7,000 ft with an estimated time of arrival at Gladstone of 1915. At 1813:25, air traffic control advised the pilot that ZGZ was radar identified 15 NM east of Emerald. At 1815:12, the pilot requested clearance to climb to 9,000 ft. At 1817:05, air traffic control issued a clearance to the pilot for the aircraft to climb 9,000 ft, and to track direct to Gladstone.

At 1820:26, the pilot reported level at 9,000 ft and requested clearance to divert up to 10 NM left and right of track to avoid anticipated weather activity ahead. Air traffic control approved that request. At 1830:56, the pilot requested clearance to divert up to 15 NM left and right of track, and 10 seconds later changed the request to 15 NM left of track. Air traffic control approved that request. At 1835:17, the pilot reported clear of the weather and requested clearance to track direct to Gladstone and to descend to 7,000 ft. Air traffic control approved those requests.

At 1848:52, the pilot reported at ‘top of descent’ to Gladstone. Air traffic control cleared the pilot to descend. At 1852:45, the pilot reported changing frequency to the Gladstone common traffic advisory frequency (CTAF). Air traffic control advised the pilot that the aircraft was leaving 5,500 ft and that the radar and control services were terminated. The pilot acknowledged that transmission at 1852:57.

Approximately 3 minutes later, at 1855:45, air traffic control noticed that the aircraft’s symbol was no longer evident on the air situation display screen and the controller attempted to contact the pilot of the aircraft by radio. The controller also requested pilots of other aircraft operating in the Gladstone area to attempt to contact the pilot of ZGZ on the Gladstone CTAF frequency. All attempts were unsuccessful.

A witness in the Raglan area recalled hearing the sound of aircraft engine(s) overhead. He then heard the engine(s) ‘roar and shut off again’ a few times. A short time later, he saw a flash and a few seconds later heard the sound of an explosion. He realised that the aircraft had crashed and telephoned the Gladstone Police. Subsequently, wreckage of the aircraft was located near Raglan, approximately 39 km west of Gladstone (Figure 1). The three occupants were fatally injured. The aircraft was destroyed by impact forces and post-impact fire.

[1] The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours

Figure 1: Aerial view showing accident site

1.2 Injuries to persons

Injuries	Crew	Passengers	Other	Total
Fatal	1	2		3
Serious				
Minor				
None				

1.3 Damage to aircraft

The aircraft sustained severe damage from the impact forces and post-impact fire.

1.4 Other damage

Nil.

1.5 Personnel

1.5.1 The pilot in command

The pilot in command held a Commercial Pilot (Aeroplane) Licence, a command multi-engine instrument rating and a Grade 1 multi-engine instructor rating. According to his pilot's log book, on 26 December 2004[2], he had in excess of 3,900 hours flying experience, including 547 hours on multi-engine aircraft. His multi-engine experience included flight time on Piper PA-23 and PA-34, Beech 76 and Partenavia PN-68 aircraft[3].

The pilot had logged about 77 hours night flight. Of that, 8.6 hours were logged as multi-engine night flying, comprising 6.2 hours dual and 2.9 hours as pilot in command. The log book recorded 8 hours single engine and 8.6 hours multi-engine night flying in 2004, and 11 hours single engine and 1.6 hours multi-engine night flying in 2003. However, the 1.6 hours entry appeared to have been the result of a transposition error in the log book.

The pilot in command's log book also indicated that, at 26 December 2004, he had flown a total of 70 hours instrument flying time. His total logged instrument time in multi-engine aircraft was about 29 hours. At the end of 1999, he had logged 50.1 hours instrument flying, of which 47.4 hours were dual, meaning that his instrument flying experience between January 2000 and 26 December 2004 was about 27 hours. Of that, 10.8 hours had been logged as multi-engine instrument time.

It was reported that the pilot in command's flying activities between 26 December 2004 and the day of the accident would have been broadly equivalent to those of the previous couple of years. His log book indicated that he had flown 534 hours in 2003 and 716 hours in 2004. Unverified information indicated that at 17 August 2006, the pilot in command had 4,787.2 hours total flying experience, including 902.8 hours on multi-engine aircraft. On that basis, the pilot in command flew 862 hours between end 2004 and 17 August 2006.

The pilot in command completed Piper Chieftain endorsement training (in ZGZ) at Archerfield, Qld, on 9 October 2006. Based on the flight information provided by the aircraft owner, the pilot had flown approximately 12 hours in ZGZ at the time of the accident. Information from the log book of the other pilot (see Section 1.5.2) on the accident flight indicated that the pilot in command flew 0.9 hours night on 9 October (while flying the aircraft to Gladstone immediately after his endorsement training), and 1.1 hours night en route Townsville to Gladstone on 13 October 2006. As far as could be determined, and apart from the accident flight, the pilot in command conducted no other night flying in ZGZ.

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[2] The pilot in command's log book covering the period between December 2004 and the occurrence date was not located.

[3] Piper PA-23 and PA-34, Beech 76 and Partenavia PN-68 aircraft are generally regarded as less sophisticated in terms of aircraft systems, engines and operating techniques compared to the Piper PA-31-350.

1.5.2 The passenger/pilot on board the aircraft

One of the passengers on board the aircraft was a qualified pilot and a member of the family company that owned the aircraft. He held a Private Pilot (Aeroplane) Licence and had about 505 hours flying experience, including 8.4 hours night flying. He had completed twin-engine endorsement training in February 2006. According to his pilot's log book, he had accumulated 57.6 hours on Partenavia PN-68 aircraft, of which 20.4 hours were as pilot in command. He had flown 4.3 hours in Piper PA-34 aircraft, all of which was recorded as dual flight time. None of his flight time on PN-68 or PA-34 aircraft was logged as night flight. He had logged 4.1 hours instrument flight time, all in single engine aeroplanes. He did not hold an instrument flight rating.

After the company took delivery of the aircraft on 9 October 2006, the passenger/pilot had accompanied the pilot in command on almost all flights in ZGZ. His pilot's log book recorded dual flight time in ZGZ with the pilot in command on 9, 11, and 13 October. Those records totalled 9.7 hours, including 1.9 hours night flight. Other than the flight time being recorded under 'dual' in his log book, there was no other documentary evidence that the flights were for endorsement training. The last entry in the passenger/pilot's log book was for 25 October. The passenger/pilot was reported to have said to others that he was in the process of gaining an endorsement on ZGZ.

Witnesses observed the passenger/pilot occupy the right cockpit seat at Emerald before departure on the accident flight.

1.5.3 Other information

According to the managing director of the company that owned the aircraft, the aircraft was to be flown exclusively by the pilot in command during at least the first six months of its operation by the company. Ultimately, the other pilot on board the accident flight was expected to undergo endorsement training on ZGZ, but that would not occur for at least 6 months. Until then, he should not have been involved in any aspect of the operation of the aircraft. The managing director indicated that he had conveyed these intentions directly to the pilot in command who, he considered, clearly understood their intent.

1.6 Aircraft information

The aircraft was manufactured in the US in 1977 and was imported into the Philippines in October 1997. The aircraft's log books indicated that, at the time of the accident, the aircraft had a total time in service of approximately 3,977 aircraft hours and had flown 474 hours between November 1997 and November 2004. That equated to an average utilisation rate of 67.7 hours per year. The log books showed that the aircraft was operated for 60 hours between November 2004 and July 2006.

The aircraft was fitted with two Lycoming T10-540-J2B engines(Turbo-charged, injected, opposed). According to the relevant log books, the left engine had completed 6,934.6 total hours of operation, and the right engine 8,055.8 total hours of operation, at the time of the accident. Both engines had been overhauled in January 2004 and had since operated for 142.2 hours. Both propellers had been overhauled in August 2004, and had since operated for 110.45 hours.

1.6.1 King KFC200 Automatic Flight Control System

The aircraft was fitted with a King KFC200 flight control system, incorporating an automatic pilot and a flight director. The autopilot could be operated in a heading and/or attitude mode, as well as in an altitude hold mode. It had the capability of interfacing with the GPS in the navigation mode.

In the attitude mode, the autopilot maintained an attitude selected by the pilot via a switch on the autopilot control panel. The autopilot could be used to establish the aircraft in a climb or descent by operating the vertical trim switch UP or DOWN. Out-of-trim forces, generated when the autopilot commanded elevator movement, were transferred via cable operated torque switches to a servo motor on the pitch trim cable drum. Any control forces were automatically trimmed out so that the aircraft was in trim following autopilot disengagement. If the elevator pitch trim motor malfunctioned, out-of-trim forces would be contained by the pitch trim servo until the autopilot was disconnected, or the limit of the servo was reached. In either case, the resultant out-of-trim forces could cause the aircraft to pitch up or down abruptly.

Operation of the vertical trim switch also drove the flight director ‘V-bar’ on the attitude indicator.

The aircraft flight manual included a section (Supplement 8) that described the normal and emergency procedures for operating the KFC200 autopilot. The system incorporated a trim warning light accompanied by an audible warning if the autotrim and/or manual electric pitch trim failed. The pre-flight check, that the manual stated must be performed before each flight, detailed the procedures for checking the functionality of the autopilot system, including the warning lights.

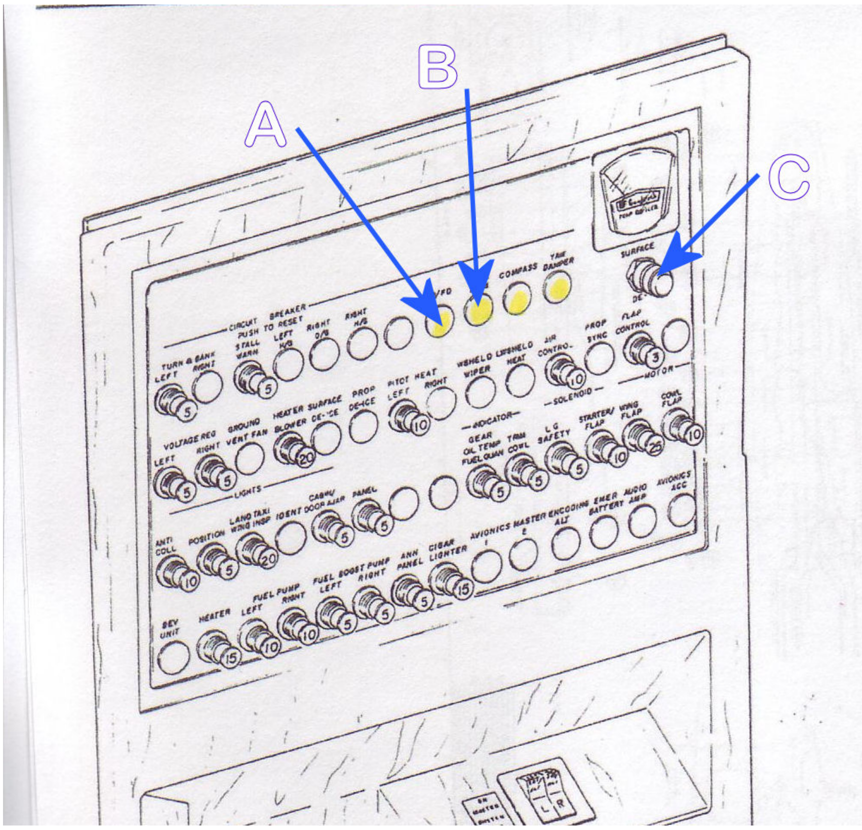
According to the flight manual, the autopilot automatically disengaged in the event of electrical supply failure, upon actuation of the manual electric trim, and if there was an internal flight control system failure. The autopilot could be manually disengaged by operating the red disconnect switch on the left control yoke, by operating the autopilot engage lever on the autopilot control panel, by pulling the autopilot circuit breaker, or by switching off the autopilot master switch or the avionics master switch.

The manual electric trim could be disengaged by pressing the autopilot disconnect/trim interrupt switch on the pilot’s control yoke, turning off the avionics master switch, or pulling the pitch trim circuit breaker.

The location of the autopilot control panel, the circuit breaker panel, and the autopilot disengage button, as fitted to the aircraft, are indicated in Figure 2.

Figure 2: **Cockpit instrument panel from VH-ZGZ: (A) autopilot control panel, (B) the red autopilot disengage button on the left control yoke, (C) forward section of the circuit breaker panel on the left cockpit wall**

Figure 3: **Left cockpit wall circuit breaker panel showing: (A) position of autopilot/flight director and (B) electric trim circuit breakers. (C) post light illuminating the circuit breaker panel**



The pilot who conducted the endorsement training in the aircraft for the pilot in command reported that the autopilot was engaged and disengaged a number of times during the flight and functioned normally. The endorsing pilot also indicated that the pilot in command satisfactorily operated the autopilot and the electric trim during the flight, including the altitude hold function and it was apparent that he had previously operated autopilot systems.

It was reported that the pilot in command operated the autopilot on most, if not all, flights in the aircraft. There were no reports of autopilot malfunction during that time.

1.6.2 Other occurrences involving autopilot operation

A search of international data bases revealed accidents and incidents in light twin engine aircraft in which autopilot failure, malfunction, or a systems related event was identified as having contributed to the occurrence[4]. Reports from investigations into those occurrences indicate that excessive control forces and significant deviations from the flight path occurred in some cases. The more extreme examples involved sudden departure from controlled flight and a steep, high speed descent into terrain.

On 12 September 1994, the US National Transportation Safety Board issued Safety recommendation A-94-163 following a series of occurrences involving *Beech* aeroplanes. The recommendation emphasised 'the need for strict adherence to the prescribed operating and procedural instructions contained in the respective airplane flight manual supplements and autopilot operating manuals'.

During this investigation, anecdotal reports were received concerning autopilot malfunctions in single and twin engine aircraft. They included instances of abnormal aircraft behaviour, such as the aircraft suddenly pitching nose-up or nose-down, which were associated with autopilot operation. Some of the events occurred while aircraft were being operated with the autopilot engaged, while other events occurred at the time a pilot disconnected the autopilot. Those events generally occurred without warning and in some instances were described as alarming. A general comment was that such an event occurring at night and/or in cloud could lead to disorientation and loss of control of the aircraft.

1.6.3 GPS navigation system

The aircraft was fitted with a Garmin 155 GPS (Global Positioning System) navigation system that was certified for en route and aerodrome approach navigation under instrument flight rules (IFR). The system could be coupled to the autopilot by pilot selection to provide automatic en route and aerodrome approach navigation.

The pilot in command was reportedly familiar with the operation of GPS equipment and its use as a navigation aid.

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[4] For example, NTSB (US National Transportation Safety Board) Report NYC89FA903; AAIB (UK Aircraft Accidents Investigation Branch) Bulletin No: 1/2000; NTSB Report MIA05FA024 ; NTSB Report DFW07FA073.

1.6.4 Weather radar

The aircraft was fitted with a Bendix 160 Weather Radar system. A display in the cockpit centre instrument panel showed three levels of rainfall intensity in green, yellow, and red that was relative to cloud formation, rainfall rate, thunderstorms, and icing conditions up to 250 km from the aircraft.

The extent of any training and the level of experience the pilot in command had in operating and interpreting weather radar display information could not be determined. However, the requests from the pilot to divert left of track and the radar record of the aircraft's track indicate that the pilot may have been acting in response to information displayed on the aircraft's weather radar display.

1.6.5 Cockpit and instrument lighting

Cockpit instrument lighting was provided by individual post lamps mounted adjacent to each instrument. Pilot and co-pilot lights were located in the overhead instrument panel. A pilot/co-pilot dome light was located in the centre of the overhead panel.

The functionality of the cockpit lighting on the accident flight could not be determined; nor could it be determined if a torch was carried on the aircraft.

1.7 Meteorological information

1.7.1 Prevailing weather conditions

On 31 October 2006, a high pressure ridge extended along the Queensland coast and an inland trough extended north-south through central Queensland. During the afternoon, showers and thunderstorms developed east of the trough and moved towards the coast. The Area 40 amended forecast, issued at 1649, was for scattered showers and thunderstorms northwest of a line Maryborough to Goondiwindi. The forecast wind at 7,000 ft was variable at 10 kts, and 270 degrees/10 knots at 10,000 ft.

Among the few documents recovered from the accident site was a copy of an amended Area 40 forecast valid from 0900 to 2100 on 31 October 2006. That forecast was for isolated showers and thunderstorms west of a line from Rockhampton to Stanthorpe, and becoming more scattered after 1200. It could not be determined if the pilot obtained the amended forecast issued at 1649.

The Bureau of Meteorology's (BoM) Gladstone Weather Watch Radar images recorded at 1840, 1850 and 1900 are shown at Figures 4 - 6. The accident location and the approximate track of the aircraft (in red) have been superimposed on those images.

Figure 4: Bureau of Meteorology Gladstone Weather Radar image, 128 km radius, recorded on 31 October 2006 at 1840. The approximate track of the aircraft, and the accident location, are shown in red

Figure 5: Bureau of Meteorology Gladstone Weather Radar image, 128 km radius, recorded on 31 October 2006 at 1850. The approximate track of the aircraft, and the accident location, are shown in red

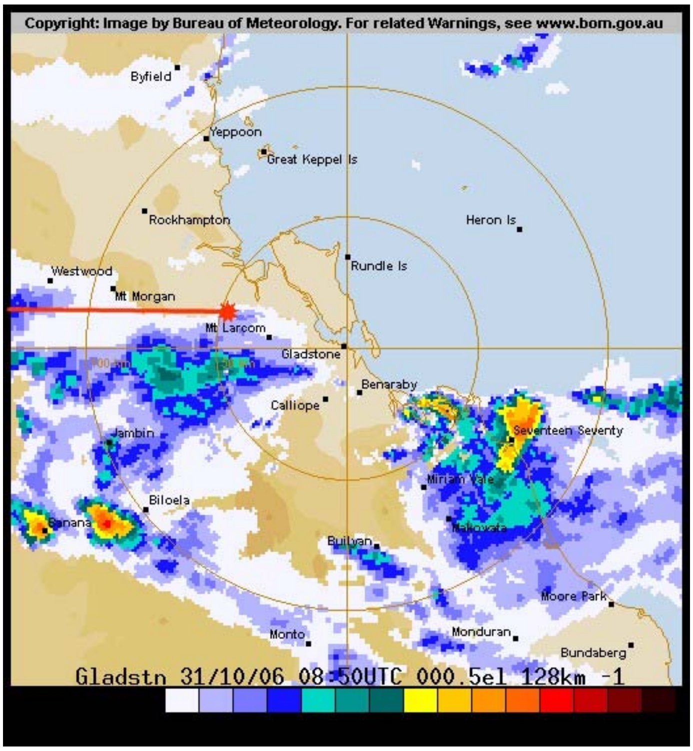
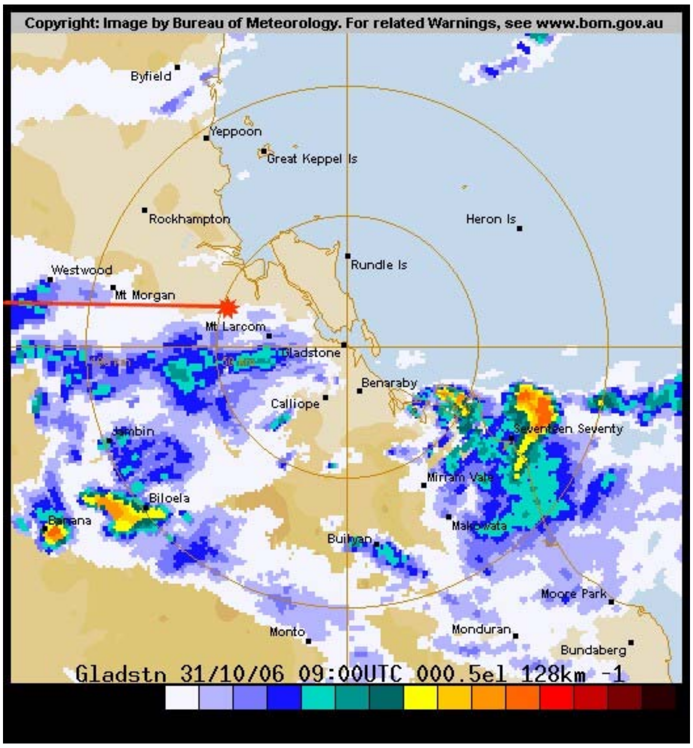


Figure 6: Bureau of Meteorology Gladstone Weather Radar image, 128 km radius, recorded on 31 October 2006 at 1900. The approximate track of the aircraft, and the accident location, are shown in red



Witnesses in the area reported conditions as overcast with light rain and very dark at the time of the accident. They did not report any lightning or thunder.

No lightning activity was recorded within a 20 km radius of the accident location between 1700 and 2000[5].

1.7.2 Aircraft icing

Two conditions were necessary for substantial ice accumulation on an aircraft; the aircraft must be flying in visible moisture conditions (rain or cloud); and the temperature of the moisture (water) and the skin of the aircraft[6] must be 0 degrees C or lower[7].

The Area 40 amended forecast, issued at 1649, forecast the freezing level as 12,000 ft. The forecast temperature at 10,000 ft was plus 3 degrees C.

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5 Information provided by Global Position and Tracking Systems Pty Ltd.

6 Aerodynamic cooling can lower the temperature of an aerofoil to 0 degrees C or less, even though the ambient air temperature is above freezing.

7 Instrument Rating Manual, Jeppesen Senderson, Inc., 1990.

1.7.3 Sun and moon information

Sunset at Gladstone Airport on the day of the accident was at 1808. Civil twilight ended at 1832. Moonrise was at 1234 and moonset at 0114 the following morning. First quarter moon occurred on 29 October and full moon on 5 November. At Gladstone Airport at 1955, the moon was at an azimuth of 316 degrees, and 77 degrees above the horizon[8].

1.8 Aids to navigation

Not relevant.

1.9 Communications

Radio communications between the pilot of the aircraft and air traffic control were recorded. A review of those recordings indicated that the quality and content of transmissions was normal. There was no indication in any of the recorded transmissions from the pilot that the flight was not proceeding in a routine manner. A comparison between the recorded transmissions from the test flight immediately before the aircraft departed Emerald, and the transmissions on the accident flight indicated that all transmissions on the accident flight were made by the pilot in command.

Communications on the Gladstone common traffic advisory frequency (CTAF) were not recorded. There were no reports of any other aircraft on the CTAF during the period that the pilot was on the frequency. Consequently, it was not possible to determine if there were any transmissions from the pilot after the last recorded transmission at 1852.57, when the pilot acknowledged the controller's advice that control services were terminated.

1.10 Recorded information

The aircraft was not equipped with any on board recording devices, and there was no regulatory requirement for such equipment to be fitted.

1.10.1 Mt Alma secondary surveillance radar

The recorded radar information included data from secondary surveillance radar (SSR) equipment located on Mt Alma, about 27 km south of the accident location at an elevation of 748 m above mean sea level (AMSL). The Mt Alma radar provided excellent coverage of the area as there were no areas of high ground that might have masked the aircraft being 'seen' by the radar in the area of its last recorded position.

Secondary surveillance radar relies on functioning aircraft equipment to obtain a radar position. In simple terms, the SSR obtained position and altitude information by interrogating an aircraft's electrically powered transponder, triggering a coded response from the transponder. If the aircraft's transponder was not functioning (e.g. if the aircraft's electrical system had stopped operating), the aircraft would not

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8 Information obtained from Geoscience Australia website.

be 'seen' by the radar. Further, if the aircraft was in an attitude where the transponder antenna was masked from the radar by the aircraft structure, then the radar data could be corrupted and/or incomplete.

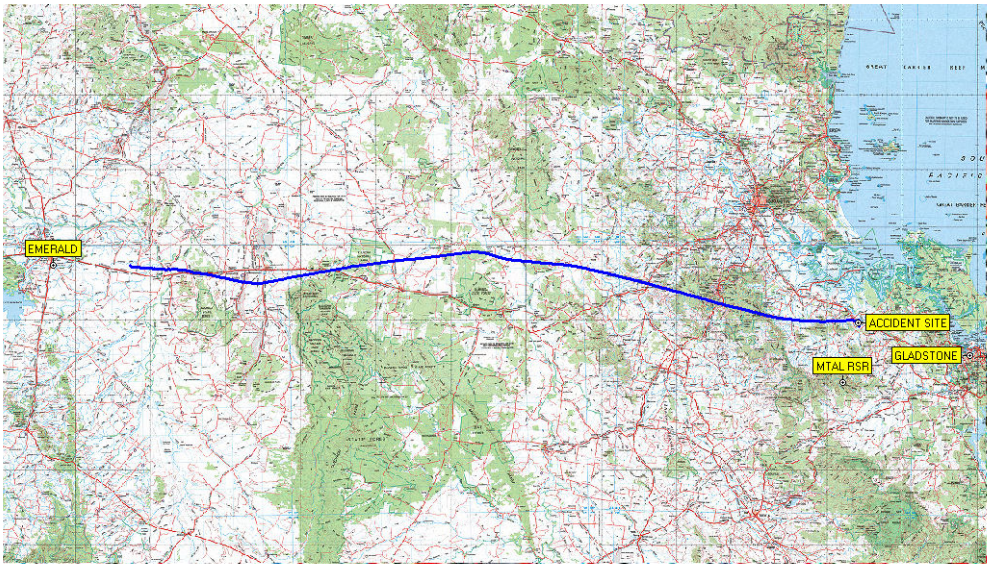
The radar data was updated (and recorded) every 4 seconds in accordance with the antenna rotation rate of 15 rotations per minute.

1.10.2 Recorded radar information

The recorded air traffic control radar data from the Mount Alma sensor station included information on the aircraft's track (Figure 7) and also groundspeed and altitude (Figure 8).

Figure 7 shows the recorded track of the aircraft from its position when it initially entered radar coverage until radar contact was lost. The track information shows that the aircraft diverged left of the direct Emerald to Gladstone track, in accordance with the pilot's radio transmissions to air traffic control. The track information supports the conclusion that the aircraft's navigation systems were functioning normally.

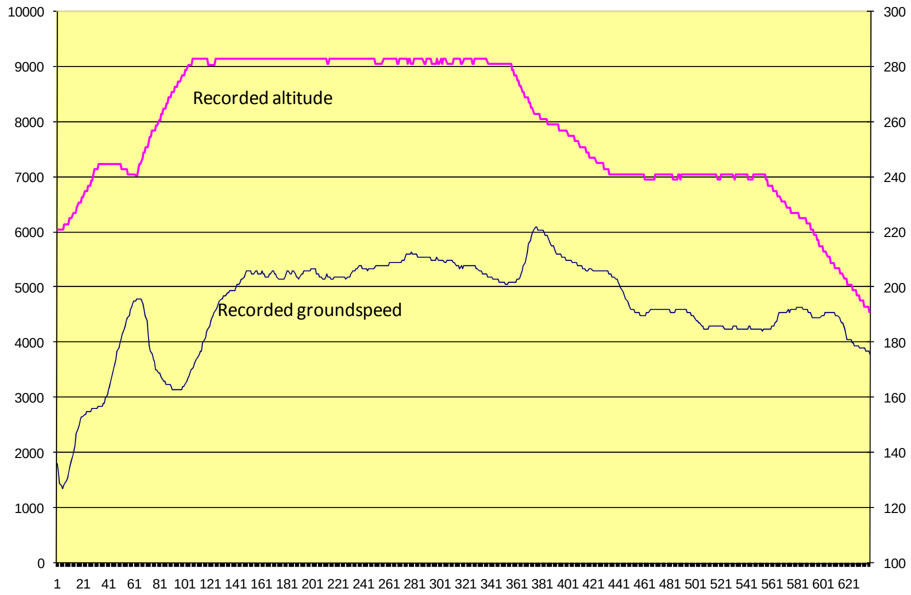
Figure 7: Recorded radar track of VH-ZGZ



Note: The label 'MTAL RSR' denotes the location of the Air Services Australia Mt Alma Route Surveillance Radar sensor (see 1.10.2).

The recorded altitude data (Figure 8) showed that the aircraft was first detected by the radar as it climbed through about 6,000 ft altitude. The aircraft levelled initially at about 7,200 ft before descending to 7,000 ft. A short time later, the altitude began to increase as the climb to 9,000 ft was initiated. The data showed that, after a period in cruise at that altitude, the aircraft descended to 7,000 ft and remained at that level until the descent towards Gladstone was initiated. The data showed that the aircraft maintained a constant altitude[9] during the cruise segments of the flight, indicating that the aircraft was probably under the control of the autopilot during those periods.

Figure 8: Recorded altitude and groundspeed of VH-ZGZ



The recorded groundspeed data (Figure 7) varied in accordance with the phase of flight (climbing, level flight, or descent) of the aircraft. During the cruise at 9,000 ft, the aircraft maintained a groundspeed in excess of 200 kts. During the subsequent cruise phase at 7,000 ft, the aircraft groundspeed exceeded 185 kts. Those speeds were consistent with the performance of a PA-31-350 aircraft with both engines operating at normal cruise power settings (and taking account of the forecast wind at those altitudes). The speeds were not achievable in level flight with one engine inoperative (assuming that the forecast winds at those altitudes were accurate).

The final 5.5 minutes of radar data showed the aircraft in a steady descent from 7,000 ft at about 450 ft per minute, with a groundspeed of about 180 kts. The last complete data record showed the aircraft at an altitude of 4,560 ft (well above the minimum safe altitude[10]) and at a groundspeed of 177 kts. Throughout those final few minutes of flight, the recorded track remained steady between about 091 and 094 degrees magnetic (M). There was no evidence of performance variations that might have been present had there been a failure of the primary flight instruments or one of the engines.

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9 The small irregularities in the recorded altitude when the aircraft was in level flight were attributable to the data sampling and recording system. They were consistent with the aircraft maintaining level flight and were not indicative of any performance irregularity.

10 The minimum safe altitude (MSA) 46 km west of Gladstone was 3,200 ft if the aircraft was north of the 270 degrees magnetic radial from Gladstone, or 4,000 ft if the aircraft was south of that radial.

As the aircraft descended through 4,560 ft, the recorded altitude information became incomplete. During the subsequent 40 seconds, some limited data was recorded. That data including some x and y axis position information which indicated that the aircraft diverged left from its steady flight path through approximately 270 degrees before the data ended. The last recorded data was at 1855.24 EST.

The last recorded position of the aircraft was within about 1 km of the accident site.

1.11 Wreckage information

The aircraft impacted open ground on the side of a hill (Figure 9) approximately 150 ft AMSL. The relative angle between the terrain slope and the flight path was greater than 70 degrees nose-down. The extent of disruption to the aircraft and its systems was severe, indicating that the impact speed was more likely to have been towards the upper, rather than the lower, end of the aircraft's speed range.

The aircraft' heading at impact was approximately 210 degrees M. That compared with the last valid recorded radar track of 094 degrees M. The wreckage had been distributed predominantly to the right of that impact heading, roughly along a line 260 degrees M.

All the aircraft extremities were identified at the impact site. It was also confirmed that all the flight controls were attached to the aircraft at impact.

Figure 9: Aerial view of accident site (arrowed) on the hillside

The force of the impact and the subsequent fire had caused the disintegration of much of the aircraft structure (Figure 10).

Figure 10: Main features of the wreckage

Pertinent observations from the wreckage examination included the following:

- There was extensive evidence of post-impact fire, indicating that there was substantial fuel on board the aircraft at impact.
- It was not possible to obtain fuel samples from the wreckage. However, there were no reports of any other aircraft using the same fuel batch being affected by fuel quality.
- It was not possible to determine the position of the wing flaps due to the extent of damage to the flaps and the flap drive mechanism.
- The landing gear was in the retracted position at impact.
- There was no evidence that the rudder, elevator or ailerons had been subjected to aerodynamic flutter[11].
- The state of the wreckage precluded confirmation of the integrity of the primary flight control cables prior to impact. It was not possible to discount a flight control jam.
- The extent of disruption through the aircraft's primary structure meant that pulling and/or stretching of the trim control cables would have occurred during the impact and break-up period. On that basis, it was not possible to determine the position of the elevator, rudder, and aileron trim tabs prior to impact.

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[11] High frequency oscillation of structure under interaction of aerodynamic and aeroelastic forces.

- The condition of the wreckage precluded examination of the aircraft's fuel and electrical systems. The fuel tank selection panel was not found.
- The extent of damage to the cockpit area prevented any meaningful information being obtained regarding cockpit switch and control positions at impact, and the cockpit and instrument lights.
- Fragmented pieces of some gyroscopic and pressure instruments were found within the compressed forward fuselage and nose sections. They were recovered from the site for further examination.
- The empennage retained some of its integrity and was predominantly unaffected by the post-impact fire, as were some segments of the wings. Examination of those items did not reveal any evidence by way of streaking or melting from sustained burning to indicate the presence of an in-flight fire.
- Both propeller/engine combinations were embedded in hard, dry, rocky earth. Excavation revealed marked differences in the impact signature of each propeller (Figures 11 and 12). The engines and propellers were removed from the accident site for further examination.
- Both engine turbochargers were recovered for further examination.

Figure 11: After excavation of the left engine/propeller

Figure 12: After excavation of the right engine/propeller

1.11.1 Engine examination

The right engine crankshaft had fractured in a single location through the rear-most flange adjoining the forward big-end bearing journal. There was no evidence to suggest that any latent defects, such as fatigue cracking or material flaws, were present in the crankshaft or associated forward big-end connection, nor was there any evidence suggesting that any defects or deficiencies within the crankshaft had contributed to the failure as observed. Checks against the engine manufacturer’s service bulletins indicated that the right engine crankshaft was not included in the range of components identified by the manufacturer for mandatory replacement. The crankshaft failure was attributed to the combined forces of engine operation and ground impact.

There was no other evidence of internal failure observed in either engine. However, the majority of the crankcase and many of the pistons, accessories and all the electrical and fuel connections to the engines had been destroyed.

1.11.2 Propeller examination

The aircraft’s right propeller, although having sustained extensive impact-related damage, remained essentially intact and was recovered with all but one blade retained in the hub. The forward position of the pitch change fork, the orientation of the blade butt fractures and the preload plate witness marks were all consistent with the governed, on-speed operation of the propeller at impact.

The left propeller hub had fractured and fragmented, destroying the internal mechanism and releasing all blades. The positions of witness marks on the preload plate were consistent with those of the right propeller, indicating that the left propeller blades were also in the normal operating pitch range at ground impact.

1.11.3 Turbocharger examination

A turbocharger consists of a turbine and an impeller linked by a common axle and enclosed within a shaped housing. Exhaust gases from an operating engine cause the turbine wheel to rotate, driving the impeller which delivers compressed ambient air to the engine intake manifold. Engine power and efficiency is increased as a result. An engine must be operating and producing power for the turbine/impeller combination to rotate.

The left engine turbo chargers had separated from the engine, while the right engine turbocharger remained attached to its engine. The subsequent off-site examination, of both turbochargers, found that the damage to the impellers and the inside walls of the impeller housings was consistent with the impellers rotating at impact.

1.11.4 Cockpit instrument examination

The results of the examination of the damaged instruments recovered from the accident site were as follows:

- ***TACHOMETERS***
  The tachometers were mechanically driven by flexible cables from the accessory gear box of each engine. Engine RPM was displayed on a dual tachometer in the cockpit centre instrument panel. Although the instrument had been substantially damaged during the impact, there was sufficient evidence available to establish that the position of the pointers at impact was between 2,200 and 2,400 RPM. That was within the normal operating RPM range for the engines during a cruise descent.
- ***GYROSCOPIC INSTRUMENTS***
  The aircraft's gyroscopic instruments included the attitude indicators, turn and balance indicators, and heading indicators. The gyroscopes within those instruments were air-driven by two vacuum pumps, one on each engine. If one pump failed, the other had sufficient capacity to drive all the gyroscopic instruments. Examination of damaged instruments confirmed that there was gyroscope rotation at impact, indicating that at least one vacuum pump was functioning. On that basis, the gyroscopic instruments should have been operating normally.

1.11.5 Electrical system examination

Due to the disruption of the wreckage and post-impact fire, no meaningful information could be obtained from the aircraft wreckage regarding the status of the aircraft's electrical system.

1.12 Medical and pathological information

A complete post mortem and pathological examination of the accident victims was not possible. To the extent that an examination was possible, the results were unremarkable.

1.13 Survival aspects

The accident was not survivable.

1.14 Other information

1.14.1 Events preceding the accident flight

In September 2006, the aircraft was imported to Australia from the Philippines. The ferry pilot reported that the aircraft and its systems had functioned normally during the flight from the Philippines.

On 2 October 2006, the aircraft underwent an inspection for the issue of an Australian Certificate of Airworthiness (CoA) and a 100-hourly maintenance inspection by an organisation at Moree, NSW. The organisation reported that no abnormalities were found during those inspections and no engine starting difficulties were experienced.

The aircraft was flown to Archerfield before the new owner took possession on 9 October 2006. The pilot in command on the accident flight was endorsed on the aircraft on the same day. He flew the aircraft from Archerfield to Gladstone later that afternoon and flew as pilot in command of ZGZ on all subsequent flights.

On 11 October, the aircraft was flown from Gladstone to Mareeba, Qld, where the pilot was unable to start the right engine. Licensed aircraft maintenance engineers (LAMEs) who examined the aircraft reported that the timing on both right engine magnetos required adjustment and that they replaced the right engine starter switch because of a short circuit. They reported that they advised the pilot in command and the other pilot that the right engine starting system required further work. However, the pilots decided to fly the aircraft back to Gladstone. During that flight, the aircraft made an unscheduled landing at Townsville, reportedly because one of the right engine top cowl flap locks was not secure.

The next reported activity concerning the aircraft was on 19 October at Gladstone when the left engine could not be started. Checks revealed that there was a short circuit in the left engine starter motor. A replacement starter motor and a new battery were fitted. It was also reported that the braided flexible lead to the positive battery terminal was worn and had to be replaced, that a return to earth wire was broken, and that a wire join was bare and of poor quality. Those faults were rectified.

The following day, the right engine could not be started and a LAME was flown from Bundaberg to examine the aircraft. He assessed that the starting system vibrator was causing the problem, but managed to start the engine. The aircraft was flown to Bundaberg to drop off the LAME. However, the right engine would not start for the return flight. The LAME reported that he then conducted tests which established that the magneto vibrator points and magneto capacitors were unserviceable. He replaced those items, but also found that spark plug gaps exceeded the correct settings, that the magneto timing was incorrect, and that one of the brushes in the right alternator was stuck. He rectified those faults and reported that both engines then started and operated normally.

The Bundaberg LAME recalled that he had checked the right engine timing and noticed that there were no timing marks on the front of the ring gear plate, but there were marks on the rear of the plate. From the marks on the rear surface and by hand-swinging the propeller, he assessed that the starter support ring gear position was correct.

The aircraft was flown back to Gladstone on 25 October. The owner recalled that both he and the pilot in command noticed a ‘hunt’ in the right engine RPM at idle, but that it disappeared at about 5,000 ft on climb after takeoff and did not re-occur.

On 26 October, the Bundaberg LAME received a call that the right engine could not be started. He travelled to Gladstone to examine the aircraft, but could find no faults and was able to start the engines. The intention was to fly the aircraft to Emerald, so the LAME travelled in the aircraft in case further problems were encountered. The LAME reported that during the flight, the right engine cylinder head temperature (CHT) increased to above 400 degrees F and was much higher than the left engine CHT. The exhaust gas temperatures (EGTs) were the same for both engines and were within limits. The LAME reported that the pilot in command had noticed the high CHT and the LAME encouraged the pilot to operate the engine cowl flaps to control the CHT. Partial opening of the cowl flaps was sufficient to maintain the CHT below 400 degrees. During the flight, the pilot in command operated the aircraft on autopilot. The LAME recalled that the autopilot appeared to have been functioning normally.

The aircraft arrived at Emerald around midday on 26 October. Witnesses (including a LAME) at an aircraft maintenance facility at Emerald reported that, after refuelling, the left engine appeared to start normally, but the right engine could not be started. They observed repeated attempts over a period of 45 minutes or more to start the right engine before the Bundaberg LAME asked the Emerald LAME for a replacement starter motor. The Emerald LAME assisted the Bundaberg LAME to replace the starter, but the right engine still could not be started.

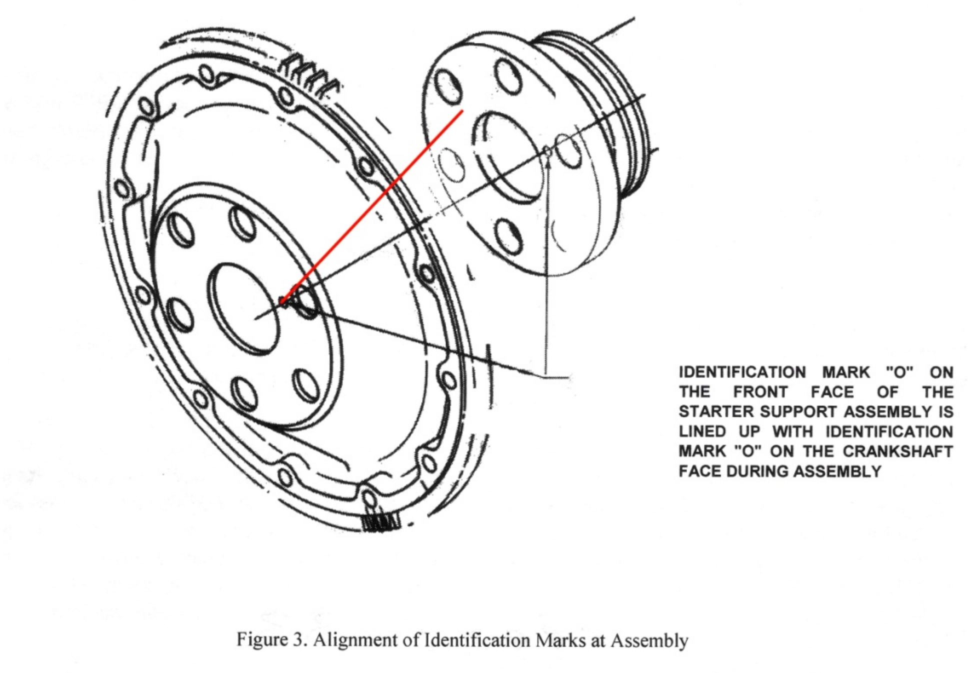
The LAMEs then undertook fault checking of the right engine. They found the primary (P) lead was chafed, creating a short circuit. That fault was repaired, but the engine still would not start. The spark plugs and leads were checked and found serviceable. Contamination was found in one of the magnetos and they replaced that unit. The right engine subsequently started, but surged at low RPM. The fuel injectors were then removed and two injectors were found partially blocked. The blocked injectors were cleaned and refitted to the engine. Another injector, that was the incorrect type for the engine, was replaced with a correct one. The engine then ran roughly at low RPM, but operated satisfactorily at high RPM.

The pilot in command, accompanied by the Emerald LAME, then took the aircraft for a test flight. The LAME said that he observed high CHT (just below the red line maximum limit of 500 degrees F), low EGT, and high fuel flow during the takeoff and told the pilot to land as soon as possible. The LAME subsequently replaced the fuel control unit, but upon restart, the engine still surged at idle RPM.

The Emerald LAME decided to check the engine timing and noticed that the starter support timing marks appeared to be in the incorrect position. To investigate further, the propeller was removed and it was found that the identification marks on the starter support assembly did not line up with the identification marks on the crankshaft face (see section 1.14.2); they were displaced by approximately 120 degrees (Figure 12) from the correct position. The LAME reported that he checked the starter support for damage and observed deformation on the support assembly where the tapered dowel or flange bushing had been forced into the flange when the propeller was secured to the crankshaft. The LAME said that the dowel was undamaged and that, apart from the deformation caused by the tapered dowel, the flange showed no cracks or other damage. He reassembled the components with the flange correctly aligned with the crankshaft, refitted the propeller and adjusted the engine timing. The engine then started and ran normally during a ground run.

The Emerald LAME also recalled that when he first observed the right engine starter ring gear position, he thought that a left engine ring gear might have been fitted to the engine. However, a check revealed that not to be the case.

Figure 12: Diagram showing starter support assembly and crankshaft face. The red line indicates the alignment reportedly found between the two components when the propeller was removed at Emerald on the day of the accident flight



The pilot, accompanied by the Emerald LAME, test flew the aircraft for about 20 minutes. They checked engine operation at climb, cruise, and descent power settings. The LAME reported that all engine parameters were normal throughout the flight and that the engine ran perfectly. At the completion of the flight, the engines were left running and the passengers boarded the aircraft for the flight to Gladstone. The passenger who was a qualified pilot was seen to occupy the right cockpit seat before the aircraft taxied.

The Emerald LAME reported that the pilot selected the outboard tanks before landing from the test flight. He did not observe the pilot change the tank selection after landing.

The aircraft maintenance records indicated that, between the time the aircraft arrived in Australia and the removal of the right propeller at Emerald, there had been no other occasion involving removal of propeller/s from the aircraft. That information was confirmed during interviews with those who had logged performing maintenance on the aircraft.

1.14.2 Engine timing and ignition

Engine timing is mechanically set during engine assembly by alignment of the camshaft to the crankshaft using preset timing marks. The engine manufacturer published Service Instruction No 1437 on 15 August 1986 titled *Engine Timing Marks.* That instruction detailed two methods for checking engine timing. There were marks on the starter ring gear support that were used to mechanically set the engine timing. Engine timing could also be set without reference to the timing marks on the starter ring gear support. Magneto timing was adjusted after engine timing was set.

There were six holes in the crankshaft flange on the TIO-540 engine. Dowels or bushes in those holes allowed the starter support assembly (which had six holes and which held the starter ring gear) and propeller to be aligned and secured to the crankshaft. Correct alignment between the starter support and the crankshaft was achieved by aligning an identification mark ’O‘ (Figure 12) on the front face of the support assembly with a similar mark on the crankshaft face. To further ensure correct alignment, one of the dowels was of marginally greater diameter than the others, as was one of the six holes in the ring gear.

Discussions with a number of experienced LAMEs and an aircraft engine overhaul organisation revealed that it was possible to assemble the propeller to the crankshaft with the ring gear aligned incorrectly, as was reportedly found when the aircraft was examined at Emerald before the accident flight. If in those circumstances the engine timing was adjusted using the ring gear markings, the timing would be ‘out’ to such an extent that the engine would not operate. However, if the timing was correct before the propeller and ring gear had been removed, and if no adjustment was made to the engine timing, the incorrect ring gear alignment on re-assembly would have no effect on engine operation.

The experienced licensed aircraft maintenance engineers and the engine overhaul organisation confirmed that it was possible to fit a left engine ring gear to the right engine, and vice versa. Further, the engines were capable of operating with incorrect ring gears fitted.

1.14.3 Engine starting system

The engine starting system was independent of the engine ignition system. The engine could be started without the starting system being operative.

1.14.4 Fuel

The information manual for the aircraft (Report 2046) contained the following information regarding the aircraft’s fuel system and its operation.

Total (usable) fuel capacity was 690 L (345 L per side), with 288 L in the inboard tanks and 402 L in the outboard tanks. Typical cruise fuel usage rate was about 150 L per hour. The manual contained checklists for normal and emergency procedures. The normal checklist indicated that the fuel should be selected to the inboard tanks for takeoff, descent and landing. The engines could be fed by the inboard our outboard tanks, as required, during cruise.

The aircraft was equipped with a system to warn the pilot of an impending fuel flow interruption. The lights were mounted at the base of the windshield divider post and illuminated when the fuel level in the right or left tank outlet dropped to a point where a fuel flow interruption and engine power loss could occur. The warning light remained on for at least 10 seconds, and remained illuminated if fuel flow was not restored.

1.14.5 Aircraft fuel status

Records from the refuelling agent showed that ZGZ had been replenished with 305 L of fuel at Emerald on 26 October 2006, the day after the aircraft arrived from Gladstone, and before the maintenance activities and test flying segments were carried out. That amount of fuel was sufficient for about 2 hours flying[12]. The evidence of extensive fire at the accident site confirmed that there was substantial fuel on board the aircraft at impact.

1.14.6 Aircraft handling

The spiral dive

A spiral dive is an unstable flight condition involving a descending turn with accelerating speed. The phenomenon is often associated with flight in conditions where the pilot's reference to the outside visual horizon is reduced or prevented by cloud or darkness. It can also arise following failure of the attitude indicator instrument in the cockpit when the pilot does not recognise the situation by reference to other flight instruments.

Because the physical forces exerted on an aircraft during a spiral dive are effectively balanced, the human body cannot readily detect the condition, particularly during its initial stages. The situation can arise where the pilot detects the aircraft's acceleration, but not its bank attitude. If the pilot responds by applying back pressure on the control yoke to pitch the nose up, the effect can be to tighten the spiral and increase the rate of acceleration.

Successful recovery from a spiral dive involves closing the throttles to reduce the rate of speed increase and rolling the aircraft so that the wings are parallel to the horizon before initiating recovery from the dive. Any factor that affects the pilot's ability to determine the aircraft's attitude with reference to the earth's surface could delay or prevent recovery.

Engine failure during descent

Anecdotal evidence from experienced PA-31-350 pilots indicated that engine failure during descent at 170 to 180 kts would be a comparatively benign and easily controlled event. The reasons for that included the inherent directional stability of the aircraft at higher speeds and lower asymmetric power effect because of the

[12] The distance from Emerald to Gladstone direct equated to about one hour ten minutes flying time in the PA-31-350 at normal operating speeds.

reduced engine power settings during descent. An emphatic view was that, unless grossly mishandled, an engine failure during descent would not lead to a loss of aircraft control.

ANALYSIS

2.1 Occurrence dynamics

The extreme nose-down attitude and high speed ground impact of the Piper Aircraft Corporation PA-31-350 (Chieftain) were symptomatic of an event that disturbed the aircraft from normal controlled flight and from which recovery was not achieved.

The absence of any on-board recording device meant that only limited information was available regarding the behaviour of the aircraft between the change in radar signature data and ground impact. Further, the nature and extent of fire and impact damage to the aircraft severely limited the information available from the wreckage to the investigation. Nevertheless, there was sufficient information from the wreckage and other sources to allow some conclusions to be drawn. Those are discussed below.

Because the aircraft's extremities and control surfaces were accounted for at the accident site, the possibility that a structural failure of the airframe occurred was considered remote. However, a malfunction of the flight controls, such as a jammed control, could not be excluded because the state of the wreckage precluded a full examination of the flight control system.

The available recorded radar and voice transmission information provided no indication of any aircraft abnormality. The continuation of recorded radar data, albeit incomplete after the aircraft diverged from steady flight at 4,500 ft, indicated that the aircraft's transponder continued to function during that period. That information indicated that the aircraft's electrical system was functioning.

The impact attitude of the aircraft was well beyond the pitch limits within which passenger-carrying aircraft such as the Chieftain are normally operated. The proximity of the last radar contact and the wreckage location indicated that a very steep descent, consistent with the impact attitude, was possible. Assuming that radar data ceased at the moment of impact, the average rate of descent of the aircraft during the final 40 seconds of flight was approximately 6,000 ft per minute. That rate was consistent with the aircraft being in a very steep descent.

The X and Y axis position information in the final 40 seconds of radar data indicated that the aircraft turned left through about 270 degrees during that time. The splay of wreckage to the right of the aircraft's heading at impact indicated that the aircraft was turning left and skidding right when it struck the ground. Those two pieces of evidence, in combination with the high speed and steep nose-down attitude at impact, suggested that the aircraft may have been in a left hand spiral dive. The witness evidence of the engine sound 'roaring and shutting off again' a few times could have been due to the Doppler effect as the aircraft travelled towards and away from the witness during a spiral dive.

2.2 The weather

The recorded radar information and voice transmissions confirmed that the pilot diverged left of track to avoid weather and then gradually returned to the Emerald to Gladstone track. While the aircraft may have flown through cloud and rain areas, there was no indication that the weather had any adverse effect on the aircraft's performance. The recorded weather radar information showed that there were no areas of heavy precipitation (indicative of thunderstorm cells) along the aircraft's track. In particular, there was no significant weather or lightning strike activity in the area where the accident occurred. On that basis, the likelihood that turbulence or lightning events associated with thunderstorm activity contributed to the accident was considered low.

From the ground witness reports of conditions in the accident area, it is very likely that the aircraft was in cloud for at least some, if not all, the time from when it diverged from its steady flight path until ground impact. The absence of an outside visual reference under those circumstances would have made any task of requiring recovery of the aircraft to normal flight extremely difficult compared to conditions where an outside horizon was visual.

2.3 The pilot

The pilot's experience level on the aircraft type was low, possibly limiting his proficiency in, and familiarity with, the aircraft's on board systems and handling characteristics. His night and instrument flying experience (assuming that his flying rate between December 2004 and October 2005 was similar to that of previous years) was also low. Those circumstances may have limited the pilot's capacity to deal with an emergency situation in the Chieftain. An emergency situation involving an in-flight upset would have further increased the complexity of the task confronting the pilot.

The engine sound fluctuations reported by the witness could have arisen if the engines were operating on the outboard tanks and the fuel in those tanks reached a level low enough to cause engine rough running before the main tanks were selected. If one engine lost power, the pilot would have been required to manage the resultant yaw (which should have been relatively benign at descent engine power settings) and rectify the fuel tank selection. If the other engine lost power at about the same time, the asymmetric situation could have been more demanding if one engine surged as the fuel supply was restored. Depending on the actual engine power settings and timings of any fuel supply interruptions, it is possible that a high workload situation could have developed in a very short timeframe. Under those circumstances, the pilot's experience on the aircraft may have limited his ability to prevent the aircraft from entering an unusual or extreme attitude.

A further possibility was that the autopilot malfunctioned. Assuming that the pilot was operating the aircraft with the autopilot engaged, it is possible that, around the time the aircraft diverged from steady flight, he disconnected the autopilot to manually fly the aircraft in preparation for the approach and landing at Gladstone. If a fault had developed causing the elevator to be out-of-trim, the resultant force could have been contained by the autopilot pitch trim servo. Under those conditions, the situation might not have been apparent to the pilot until the autopilot was disconnected or when the pitch trim servo could no longer hold the out-of-trim force. In either case, the aircraft could have suddenly pitched nose-up or nose-down, possibly leading to loss of control of the aircraft. The difficulty confronting the pilot under those circumstances might have been increased if he found that corrective action required the autopilot or the electric trim circuit breaker to be pulled. The location and operation of those controls on the left cockpit side panel, and the lighting available in that area, may have diverted the pilot's attention and slowed his response at a critical time.

The investigation considered the possibility of pilot incapacitation. Any physiological issue involving the pilot in command was likely to have been noticed by the right seat occupant, who knew the pilot in command well and often flew with him. The right seat occupant was a qualified pilot who had multi engine experience and some instrument and night flying experience. He also had some familiarity with the aircraft. The investigation concluded that, in the event of the pilot in command being incapacitated, the right cockpit seat occupant was probably capable of maintaining control of the aircraft, at least to the extent of preventing it from entering a spiral dive.

2.4 The aircraft's engines

Evidence of turbocharger rotation at impact provided conclusive evidence that both engines were operating at impact. The blade pitch angle of the propellers at impact and the engine tachometer examination results supported that conclusion. The difference in ground signatures from the engine/propeller impacts was attributed to each propeller being subjected to different dynamics during impact. Those arose because the propellers rotated in opposite directions and because the aircraft was yawing at impact, meaning that the propellers did not contact the ground at the same time or in the same direction of travel.

The engine operating checks conducted during the test flight before the aircraft departed Emerald, the performance of the aircraft during the accident flight, and the absence of any report from the pilot indicated that the engines were functioning normally during the flight. Those facts also indicate that the series of engine starting and operating issues that arose after the owner took delivery of the aircraft had been satisfactorily addressed. It appears unlikely, therefore, that the engine starting and operating issues affected the operation of the engines during the accident flight.

FINDINGS

From the evidence available, the following findings are made with respect to the loss of control event involving Piper Aircraft Corporation PA-31-350 aircraft registered VH-ZGZ and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The aircraft diverged left from a steady, controlled descent and entered a steep, left spiral descent from which recovery was not achieved.

Other safety factors

- The dark and very likely cloudy conditions that existed in the area where the aircraft suddenly diverged from its flight path meant that recovery to normal flight could only have been achieved by sole reference to the aircraft's flight instruments. The difficulty associated with such a task when the aircraft was in a steep descent was likely to have been significant.

SAFETY ACTION

In February 2006, the ATSB issued a safety recommendation to the Civil Aviation Safety Authority (CASA) regarding the carriage of on-board recording devices in Australian registered aircraft as a consequence of technological developments. That recommendation followed the investigation of an in-flight break-up where the absence of recorded information regarding the behaviour of the aircraft limited the extent of the investigation. That recommendation, along with the CASA responses, is reproduced below.

Recommendation 20060004

The Australian Transport Safety Bureau recommends that the Civil Aviation Safety Authority (CASA), review the requirements for the carriage of on-board recording devices in Australian registered aircraft as a consequence of technological developments.

CASA Response – 11 May 2006

The Civil Aviation Safety Authority will analyse the cost benefit of the recommendation regarding the carriage of on-board recording devices to this type of operation.

CASA Response – 23 November 2008

As you would be aware, there has been extensive liaison between CASA and the ATSB on this matter over the last twelve months. I can now advise that CASA has completed its cost benefit analysis (CBA). The CBA results confirm CASA's initial view that there is no justification to mandate the carriage of recording devices in smaller aircraft. The analysis considered 7 categories of small aeroplane operations, from Low Capacity RPT and Charter, down to aerial work, business and private operations and did not find fitment justified on safety grounds.

CASA believes that the safety regulator's focus should be on passenger carrying operations and preventing accidents by fitment of new generation technologies such as Airborne Collision Avoidance Systems, Terrain Avoidance and Warning Systems and Automatic Dependent Surveillance Broadcast equipment, rather than mandating fitment of OBR devices to assist in determining the cause of an accident.

The CBA determined that the industry was unlikely to make this investment on its own accord. The use of quick access recorders by larger airlines provides considerable economic and business benefits which outweigh the costs involved. With the recent emergence of low cost and light weight recorders for small aircraft it is expected that the take up of recorders may gather momentum over the next couple of years once suppliers become more active in the market and prices come down. In the interim, CASA will be monitoring voluntary fitment of OBRs.

Recommendation status: Closed-Accepted

APPENDIX A : SOURCES AND SUBMISSIONS

Sources of information

The sources of information during the investigation included:

- the aircraft owner
- organisations that conducted maintenance on the aircraft
- the aircraft's maintenance records
- the aircraft manufacturer
- the Bureau of Meteorology
- Airservices Australia
- pilot logbooks
- pilots that had previously flown the aircraft.

Submissions

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

A draft of this report was provided to:

- the Civil Aviation Safety Authority (CASA)
- the aircraft owner
- the maintenance organisations
- Bureau of Meteorology
- Airservices Australia

Submissions were received from CASA and the Bureau of Meteorology. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.