Australian Government
Australian Transport Safety Bureau

Collision with terrain involving Van's RV-6A, VH-JON

8 km south of Moorabbin Airport, Victoria | 14 October 2014

Investigation

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Addendum

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Safety summary

What happened

VH-JON

Source: Supplied

On the afternoon of 14 October 2014, the pilot/owner of an amateur-built Van's Aircraft Inc. RV-6A aircraft, registered VH-JON and operated in the 'experimental' category, departed Moorabbin Airport, Victoria on a local flight.

Shortly after reaching a cruise altitude of 2,900 ft, the aircraft descended to 2,500 ft. After that time, no further air traffic control radar returns were received from the aircraft. The aircraft descended rapidly and a witness reported observing objects falling from the aircraft. The aircraft subsequently collided with the ground next to a house in the suburb of Chelsea, 8 km south of Moorabbin. The pilot was fatally injured and the aircraft was destroyed.

Following the accident, members of the public found a number of aviation-related items away from the accident site that belonged to the pilot.

What the ATSB found

The liberation of the items from the aircraft's interior indicated that the canopy likely opened in-flight. However, this was based on the assumption that the items were initially inside the cabin.

Examination of the primary and secondary canopy locks found varying degrees of damage and one component was missing. Therefore, the state of the locking mechanisms prior to the impact could not be established.

It was possible that the pilot was startled and distracted after the canopy opened due to the severe cockpit wind, noise and debris flying about. Though, the extent to which this contributed to the occurrence was unknown.

Also, while the ATSB was unable to determine how the canopy opening would have affected aircraft control, there were indications that the pilot was attempting to respond to the situation. However, for reasons undetermined, recovery did not occur.

Finally, the ATSB identified a safety issue regarding the potential for the in-flight opening of a tip-up, forward-hinged canopy to result in a significant pitch down tendency in a number of Van's Aircraft Inc. models that may affect aircraft control.

What's been done as a result

Van's Aircraft Inc. developed a service letter for distribution to builders and operators highlighting the varying consequences of a canopy opening in-flight, in particular, involving a tip-up canopy. The letter recommends inspecting the canopy locking mechanism to confirm that it operates as designed and to ensure the mechanism fully engages when closed, and highlights the need to secure the secondary latch at the top-rear of the canopy in the RV-6/7/9 design prior to take-off.

Additionally, the ATSB has issued a safety advisory notice to all owners of Van's aircraft to highlight the findings of this investigation.

Safety message

This accident and other reported experiences highlight the varying consequences when a canopy opens in-flight from no effect to a sudden pitch down. The result can vary from being relatively benign to significant, but pilots could expect an element of startle and distraction. Additionally, the ATSB reminds pilots to check the security of the canopy prior to take-off.

Contents

The occurrence

On the afternoon of 14 October 2014, the pilot/owner of an amateur-built Van's Aircraft Inc. (Van's) RV-6A aircraft, registered VH-JON (JON) and operated in the 'experimental' category, departed Moorabbin Airport, Victoria on a local flight.

The aircraft departed at about 1323 Eastern Daylight-saving time[1] and was identified on Airservices Australia surveillance radar tracking southbound toward the coast. The wind conditions at the time were 17 kt from the south-south-east. At about 1325, the aircraft reached an altitude of 2,900 ft. Shortly after, at 1326, the aircraft descended to 2,500 ft. After that time, no further radar returns were received from the aircraft.

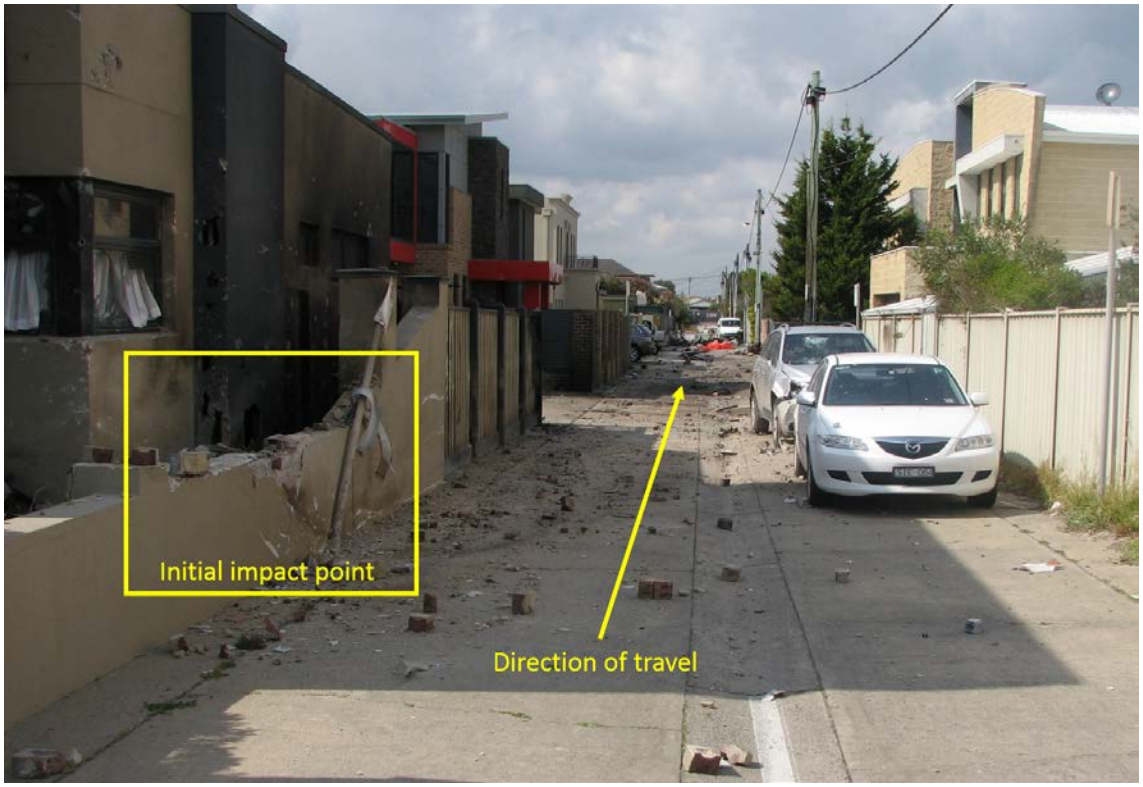
A witness reported observing the aircraft banking and seeing objects falling, like 'packages' were being 'dropped'. The aircraft's wings then became level. Another witness also reported sighting the aircraft banking and then becoming level. Both reported that the aircraft was descending rapidly. The aircraft subsequently collided with the ground in a laneway next to a house in the suburb of Chelsea, 8 km south of Moorabbin (Figure 1).

The pilot was fatally injured and the aircraft was destroyed. A number of small post-impact fires were extinguished and a number of houses and cars sustained damage.

Members of the public reported finding a number of aviation-related items belonging to the pilot. These items were recovered at distances of up to 3 km north of the accident site.

Examination of the recorded air traffic control radio frequencies revealed no emergency broadcast from the pilot.

Figure 1: Accident site from the initial impact point on the left, looking south down the laneway



Source: ATSB

[1] Eastern Daylight-saving Time (EDT) was Coordinated Universal Time (UTC) + 11 hours.

Context

Pilot information

The pilot held a Private Pilot (Aeroplane) Licence that was issued on 24 September 1985.[2] As at 2 October 2014, the pilot had a total flying experience of 1,659 hours.

The pilot held a valid Class 2 Aviation Medical Certificate and was required to wear distance vision correction and have vision correction available for reading. The pilot was reported to have been well rested and in good health prior to the accident.

The pilot's post-mortem examination found amyloid deposition[3] in the heart, which was often considered age-related. However, the role of this and any other natural disease in the development of the occurrence could not be established. Furthermore, there was no evidence to suggest that fumes, smoke, or fire had affected the pilot prior to the impact. The pilot's clothing did not show any obvious evidence of grease or foreign materials such as bird feathers from a birdstrike.

Aircraft information

The Van's Aircraft Inc. (Van's) RV-6A is a kit-built aircraft with a low-wing and fixed undercarriage. VH-JON (JON) was constructed by the pilot and registered with the Civil Aviation Safety Authority on 4 July 2003 (Figure 2). A review of the aircraft's logbook and other related documentation indicated that JON was maintained in accordance with an approved Civil Aviation Safety Authority maintenance schedule. The last periodic inspection was conducted on 1 July 2014, at which time the total time in service was about 338 hours for the airframe and 201 hours for the engine. The last oil change occurred on 30 September 2014. At the time of the occurrence, all of the required maintenance had been completed and there were no defects recorded.

Figure 2: JON showing the tip-up canopy in the open position

Source: Supplied

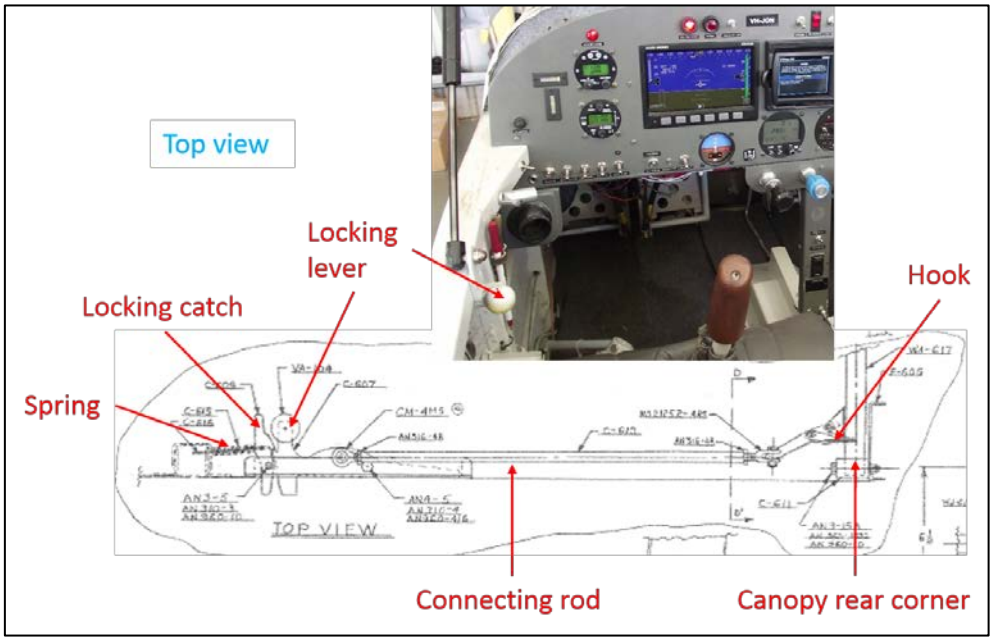
[2] The pilot also held a Commercial Pilot (Aeroplane) Licence, but because their Class 1 Aviation Medical Certificate was out-of-date, could not perform flying duties associated with this licence.

[3] A disorder caused by deposits of an abnormal protein in the heart tissue.

Tip-up canopy

Although the Van's RV-6 could be installed with aft- and forward-hinged canopies, JON was fitted with a forward-hinged 'tip-up' canopy (Figure 2), which had two locking mechanisms. The primary locking mechanism was operated by a locking lever located on the left side of the fuselage, adjacent to the pilot's seat. When placed into the locked position, a connecting rod from the lever latched two hooks into corresponding receptacles in the two rear corners of the canopy. The lever was then locked by a spring-loaded locking catch (Figure 3 and Figure 4).

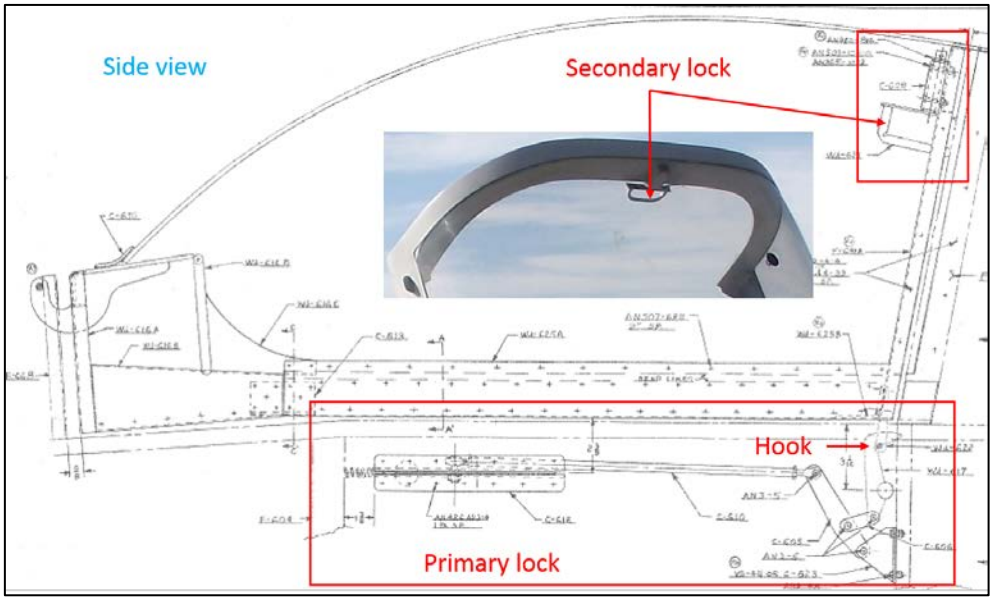
Figure 3: Van's Aircraft Inc. diagram showing the primary canopy locking mechanism from the top view in the locked position (labelled in red). The locking lever in JON is shown in the photograph at inset



Source: Van's Aircraft Inc. and supplied, both modified by the ATSB

The secondary mechanism was a handle attached to the centre of the canopy frame, which was also used to assist with closing (Figure 4). Once closed, the handle was turned 90° so that a tang on the end of the handle extended under the adjacent fuselage frame. This provided redundancy in the event the main locking mechanism malfunctioned.

Figure 4: Van's Aircraft Inc. diagram from the side view showing the primary and secondary locking mechanisms. The secondary lock attached to JON is shown in the photograph at inset



Source: Van's Aircraft Inc. and supplied, both modified by the ATSB

Previous occurrences involving JON

A search of the ATSB's occurrence database revealed that JON was involved in two previous landing accidents. One in 2007 and in 2010. On both occasions, the engine was replaced, the damage repaired and the aircraft returned to flying status.

The aircraft was also involved in an incident about 1 month prior to the October 2014 accident. It was reported that a minor engine fire occurred on the ground at Moorabbin due to over priming the engine for a 'hot start'.[4] The fire was extinguished with the assistance of ground personnel. The pilot reportedly conducted an inspection of the engine and associated area, with nil damage found. Several flights were conducted since that time and it could not be established if the fire contributed to the occurrence south of Moorabbin Airport on 14 October 2014.

Recorded information

The aircraft was fitted with two Garmin global positioning system (GPS) units, a Dynon EMS-D120 engine monitoring system and a Dynon EFIS-D100 electronic flight information system. The aircraft's track on the day was recovered from recorded data from one of the GPS units and was consistent with the Airservices Australia surveillance radar track (Figure 5).

The Dynon D100 system did not provide any recorded data, but the D120 system recorded a number of engine parameters and the fuel level in each wing. The data was downloaded by the ATSB and captured the accident flight up until 1326:09, several seconds before the impact with terrain. Specifically, the data showed:

- Up until 1325:52, the engine data appeared stable and the oil pressure remained normal at around 75 pound per square inch (psi). After this, the pressure fluctuated to as low as 34 psi (Figure 5). By the last second of the recorded data, the pressure increased to 72 psi. The fluctuations likely resulted from a sudden change in aircraft attitude temporarily disrupting the oil supply in the oil sump.

[4] A start, or attempted start of the engine after it had been recently run.

- An analysis of the recorded fuel levels indicated that, at around the same time the oil pressure began to fluctuate, the fuel levels diverged at a rate higher than previously recorded. This was possibly due to an abrupt roll[5] to the left or acceleration in yaw.[6]
- Until 1326:00, the propeller revolutions per minute (RPM) was relatively constant at 2,405 RPM. Immediately after, it reduced for 1 second and then increased to 3,069 RPM over the next 3 seconds. From 1326:05 until the recording ceased, the RPM stabilised, indicating that the propeller governor was functioning as required. The variation in RPM was also likely the result of a change in the aircraft's attitude.
- At 1326:00, the engine manifold pressure was recorded as 26.625 inches Hg. After this, it reduced to as low as 4.6875 inches Hg. This coincided with a reduction in fuel pressure and was representative of the pilot reducing the engine power to idle (Figure 5).
- The exhaust gas temperatures were stable, but decreased with the reduction in manifold pressure, which would be expected.

Figure 5: Downloaded GPS track, and the position of the first oil pressure fluctuation and reduction in engine manifold pressure

Source: Google earth, modified by the ATSB

Wreckage and impact information

Examination of the wreckage found that the aircraft initially impacted a house fence at a descent angle of about 35° and slightly left wing down. Images recovered from a nearby closed-circuit television camera showed the last seconds of the flight and confirmed a steep nose-down flight path (Figure 6). The ATSB estimated that, based on the video footage, the aircraft's speed at that time was about 200 kt (370 km/h).

[5] Term used to describe movement of an aircraft about its longitudinal axis.
[6] Term used to describe movement of an aircraft about its vertical axis.

Figure 6: Composite image of the aircraft's descent. The image was developed from sequential video frames to show the aircraft's descent and was used to estimate the aircraft's speed within a 1-second timeframe

Source: Victoria Police, modified by the ATSB

The left wing and top section of the canopy remained at the initial impact point and the remainder of the aircraft continued along the laneway. The propeller, engine, and tail surface also separated from the remainder of the wreckage and were located along the wreckage trail. The right wing and fuselage came to rest about 90 m from the initial impact point. Items associated with the aircraft were located in the laneway up to 130 m away.

A number of fires occurred along the wreckage trail. A number of small, localised fires on the engine were captured by the closed-circuit television footage. The wreckage examination also:

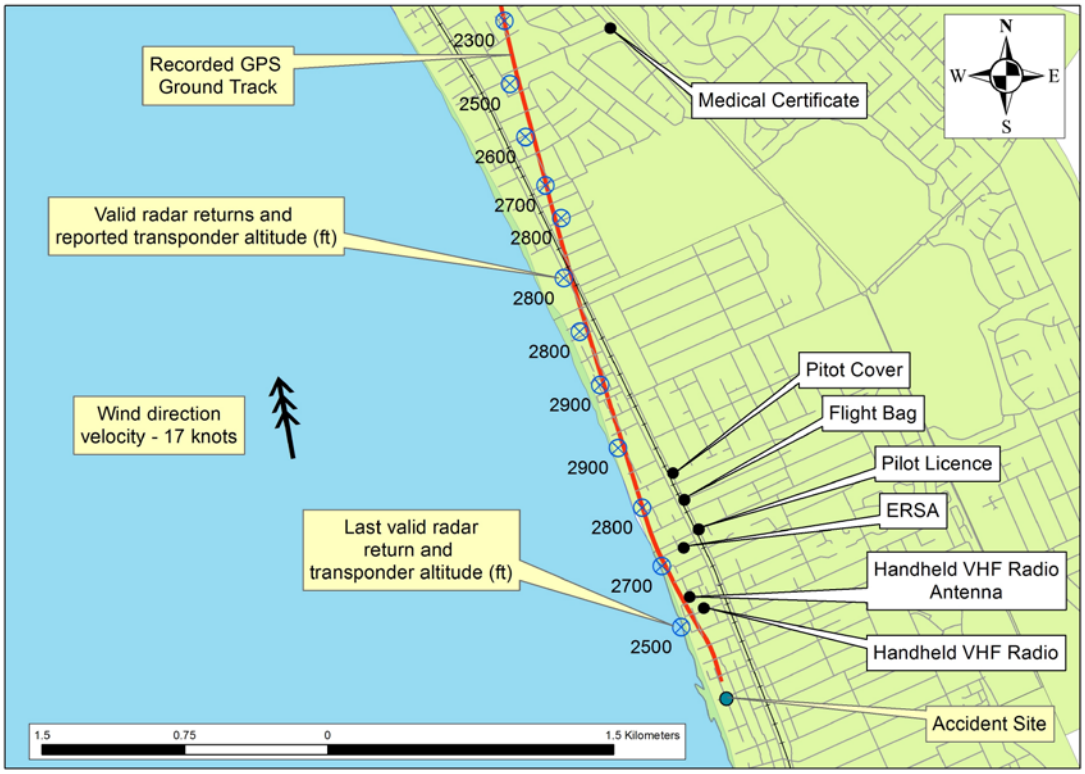
- Identified all flight controls and major aircraft components and established control continuity. The aircraft damage was consistent with the impact.
- Identified parts of the aircraft's canopy at the beginning and along the wreckage trail. The secondary canopy locking mechanism was found in the unlocked position.
- Found evidence of propeller rotation.
- Established that the engine oil hoses and oil filler cap/dipstick were secure, though the dipstick housing had fractured from the impact. Oil was observed over the engine, consistent with impact damage to the crankshaft.
- Found that all fuel hoses were secure; however, a localised area of burning was observed on the fuel hose. The firewall and in-cockpit soundproofing foam also showed evidence of burning.
- Established that the exhaust muffler, air filter and induction system were clear of debris or restriction.
- Established continuity of the engine and propeller cockpit controls.
- Found an oil coating on some sections of the aircraft, including the tail, right wing, fuselage and canopy Perspex. This was likely due to the significant disruption to the aircraft.

The engine was recovered from the wreckage and transported to an approved overhaul facility for detailed inspection under the supervision of the ATSB. The ATSB also conducted further examinations of the engine fuel hose, the engine firewall and part of the canopy locking mechanism at the ATSB's technical facilities in Canberra, Australian Capital Territory.

Recovered items

A number of aviation-related items were found by members of the public at distances up to 3 km north of the accident site (Figure 7). These items included the pilot's Civil Aviation Safety Authority flight crew licence and aviation medical certificate, an aircraft pitot tube cover and warning flag, a flight bag, an En Route Supplement Australia and a very high frequency handheld transceiver and antenna. None of these items displayed evidence of fire damage.

Figure 7: Location of recovered aviation-related items relative to the accident site



Source: ATSB

Test and research

Engine examination

The engine examination found no evidence of internal mechanical failure that would have prevented normal operation prior to the occurrence. Any damage observed was consistent with impact forces.

Fuel hose and engine firewall

Examination of the fuel hose determined that the localised scorching and sooting was limited to the outer fire sleeve. The inner steel braiding and hose showed no evidence of heat or fire damage. A very small breach was observed in the inner hose; however, its position suggested that this was caused by deformation of the hose from impact forces.

Heat testing of a piece of undamaged firewall and in-cockpit soundproofing foam showed that, if a fire was present in the engine bay near the firewall, some smoking could be expected in the cockpit. However, the results of the heat testing indicated that the extent of the fire damage was more likely from the post-impact fire.

Canopy locking mechanism

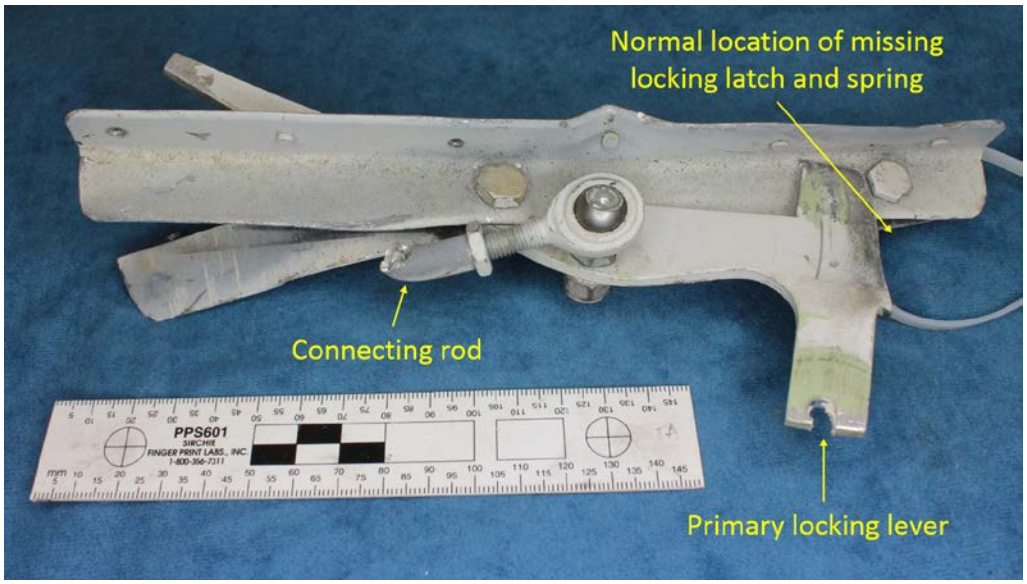
An inspection of the canopy locking mechanism found that the secondary lock was in the unlocked position. There was no evidence to indicate that the lock was forced open.

The primary locking lever was found in the unlocked position, however, the surrounding airframe structure was damaged and deformed. The locking catch and spring were not located, but the corresponding bolt was in place. The two hooks and hook receptacles on the rear corners of the canopy were not damaged or deformed.

Examination of the primary locking lever found that (Figure 8):

- The damage and deformation of the lever suggested that it was initially closed, but was forced out of its housing into a partially-open position at some point during the impact sequence.
- While the locking catch and spring were not found, the attaching bolt was intact. It could not be determined whether the catch fractured during the impact sequence or was not previously in position.
- The locking lever connecting rod fractured in overstress, likely due to the impact. It could not be determined whether those impact forces caused the lever to open.

Figure 8: Primary locking lever, normal location of the missing locking catch and spring, and the fractured connecting rod



Source: ATSB

Related occurrences

ATSB occurrence database

A review of the ATSB's aviation occurrence database identified a range of reports where an aircraft's canopy opened in flight. None of these reports involved the RV-6/6A, RV-7/7A or RV-9/9A model aircraft.

Overseas investigations

On 20 June 2014, a Brumwell (Van's) RV-6 aircraft impacted a house in the United States after departure from cruise flight. A witness reported observing a jet aircraft flying east and a small aircraft flying north. The small aircraft's wings then started 'rocking back and forth' before the 'nose went down'. That witness also reported seeing two objects come from the aircraft. The objects were later found near the accident site. The effects of wake turbulence from the jet aircraft, if any, could not be determined. However, the United States National Transportation Safety Board determined that the exit of the objects from the aircraft's interior indicated that the canopy likely opened in-flight, which led to a loss of pitch control. The safety board was unable to establish the reason for the canopy opening due to fire damage (NTSB report CEN14FA306).

The pilot of an RV-12 aircraft reported that, as the aircraft became airborne, the tip-up canopy opened to about 3 inches (7.6 cm). The pilot reported grasping the canopy and simultaneously lowering the nose of the aircraft and partially reducing engine power in an attempt to land on the remaining runway. As the aircraft pitched down, the pilot lost grip of the canopy and it opened to the full vertical position. This reportedly caused the nose of the aircraft to pitch over further and, when the pilot applied back pressure on the control stick, there was no response from the elevator. The pilot also reported that there was no response from the rudder. The pilot was able to level the aircraft's wings prior to landing hard. The pilot indicated that the canopy latch was hard to latch and they most likely did not secure it properly. Van's commented on the accident, stating that they had not conducted any testing on the aerodynamic effects of the RV-12 canopy opening in flight. Therefore, they could not contest the pilot's claims that the canopy opened to the full vertical position. Van's indicated that they had a reasonable amount of field experience with tip-up canopies opening in flight on the RV-6/6A, RV-7/7A, RV-9/9A models and other incidents involving the RV-12 where no loss of control was reported. They further stated that, while the extent that a canopy opens tends to vary with the aircraft's airspeed, from their experience, the canopy typically opens to a point of aerodynamic equilibrium. At this point, the canopy's position stabilises. This accident was the first reported where the aircraft's pitch authority was affected by a tip-up canopy opening in flight on a Van's aircraft (NTSB report CEN13LA340).

The pilot of an RV-12 aircraft did not secure the canopy latch after entering the cabin. After take-off, the pilot noticed that the canopy was unsecured. The pilot became distracted with securing the canopy as the aircraft descended toward the runway. The aircraft collided with the runway as the pilot attempted to re-establish a level flight attitude. The pilot indicated that the accident could have been prevented had they focused on flying the aircraft instead of attempting to secure the unlatched canopy (NTSB report CEN11LA601).

Pilot forum reports

Anecdotal reports from a number of Van's RV-6 pilots detailed varying consequences from an open canopy in flight. These included:

- An instance when the aircraft was in the cruise at 4,500 ft and about 155 kt. After several minutes, the pilot heard a loud noise or pop and determined that the canopy had opened. The pilot noted that the primary locking lever was in the locked position. The pilot reported that the aircraft 'had a definite pitch down attitude' but was controllable. The pilot reduced the airspeed to about 85–105 kt before closing and re-locking the canopy. The pilot could not recall if the secondary latch was locked, though this would normally be double-checked before take-off.
- A case where the pilot reported not double-checking the secondary latch prior to take-off, but indicated that the primary latch was locked. As the aircraft was climbed through 3,000 ft at 100 kt, the canopy opened. The aircraft was reported to instantly pitch 45°down with lots of wind noise in the cockpit. The pilot reduced power to idle and commenced arresting the descent. The pilot reported a 1,000 ft altitude loss. With the aircraft slowed to 60 kt, the two occupants closed the canopy. The pilot reported that, as a result of this occurrence, they included an additional checklist item to check that the canopy was locked.
- A report from one pilot that they intentionally flew an RV-6A and an RV-7A with the tip-up canopy open during flight testing. The pilot indicated nil effect on the aircraft's handling, other than a high noise level. This pilot further suggested that, from testing, the canopy could be used in place of a non-usable elevator. The pilot indicated that, once their aircraft was slowed and trimmed for level flight, pushing the canopy up caused the aircraft's nose to lower and closing the canopy caused the nose to rise.
- A report of an RV-6A tip-up canopy that came open during cruise at 4,000–5,000 ft and 155-170 kt. When the canopy opened it reportedly 'jerked the stick' out of the pilot's hand and the aircraft began a rapid descent. The pilot attempted to close the canopy but it did not move

until the aircraft was under control and slowed down to near the stall[7] speed. The aircraft was recovered after descending through several thousand feet.

- An instance where an RV-6 aircraft's tip-canopy was reported to have opened twice during flight. The pilot reported that in the first incident they forgot to close and lock the canopy after leaving it open during taxi. During climb-out, the canopy gradually opened as the aircraft's airspeed increased. The pilot reported slowing the aircraft and securing the canopy. On the second occasion, the aircraft was in a 'dive' at about 185 kt when the canopy suddenly opened 'violently' resulting in a pitch down. The canopy was reported to have lifted up before settling at a height of about 18 inches (45.7 cm). The pilot reduced the power to idle and arrested the descent until approaching the stall speed. With some effort, the pilot closed the canopy. After landing, the pilot determined that the secondary lock had been secured, but the primary mechanism had not been completely locked. The pilot felt that with in-flight vibrations, the primary mechanism released and that, due to the descent, the secondary latch had worked its way open.

Van's comments

Van's, the manufacturer of the aircraft kit advised that they were aware of incidents where the tip-up canopy opened on RV-6 aircraft. They reported that this typically happened when the primary and/or secondary locking mechanisms were not engaged. Van's also indicated that:

- While not normal, it may be possible for the primary locking mechanism to not engage completely if the aircraft was not built accurately.
- When the primary lock was not engaged or was ineffective due to build issues, the secondary lock may be sufficient to hold the canopy until the aircraft's speed built up. As the aircraft's speed built and the amount of suction on the canopy increased, there was the risk that the secondary lock would twist, allowing the canopy to open.
- The suction holding the canopy open could make it difficult for pilots to overcome.
- Generally, the canopy opening did not result in any control issues. The main risk was the pilot becoming distracted, particularly when close to the ground.
- Some pilots have reported a pitch down, while others have not.
- Theoretically, it is possible that at higher airspeeds, an open canopy may disrupt the airflow over the aircraft's horizontal stabiliser. If this occurred, a forward pitching moment results. However, this had not been tested.

[7] Term used when a wing is no longer producing enough lift to support an aircraft's weight.

Safety analysis

Introduction

Shortly after reaching 2,900 ft, Vans Aircraft Inc. RV-6, registered VH-JON (JON), descended rapidly and collided with the ground next to a house. The pilot was fatally injured and the aircraft was destroyed. Following the accident, members of the public found a number of aviation-related items belonging to the pilot at distances of up to 3 km north of the accident site.

The recorded engine data showed that the engine was operating normally prior to the impact. This was consistent with the engine examination, which identified no internal mechanical failure or abnormality that would have precluded normal operation. In addition, the integrity of the aircraft structure and the flight controls was also established.

This analysis will examine why the aircraft's canopy likely opened in flight, how this may have occurred and the possible consequences for continued safe flight.

Canopy opening in flight

Timing of the canopy opening

A witness reported observing items falling from the aircraft during the aircraft's descent. This was consistent with the location of some of the pilot's belongings found external to the aircraft and away (up-track) from the accident site. With no other place for the items to exit the cockpit, the liberation of the items from the aircraft's interior indicated that the canopy likely opened in flight. While based on the assumption that the items were initially inside the cockpit, this conclusion was similar to that by the United States National Transportation Safety Board's (NTSB) investigation into an RV-6 accident on 20 June 2014 (see NTSB report CEN14FA306).

The ATSB considered the possibility that the pilot's flight bag containing the items was inadvertently left on the aircraft's wing during the departure from Moorabbin Airport. However, as the bag would most likely slide off the wing during the take-off, this was the least probable scenario.

The ATSB also examined the possibility that the pilot deliberately opened the canopy for a particular reason such as experiencing smoke, fire or fumes in the cockpit. While there was insufficient evidence to support this scenario one way or the other, given the results of the pilot's post-mortem, it was deemed unlikely.

Canopy locking mechanism

Damage to the primary locking lever mechanism suggested that it was initially closed but forced open during the impact. However, anecdotal reports from RV-6 pilots indicated that, under some circumstances, it was possible for the canopy in these aircraft to open when the lever was in the closed position. Furthermore, the ATSB could not discount that the pilot of JON may have manipulated the lever in attempt to lock the canopy during the descent.

There was no damage to the two hooks and their respective receptacles at the rear of the canopy whereas, if engaged at the time of impact, some level of damage to these components would be expected. While it was possible that the primary lock was open prior to the impact, the aircraft sustained significant damage, which may have affected the state of the mechanism. Also, the locking catch and spring were not found and could not be examined.

The secondary lock was found in the unlocked position and showed no signs of damage. However, as this lock is readily moved by turning the associated handle, it could not be discounted that it moved on impact. Also, it was possible that the lock was initially closed prior to take-off and worked its way open during the flight.

In summary, there was insufficient evidence to establish if either of the locking mechanisms remained unlocked since prior to take-off, or if they failed in flight.

Consequences of an open canopy

Startle and distraction

The United States Federal Aviation Administration (Advisory Circular 120-111) recognised that:

> Because upsets that occur in normal flight operations are unplanned and inadvertent, pilots may be startled or surprised, adversely impacting recognition or recovery.

Martin and others (2012) also stated that, if pilots were not expecting things to go wrong, the level of startle or surprise they experience could be significant and may last between 0.3 and 1.5 seconds. The rapid capture of attention due to a startling event can distract a pilot from the primary task of flying.

The NTSB investigation report into the fatal RV-6 accident in the United States on 20 June 2014 recognised that there may be a tendency for pilots to experience 'shock and chaos' with an open canopy due to the severe cockpit wind, noise and debris flying about. This was similar to reports from a number of RV-6 pilots who cited lots of wind noise and distraction when their canopy opened in flight. Van's also indicated that an open canopy could be distracting.

The recorded engine data showed that, about 7 seconds after the oil pressure began to fluctuate, the pilot reduced the engine power to idle. This was slightly above the typical reaction time of 4-6 seconds for pilots responding to an emergency situation.[8] However, it was unknown if the pilot conducted any other actions prior to this time.

The ATSB concluded that it was possible that the pilot of JON was startled and distracted after the canopy opened. The extent to which this contributed to the occurrence could not be established.

Aircraft control

Reports from a number of RV-6 pilots who had experienced an in-flight opening of a tip-up canopy showed varying results. Some reported no consequences while others experienced a sudden pitch down. In these cases, the aircraft was reported to remain controllable. In contrast, the NTSB concluded that the likely in-flight opening of an RV-6 canopy resulted in a loss of pitch control and collision with terrain. Similarly, the pilot of an RV-12 reported experiencing a pitch down after their aircraft's canopy opened in flight to the full vertical position shortly after take-off. That pilot also reported that there was no response from the elevator or rudder after the canopy opened.

Van's advised that an in-flight canopy opening would generally not cause any problems. However, while not tested, they theorised that a forward pitching moment may occur at higher airspeeds due to a disruption in the airflow over the aircraft's horizontal stabiliser. Given the variability in consequences reported, and without flight testing, the ATSB was unable to establish how the canopy opening on JON would affect its controllability, and if this directly resulted in the loss of control. Nonetheless, other reported experiences after an in-flight canopy opening suggest that, under some circumstances, in-flight opening of the tip-up canopy on some Van's aircraft can result in a sudden pitch down with related controllability issues.

The reduction by the pilot of engine power to idle and witness observations of the aircraft banking and the wings then coming level, suggest that the pilot was attempting to respond to the in-flight canopy opening. However, for reasons undetermined, the pilot was unable to recover the situation before impacting terrain.

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[8] In 1999, the United Kingdom Civil Aviation Authority commissioned a simulator-based study into helicopter pilot reaction times in response to an emergency. The study determined that the mean total reaction time (time taken to detect and respond) generally ranged between 2–4 seconds, with 4–6 seconds typical of a longer but acceptable reaction time.

Summary

While the ATSB was unable to establish how the canopy likely opened, this accident and other reported in-flight canopy openings in a number of Van's aircraft models highlight the varying consequences when such occurrences take place. The result can vary from being relatively benign to significant, but pilots can expect an element of startle and distraction. Additionally, such occurrences serve as a reminder for pilots to check the security of their aircraft's canopy prior to take-off. Of note, Van's advised the ATSB that the RV-12 and RV-14 models now have a 'canopy open' warning switch incorporated into the kit design. Other pilots who have experienced an in-flight canopy opening have included an additional checklist item to confirm the canopy was locked before departing.

Findings

From the evidence available, the following findings are made with respect to the collision with terrain involving an amateur-built Van's RV-6A, registered VH-JON, which occurred 8 km south of Moorabbin Airport, Victoria on 14 October 2014. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance. A safety issue is an event or condition that increases safety risk and (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 operating environment at a specific point in time.

Contributing factors

- Shortly after levelling off in the cruise, the tip-up canopy in VH-JON likely opened, resulting in a loss of control from which the pilot was unable to recover before impacting terrain.

Other factors that increased risk

- **In-flight opening of the tip-up canopy in a number of Van's Aircraft Inc. models has resulted in varying consequences, including a significant pitch down tendency, increasing the risk of a loss of control. [Safety issue]**

Other findings

- The reason for the canopy opening in VH-JON could not be determined.

Safety issues and actions

The safety issues identified during this investigation are listed in the Findings and Safety issues and actions sections of this report. The ATSB expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the directly involved parties were provided with a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

The initial public version of these safety issues and actions are repeated separately on the ATSB website to facilitate monitoring by interested parties. Where relevant the safety issues and actions will be updated on the ATSB website as information comes to hand.

Potential adverse effects of a tip-up canopy opening in-flight

Number:	AO-2014-164-SI-01
Issue owner:	Van's Aircraft Inc.
Operation affected:	Aviation: General aviation
Who it affects:	Owners of Van's aircraft fitted with a tip-up canopy

Safety issue description:

In-flight opening of the tip-up canopy in a number of Van's Aircraft Inc. models has resulted in varying consequences, including a significant pitch down tendency, increasing the risk of a loss of control.

Proactive safety action taken by Van's Aircraft Inc.

Action number: AO-2014-164-NSA-013

In response to this safety issue, Van's Aircraft Inc. developed a service letter for distribution to builders and operators highlighting the varying consequences of a canopy opening in flight, in particular, involving a tip-up (forward opening) canopy. The letter recommends inspecting the canopy locking mechanism to confirm that it operates as designed and to ensure the mechanism fully engages when closed. Keeping seatbelts fastened during all phases of flight is also emphasised.

Current status of the safety issue

Issue status: Monitor

Justification: The safety action taken by Van's Aircraft Inc. will, once the service letter is distributed, make builders and operators of Van's Aircraft Inc. aircraft fitted with a tip-up canopy aware of the consequences of the canopy opening in flight, and how to reduce the risk of such an event. The ATSB will monitor the release of the service letter.

ATSB safety advisory notice to pilots of canopy-equipped aircraft

In an effort to inform industry more widely of this safety issue, and the safety benefits from ensuring the canopy is secured prior to take-off, the ATSB has issued the following safety advisory notice.

Action number: AO-2014-164-SAN-012

The consequences when an aircraft canopy opens in-flight, including other than Van's aircraft types, can vary from being relatively benign to significant, such as a sudden pitch down. In any event, in the first instance, pilots should expect an element of startle and distraction. The detection of an unsecured canopy prior to take-off could prevent in-flight control issues resulting in injury or aircraft damage. The ATSB advises pilots to be vigilant and to confirm the security of their aircraft's canopy prior to take-off.

General details

Occurrence details

Date and time:	14 October 2014 – 1326 EDT	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	8 km south of Moorabbin Airport, Victoria	
	Latitude: 38° 3.176’ S	Longitude: 145° 6.851’ E

Aircraft details

Manufacturer and model:	Amateur-built Van’s Aircraft Inc. RV-6A	
Year of manufacture:	1999	
Registration:	VH-JON	
Serial number:	25081	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 1 (fatal)	Passengers – 0
Damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- a number of witnesses
- Van's Aircraft Inc.
- the Van's Airforce Forum
- Airservices Australia
- the Civil Aviation Safety Authority
- Victoria Police.

References

Federal Aviation Administration 2004, *Airplane Flying Handbook*, United States Department of Transportation.

Federal Aviation Administration 2015, *Upset Prevention and Recovery Training (Advisory Circular 120-111),* United States Department of Transportation.

Flight Safety Foundation 1999, 'Simulator-based study of emergencies yields insights into pilots' reaction times', *Helicopter Safety*, March-April 1999, vol. 25, no. 2.

Martin, WL, Murray, PS & Bates, PR 2012, *The Effects of Startle on Pilots During Critical Events: A Case Study Analysis*, Brisbane, Griffith University.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the 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 Van's Aircraft Inc., the Civil Aviation Safety Authority and the United States National Transportation Safety Board.

A submission was received from Van's Aircraft Inc. The submission was reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The ATSB is an independent Commonwealth Government statutory agency. The ATSB 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 operations involving the travelling public.

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 factors related to the transport safety matter being investigated.

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.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation

Collision with terrain involving Van's RV-6A, VH-JON
8 km south of Moorabbin Airport, Victoria, 14 October 2014

AO-2014-164
Final – 25 November 2016