



Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT

Aviation Occurrence Investigation – 200701033

Final

**Loss of Control
Clyde North, Victoria
23 February 2007**

Van's Aircraft Inc. RV-4, VH-ZGH



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Abstract

On 23 February 2007, the owner-pilot of a Van's Aircraft Inc RV-4 aircraft, registered VH-ZGH, was observed conducting aerobatic manoeuvres in the designated Moorabbin aerobatic area over Clyde North. At approximately 1740 Eastern Daylight-saving Time, witnesses observed the aircraft descending in a spin after completing a stall turn. The aircraft then appeared to enter an unstable spiral dive and, at approximately 500 m above the ground, pieces were observed separating from the aircraft. The aircraft was seen to impact the ground almost vertically and was destroyed by impact forces and a post-impact fire. Both occupants were fatally injured.

The investigation found that the pilot probably lost control of the aircraft performing an aerobatic manoeuvre, and entered a spin from which he was unable to recover. The investigation also found that the pilot performed manoeuvres in an aircraft that was loaded above the maximum weight limit for aerobatic flight, and with the centre of gravity outside the rear limit.

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 bodies.

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

Sequence of events

On 23 February 2007, at approximately 1710 Eastern Daylight-saving Time¹, the owner-pilot of a Van's Aircraft Inc. RV-4 aircraft (RV-4), registered VH-ZGH, departed Essendon Airport, Vic. with one passenger on board. The flight was to the designated Moorabbin aerobatic area over Clyde North (Figure 1).

Witnesses observing the aircraft reported that, at approximately 1740, they saw it descending in a spin after completing a stall-turn². The engine was heard to gain power during the spin, and the aircraft's speed rapidly increased before it entered what appeared to be an unstable spiral dive. At approximately 500 m above the ground, while the engine noise was very high-pitched and loud, objects were seen to separate from the aircraft. The rapid spiral descent continued and the aircraft was observed to impact the ground almost vertically. The aircraft was destroyed by impact forces and a post-impact fire. Both occupants were fatally injured.

Figure 1: Moorabbin aerobatic area in red box. The accident site is indicated by the red arrow.



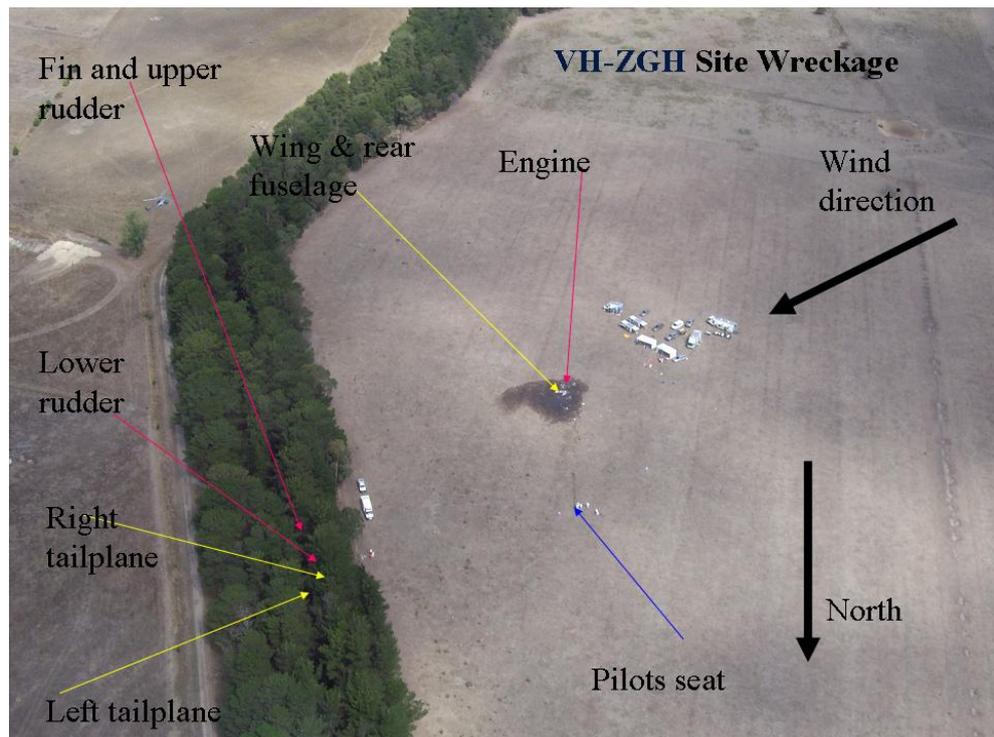
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- 1 The 24 hour clock is used in this report to describe the local time of day, Eastern Daylight-saving Time (EDsT), as particular events occurred. Eastern Summer Time was Coordinated Universal Time (UTC) + 11 hours.
 - 2 Flight manoeuvre in which an aircraft is pulled up into a very steep climb, usually with reduced engine power, until, on the point of aerodynamic stall, full rudder is applied to cause rapid rotation to the left or right, then once the rotation is stopped the aeroplane is pointed vertically downwards.

Accident Site

The terrain at the accident site was flat and open. An examination of the site revealed the aircraft had impacted the ground in a very steep, nose-down attitude at high speed.

Both right and left tailplanes, the fin and rudder were recovered in trees approximately 117 metres from the main aircraft impact point (Figure 2). The left and right elevator balance weights were recovered either side of the burnt area of the accident site.

Figure 2: Accident site



The force of the impact and the subsequent fire resulted in disintegration of the aircraft (Figure 3). As a result, no instrumentation was able to be recovered from the wreckage. An examination of the engine and propeller showed that the engine was developing significant power at the time of impact.

The ground marks and twisting of the tailplane rear spar indicated the aircraft had been rotating in a clockwise direction at the time of impact. Examination of the separated tail structures (Figure 4) showed twisting and tearing of the attachment fittings.

Figure 3: View of wreckage



Figure 4: Fin, rudder, and tailplanes with the spars and elevators loosely assembled after recovery.



The pilot

The pilot held a valid private pilot (aeroplane) licence issued on 23 October 2006 and a valid Class 1 medical certificate with the endorsement 'renew by the Civil Aviation Safety Authority (CASA)'. At the time of the accident, the pilot had accrued approximately 279 hours total flying time in powered aircraft, including approximately 22.7 hours in VH-ZGH.

The pilot held endorsements for single-engine aeroplanes under 5,700 kg maximum take-off weight, tail-wheel aircraft, and variable pitch propeller. He held a night visual flight rules rating and a logbook endorsement for a number of aerobatic manoeuvres (see training section below).

The pilot's logbook indicated his first solo flight in VH-ZGH, a steerable tail-wheel aircraft, was on 11 November 2006 and lasted 1.2 hours.

Training

The pilot had undergone flying training for a commercial pilot (aeroplane) licence (CPL) since 24 February 2006. This flying training began in Victoria, with the last 6 weeks of training conducted in Queensland.

On 19 November 2006, after 7.6 flying hours of instruction, the pilot received his tail-wheel endorsement for the landing and ground manoeuvring of aircraft with a steerable tail-wheel.

On 18 February 2007, the pilot was issued with a logbook endorsement for loop, aileron roll, stall-turn, and wingover manoeuvres, after 4 hours of aerobatic flight training. The pilot did not complete a full aerobatic training course that would have included vertical rolls and spins due to inclement weather and his other training commitments. The aircraft type used for the aerobatic training was a Pacific Aerospace Corporation Ltd CT/4A.

The pilot's aerobatics instructor reported that he had briefed the pilot on the need to find an instructor experienced with the RV-4 aircraft or similar, to undergo spin training and ensure his technique was appropriate for that aircraft type. The pilot reportedly agreed to arrange appropriate training.

The instructor also reported that he had shown the pilot Civil Aviation Order (CAO) 40.0 subsection 2 *Conditions on aeroplane pilot licences* which prohibits a pilot from conducting aerobatic flight unless they hold a spin recovery endorsement.

There was no entry in the pilot's logbook indicating any formal training on the RV-4, although the previous owner of VH-ZGH took the pilot for a 1.5 hour flight during August 2006. He also informed the pilot of the aircraft's structural limitations and that it was easy to exceed the V_{ne}^3 of 183 kts as marked on the airspeed indicator.

3 The V_{ne} or 'never exceed speed' is the speed which should never be exceeded due to risk of structural failure. This speed is specific to the aircraft model, and represents the limit of its performance envelope.

Other events

During the investigation, the Australian Transport Safety Bureau was advised of the following events.

During November 2006, the pilot had been observed by another pilot carrying out aerobatic manoeuvres in VH-ZGH close to the ground at the training area between Hamilton, Vic and Dunkeld, Vic. Aerobatic flight below 3,000 ft is prohibited by the Civil Aviation Regulations without specific permission from the Civil Aviation Safety Authority.

On 21 February 2007, at approximately 2130, the pilot departed Moorabbin Airport in VH-ZGH. He intended to fly to Hamilton Airport, but was forced to land at Stawell Airport, Vic. because of bad weather. The aircraft was not fitted with the required instrumentation for night visual flight rules (VFR) flight. The pilot's logbook indicated that the flight was for 1.5 hours at night.

On the morning of 22 February 2007, the pilot was observed by a flying instructor flying VH-ZGH into Hamilton Airport in weather assessed as being below the minimum visual meteorological conditions⁴ (VMC).

Weather conditions

At the time of the accident, the wind was reported to be a south to south-westerly wind of 5 to 15 kts blowing over the eastern seaboard of Port Phillip Bay, Vic. Witnesses located near the accident site reported that the skies were clear.

⁴ Visual meteorological conditions (VMC) are those in which visual flight is permitted. In VMC pilots have sufficient visibility to fly while maintaining visual separation from terrain, weather, and other aircraft.

Aircraft information

Figure 5: VH-ZGH



VH-ZGH was an amateur-built aircraft constructed in Australia in December 1994 and had accumulated an estimated 474.6 flying hours at the time of the accident. It was powered by a Lycoming AIO-360-H1A engine, driving a constant-speed propeller. The maximum fuel capacity was 118 litres of Avgas carried in two wing tanks.

On 2 March 2005, an experimental certificate (which superseded the original certificate of airworthiness) was issued at the previous owner's request. VH-ZGH had been owned by the accident pilot since 28 August 2006.

Recent maintenance

On 24 November 2006, the pilot flew the aircraft from Hamilton Vic. to Moorabbin Airport with bent propeller blades after tipping it on its nose while taxiing. The time recorded in the pilot's logbook was 1.2 hours. The incident was not reported to the Australian Transport Safety Bureau at that time.

On the same day, the pilot engaged a maintenance organisation at Moorabbin Airport to carry out a damage assessment of the propeller. The maintenance organisation reported the propeller had sustained substantial damage. The propeller had to be removed and the engine disassembled for examination and repair. The vibration caused by the damaged propeller during the flight to Moorabbin necessitated repairs to the engine mounts.

While at Moorabbin, the aircraft was fitted with electrically operated flaps, and a set of removable rudder pedals were also fitted to the rear cockpit.

A periodic inspection was completed on 21 February 2007 and a maintenance release was issued for the aircraft that was valid until 21 February 2008 or at 570.61 aircraft hours. It was reported that the pilot had left the maintenance facility with

the aircraft logbook for the aircraft. Since the accident, the aircraft logbook has not been located by the Australian Transport Safety Bureau.

Structural integrity

The structural integrity of the separated tail aerofoil sections (Figure 4) was assessed against the original approved construction drawings. This showed that the tailplanes and the fin and their attachments were compliant with the design specifications.

Aircraft experimental certificate

Amateur-built aircraft do not have to comply with any airworthiness or crashworthiness standards. The responsibility for the airworthiness of an experimental aircraft rests with the builder or subsequent owner. Accordingly, a placard is required to be fitted in experimental aircraft which states:

Warning. Persons fly in this aircraft at their own risk. This aircraft is not operated to the same safety standards as a normal commercial passenger flight. CASA does not set airworthiness standards for experimental aircraft.

Placards bearing this warning were fitted in the front and rear cockpit of VH-ZGH.

Aircraft weight and balance

Weight and balance limitations and cautions were contained in the Pilot's Operating Handbook (POH). These limitations defined the gross weights and design centre of gravity limits (C of G). The maximum take-off weight of VH-ZGH for normal flight operations was 680 kg and for aerobatic manoeuvres was 625 kg.

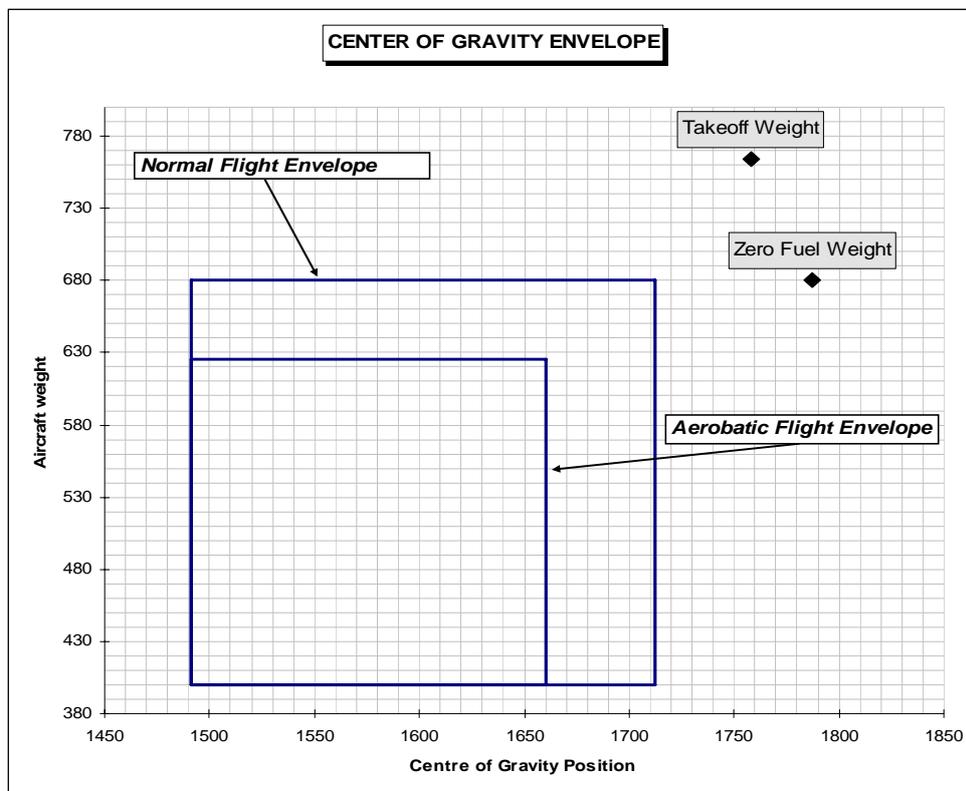
The C of G range for VH-ZGH was referenced to a datum located 1,270 mm forward of the wing leading edge. The C of G range for normal flight was between 1,491mm (forward limit) and 1,711 mm (rear limit) to the rear of the datum. The rear C of G limit for aerobatic manoeuvres was 1,660 mm rear of the datum.

The aircraft empty weight was 455 kg. The combined weight of the pilot and passenger on the final flight was estimated to be 195 kg. The fuel tanks had been filled at Essendon Airport prior to the accident flight, bringing the fuel quantity to 118 litres (84 kg). Baggage weight was estimated to be 30 kg. Maximum allowable baggage weight was 16 kg.

Based on the above weights, the take-off weight of VH-ZGH on its final flight was calculated to be 764.5 kg. This exceeded the maximum allowable weight for normal flight operations by 84.5 kg and for aerobatic operations by 139.5 kg. In addition, the centre of gravity at this weight was determined to be at 1757.9 mm, which was 97.9 mm outside the limit permitted for aerobatic manoeuvres.

Figure 6 shows the C of G envelope for normal and aerobatic flight in VH-ZGH. Also plotted for the accident flight is the zero fuel weight (aircraft fully laden but without fuel) and the take-off weight (aircraft fully laden with fuel added). The diagram indicates that both the zero fuel weight and the weight of the fuelled aircraft on the accident flight were well outside the envelope for safe flight.

Figure 6: Centre of gravity envelope for VH-ZGH



Aircraft operating limitations

The pilot's operating handbook issued for this aircraft detailed a number of operating limitations.

Aerobatic manoeuvres were permitted within certain limitations, providing the aircraft weight did not exceed 625 kg and the rear C of G limit was not more than 1660 mm behind the datum.

The never exceed airspeed (Vne) was 183 kts. The manoeuvring speed of 115 kts was the maximum speed at which full and abrupt control movement was permitted. There were also recommended entry speeds for various aerobatic manoeuvres.

Previous occurrences

There have been no previous reported occurrences of this type recorded whereby the tailplanes, fin, and rudder separated during flight from a Van's RV-4.

ANALYSIS

With the rear centre of gravity (C of G) calculated to be 97.9 mm outside the limit permitted for aerobatic manoeuvres, positive control about the pitch and yaw axis of VH-ZGH was diminished.

With the C of G behind the rear limit, the moment arm of the rudder would be reduced, making the rudder less effective at stopping the aircraft from spinning. This would be further compounded because the aircraft was overweight, resulting in a higher stalling speed. Recovery from a spin with the C of G so far to the rear of the approved limits (Figure 6) was untested and likely to be difficult or impossible.

The engine was heard to gain power during the spin before the aircraft entered an unstable spiral. This would have caused gyroscopic moments from the rotation of the engine and propeller to be introduced, which may have further inhibited spin recovery.

When an aircraft enters a fast, tight spiral with engine power applied, the aerodynamic and inertial forces acting on the airframe increase significantly. If unchecked, these high structural stresses can rapidly overload the aircraft's aerodynamic surfaces, leading to eventual failure.

The pilot had conducted training in a number of aerobatic manoeuvres but had not completed the spin recovery training required prior to conducting aerobatics.

FINDINGS

Contributing safety factors

- The pilot performed manoeuvres in an aircraft that was loaded above the maximum weight limit for aerobatic flight and with the centre of gravity outside the rear limit.
- The pilot probably lost control of the aircraft performing an aerobatic manoeuvre and entered a spin from which he was unable to recover.
- The aircraft structure failed as the result of the aircraft exceeding its design limits during aerobatic manoeuvres.

Other safety factors

- The pilot conducted aerobatics without completing the required spin recovery training.