Australian Government
Australian Transport Safety Bureau

Loss of control and collision with terrain involving BRM Aero S.R.O Bristell LSA aircraft, VH-YVX

Stawell, Victoria, on 5 October 2018

ATSB Transport Safety Report
Aviation Occurrence Investigation
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Addendum

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Safety summary

What happened

On 5 October 2018, a BRM Aero Bristell light sport aircraft (LSA), registered VH-YVX, departed Moorabbin Airport, Victoria, with a pilot and passenger on board. The purpose of the flight was a navigation exercise in support of the pilot's commercial pilot training requirements. Following an overfly of the intended waypoint at Stawell Airport, the aircraft was observed by witnesses to conduct a number of aerobatic-type manoeuvres before control was lost. The pilot was unable to recover control of the aircraft before it impacted terrain. The occupants sustained significant injuries and the aircraft was destroyed.

What the ATSB found

The ATSB determined that, contrary to the aircraft's limitations and the pilot's qualifications, aerobatic manoeuvres were conducted during the flight, and immediately prior to the loss of control. The aircraft experienced an accelerated aerodynamic stall and entered into an upright, fully-developed spin. Although the pilot did not consistently apply the manufacturer's recommended spin recovery technique, recovery from a fully-developed spin may not have been possible in the aircraft type.

The avionics system fitted to the accident aircraft had data storage capability and also backup storage capability by way of a secure digital (SD) card which could be fitted to the avionics system. An SD card was not fitted as standard equipment when Bristell aircraft were delivered to operators from new. Further, the operator was not aware of the additional memory card storage capability and had not installed SD cards in any of their Bristell fleet.

What's been done as a result

Following a number of fatal spin-related accidents involving BRM Aero Bristell aircraft in Australia and overseas, the Civil Aviation Safety Authority (CASA) reviewed the flight test data supplied by the aircraft manufacturer against the ASTM standard for which the manufacturer self-certifies compliance. CASA found that there was not enough information in the initial and follow-up test data to provide them with assurance that the aircraft type meets the required standards for spin recovery. At the time of writing the final investigation report, the manufacturer and CASA were still in discussion.

The operator conducted a fleet-wide installation of SD cards to all aircraft capable of storing data.

Safety message

Aerobatic flight should not be undertaken by pilots who have not been adequately trained, as it requires specialist techniques and methods to maintain control of the aircraft during significant manoeuvring. Further, aircraft manufacturers that prohibit aerobatics in certain aircraft types do so because the aircraft has not been designed and/or tested to ensure these manoeuvres can be conducted safely. This accident clearly demonstrates the catastrophic consequences when the hazards of aerobatic flight are not managed.

Aircraft data recording systems can be a readily accessible tool for both flying training, maintenance and safety investigation. Aircraft owners should make themselves aware of the data recording capability of their aircraft and ensure that the systems are fully functioning and backing up information.

Contents

The occurrence

What happened

On 5 October 2018, at about 1220 Eastern Daylight-saving Time,[1] a Bristell light sport aircraft, registered VH-YVX, departed Moorabbin Airport, Victoria, with a pilot and passenger on board. The purpose of the flight was a navigation exercise in support of the pilot's commercial pilot training requirements. The passenger held a student pilot licence, however their aviation medical certificate was not current. Photographs taken during the flight indicated that the passenger operated the aircraft for brief periods, but the ATSB assessed that this did not contribute to the development of the accident.

Automatic Dependence Surveillance Broadcast and on-board flight and GPS data recorded the aircraft position and attitude throughout the flight (see the section titled Recorded information). The data showed the take-off and flight over the northern part of Port Phillip Bay, followed by the commencement of significant manoeuvring overhead a built-up area to the west of Melbourne (Figures 1 and 2).

Figure 1: Aircraft's flight path and accident site location

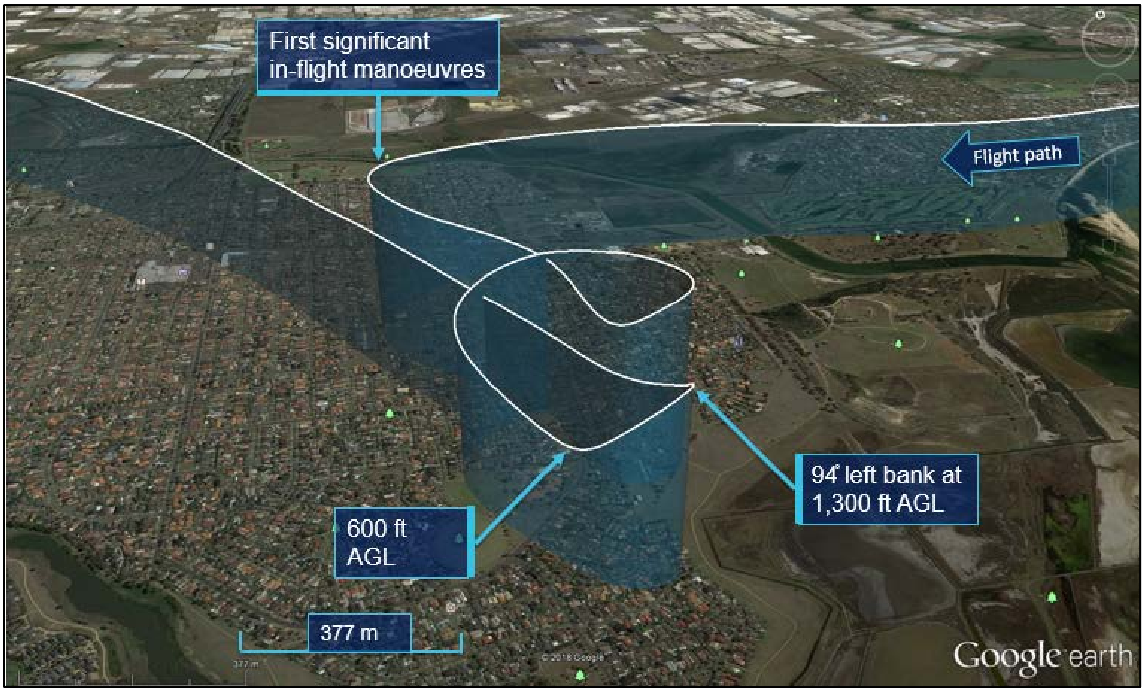
Source: Google Earth, modified by the ATSB

Figure 1 details the flight path of the aircraft in the area labelled as 'Detail A' in Figure 1. The data showed that the pilot conducted significant manoeuvres including steep climbs, descents and turns in excess of 90° angle of bank over a built-up area and at heights between 600-1,300 ft above ground level (AGL).

In discussing that segment of the flight, the pilot stated that a 360° turn was conducted over the house of someone the pilot knew in the area. The pilot did not recall conducting any aerobatics or significant manoeuvring at that time.

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

Figure 2: Detail A – Recorded data of the aircraft flight path over a built-up area



Source: Google Earth, modified by the ATSB

The aircraft then continued to Bacchus Marsh Airport where the pilot conducted a circuit followed by a touch-and-go landing. The aircraft then continued in a north-west direction until overhead Stawell Airport (Figure 3).

At about 1240, three witnesses at Stawell Airport observed the aircraft overfly the airport before commencing a 180°turn back towards the south-east. Following that turn, the aircraft was observed to commence a number of significant manoeuvres including steep climbs and turns described as aerobatic in nature. The aircraft was then observed to abruptly enter a flat spin (see the section titled *Spins and spin recovery*) and descend out of view.

Analysis of the recorded data identified that, after passing overhead the airport, manoeuvres far in excess of the aircraft's performance limitations were conducted. Based on the magnitude of the recorded pitch and roll values, the manoeuvres were classified as aerobatic. Further data analysis established that while the aircraft was pitching and rolling out from a diving left steep turn, it experienced an accelerated aerodynamic stall[2] while rolling at an indicated airspeed of about 93 kt. The aircraft subsequently flick-rolled and entered a fully developed upright spin at an altitude of about 1,650 ft AGL. The aircraft maintained the spinning descent until it impacted terrain.

The pilot stated that, immediately prior to the accident, a turn of no more than 50° angle of bank was conducted in the process of lining up for a practice circuit and landing at Stawell Airport when 'the back end of the aircraft slid out' and control was lost. The pilot also stated that the accident occurred prior to reaching the airport.

When provided with detail of the recorded flight data and other accounts, the pilot was unable to reconcile the difference between their recollection of the event and that of the witnesses and the recorded data. Figure 3 shows the aircraft track, manoeuvring and spin. The red portion of the flight track is the point at which the GPS lost signal and position data was no longer recorded. This

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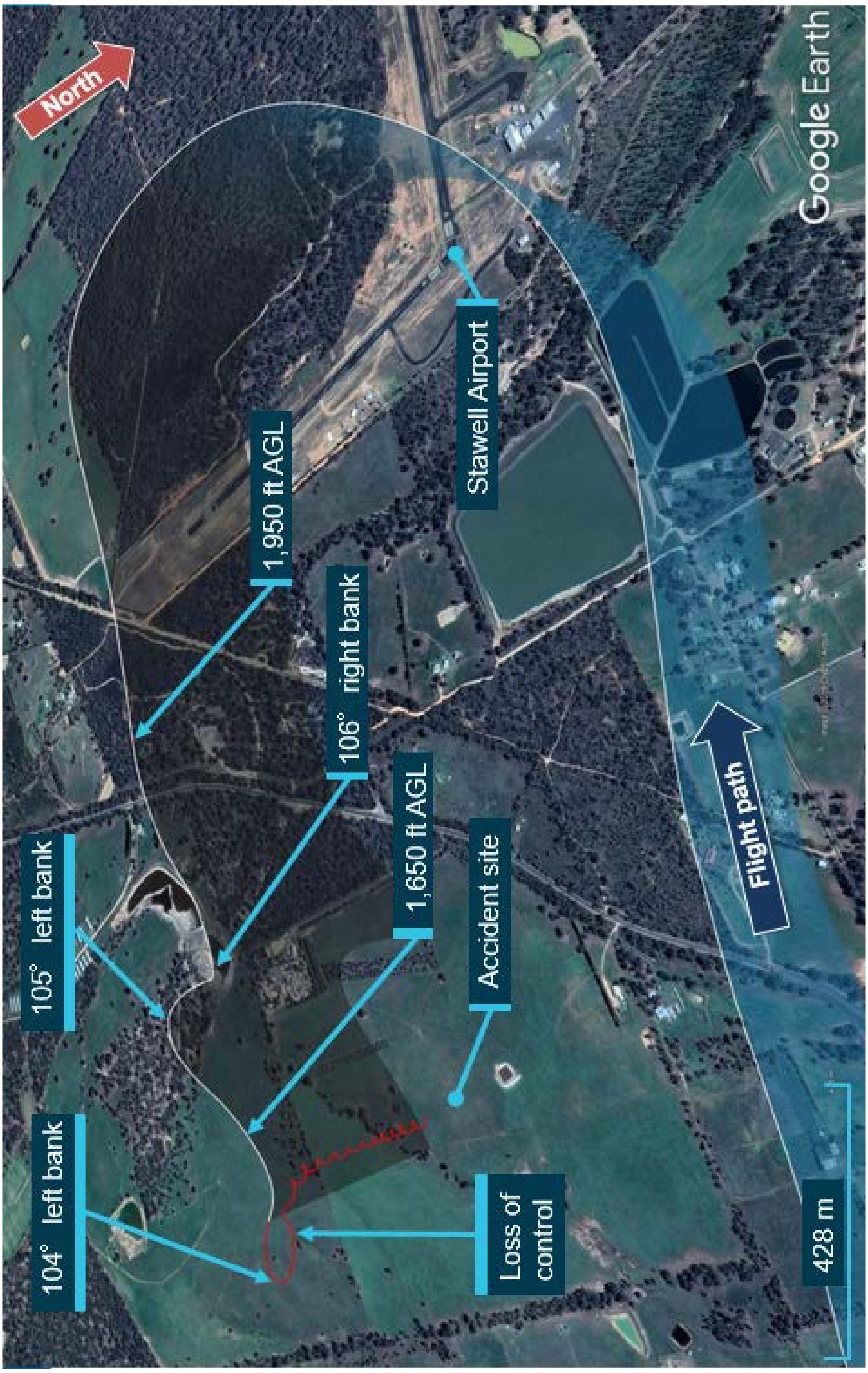
2 An aerodynamic stall occurs when the relative angle of the wings through the air exceeds a critical angle. This can occur at any airspeed and aircraft attitude within the structural limitations of the aircraft. In this case, the term 'accelerated' refers to the wings supporting a load greater than the weight of the aircraft due to manoeuvres, resulting in an aerodynamic stall occurring at higher than the published 1 G wings-level indicated airspeed.

was likely due to a combination of the aircraft's rapid movements and the GPS antenna position. From that point onwards, position data was calculated using groundspeed, bearing and barometric altitude data.

Figure 3: Detail B – Aircraft operation in the vicinity of Stawell Airport



Source: Google Earth, modified by the ATSB

A witness at Stawell Airport notified emergency services about the accident. Two other witnesses at the airport used an aircraft to locate the accident site, and guided the emergency services to the location by flying overhead. The pilot and passenger sustained serious injuries and were airlifted to hospital. The aircraft was destroyed.

Context

Pilot information

General information

The pilot attained a Private Pilot Licence (Aeroplane) on 13 August 2018 and had about 160 hours of flying experience. At the time of the accident the pilot was undergoing training for the issue of a Commercial Pilot Licence (Aeroplane) qualification. The pilot was not trained or endorsed to conduct aerobatics.

Medical information

The pilot held a current Class 1 Aviation Medical Certificate with a requirement to conduct additional assessments as directed by the Civil Aviation Safety Authority. The pilot confirmed being well-rested on the day of the flight, with no medical issues.

Stall and spin recovery training

According to the pilot's instructor, the pilot had been taught theoretical and practical stall recovery techniques, including recovery from an incipient spin. The pilot's training records indicated that the pilot had demonstrated the correct incipient spin recovery technique to their instructor and flight examiner on several occasions.

Aircraft information

General

The BRM Aero Bristell is a light sport aircraft (LSA). It is an all-metal, low-wing monoplane of semi-monocoque construction with side-by-side seating and dual flight controls. It is driven by a 4-cylinder, 4-stroke, normally aspirated piston engine, driving a composite three-blade constant-speed propeller. It has a maximum all up weight of 600 kg (Figure 4).

Figure 4: Exemplar BRM Aero Bristell LSA aircraft

Source: Aircraft operator with permission

VH-YVX Airworthiness and maintenance

BRM Aero Bristell LSA serial number 284 was manufactured in 2017 and registered in Australia as VH-YVX.

At the time of the accident, the aircraft was:

- operating on a special Certificate of Airworthiness in the light sport aircraft (LSA) category

- approved for private operations/flight training
- maintained in accordance with the manufacturer's maintenance schedule
- operating under a current maintenance release with no outstanding defects or maintenance. It indicated that the aircraft had about 928 flight hours since new.

Approved aircraft manoeuvres

The aircraft operating instructions (AOI) section 2.9 had approved manoeuvres listed as follows:

- Steep turns not exceeding 60° bank
- Lazy eights
- Chandelles
- Stalls (except whip stalls).

The section also had the following warning:

> Aerobatics and intentional spins are prohibited.

The same warning is also included as a placard on the cockpit instrument panel (Figure 5).

Figure 5: **Depiction of placard attached to the instrument panel**

Source: Bristell LSA operating instructions

Section 2.10 of the AOI identified the maximum manoeuvring load factors as +4.0 to -2.0 G.

Integrated instrument and avionics system

The aircraft was fitted with a Garmin G3X avionics system, which was an integrated flight instrumentation, position, navigation and communication system.

Recorded flight data

The G3X unit had a flight data logging feature which automatically stored flight and engine data to its memory module. A secure digital (SD) card can also be fitted as a backup memory storage that can be easily removed from the aircraft so that the flight data can be downloaded for operational and maintenance monitoring purposes. A data file was created each time the system was powered on with an SD card inserted, or each time an SD card was inserted after power on.

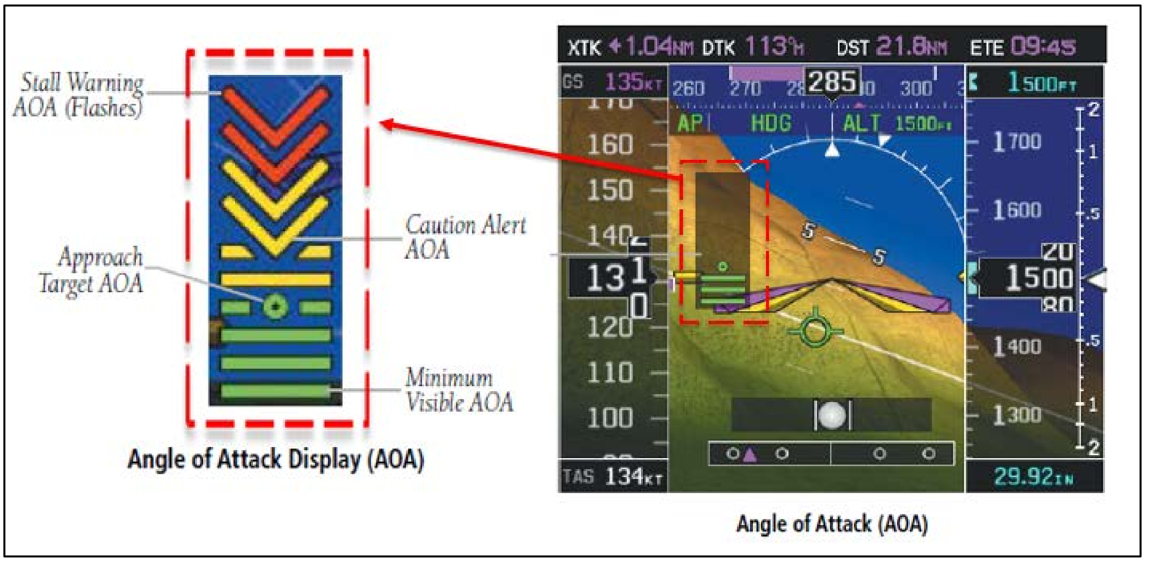
A 2 GB SD card can store over 1,000 hours of flight data or up to 1,000 files (whichever comes first). The SD card is normally located in a receptacle on the right upper face of the unit. However, an SD card was not provided with the aircraft when it was first supplied from the manufacturer. It was therefore at the owner's discretion if they wished to utilise the recording feature. No SD card was installed at the time of the accident.

Stall warning and angle of attack display

When the angle of attack (AOA) system identifies an exceedance in the calibrated caution alert threshold, an intermittent audible warning will be heard. The tone will increase in frequency until it reaches the AOA stall warning threshold, at which point the audible warning will change from intermittent to continuous.

In conjunction with the audible warning, the AOA system will display a change from a solid green to yellow in the caution level. It flashes from yellow to red when it reaches the stall warning threshold (Figure 6).

Figure 6: Angle of attack on the primary flight display



Source: Garmin G3X Pilot's Guide, modified by the ATSB

Regulatory definition and requirements for aerobatic flight

Definition of aerobatic flight

Civil Aviation Safety Regulations 1998 (CASR) Dictionary, Part 1 *Definitions* defined aerobatic manoeuvres as those that involve:

> (a) bank angles that are greater than 60˚; or
>
> (b) pitch angles that are greater than 45˚, or are otherwise abnormal to the aircraft type; or
>
> (c) abrupt changes of speed, direction, angle of bank or angle of pitch.

Regulatory requirements for aerobatic flight

To conduct aerobatic manoeuvres, pilots are required to have an aerobatics flight activity endorsement entered on their pilot's licence. To obtain this endorsement, a pilot is required to have received training and demonstrated competency in all the course units mentioned in CASR Part 61 *Manual of Standards.* That training includes recovery from unusual attitudes and spins.

CASR 61.065 prohibits the conduct of any activity for which the licence holder is not authorised. In addition, CASR subpart 61.S *Flight activity endorsements* stated the requirements for aerobatic endorsements. These included an initial aerobatic endorsement that would authorise the pilot to conduct aerobatic manoeuvres in an aeroplane above 3,000 ft above ground level (AGL). Subsequent endorsements were necessary for aerobatic activities at lower altitudes.

Also, Civil Aviation Advisory Publication (CAAP) 155-1(0) *Aerobatics* provided pilots with:

> information and guidance on safety issues related to aerobatic flight, including in respect of the aircraft, pilot and regulations
>
> an explanation of spin recovery techniques
>
> advice on the importance of ensuring sufficient height to recover from an aerobatic manoeuvre by 3,000 ft AGL (or the lower limit of the pilot's approval).

In particular, section 7.3.2 of the CAAP stated:

> It is highly probable that the consequence of an error or failure during low-level aerobatics will be fatal to the participants.

Finally, Civil Aviation Regulation 1988 (CAR) 155 at section 5.1 (5) stipulated that:

> Aerobatics are not permitted over populous areas or public gatherings without the written permission of CASA.

Spins and spin recovery

Overview

An aerodynamic spin is a sustained spiral descent in which one or both an aircraft's wings are in a stalled condition,[3] with the outside wing producing more lift and less drag than the other wing. The associated forces sustain the rotation and keep the aircraft in the spin. A spinning aircraft will descend more slowly than one in a vertical or spiral dive and it will have a lower airspeed, which may oscillate. The pitch angle can also vary considerably from significant pitch down to a relatively flat-attitude.

Intentional spins are normally entered from a stall in straight and level flight, via the application of full back elevator and full rudder in the intended direction of rotation at the moment of the stall. The circumstances of a spin entry during aerobatic manoeuvring can be very different. If for example, aerobatic manoeuvres are incorrectly conducted, an unintentional consequence can be a flick roll[4] and entry into a spin.

Incipient spin

When entering a spin, an aircraft motion through the air is irregular at first. This is a transition phase from the stall and is known as incipient spin. Though the nature of the incipient spin is heavily dependent on the aircraft type and the manner of entry, recovery may be more rapid and require less control input in this stage compared with recovery from a developed spin.

Developed Spin

After a number of rotations and depending on the aircraft loading, type and control inputs, an aircraft in an incipient spin may settle into a regular rotating descent known as a developed spin. A developed spin is typified by reduced oscillations when compared to an incipient spin and the axis of rotation becomes vertical. The spin may steepen (nose down) or flatten (nose more horizontal) as it continues.

Recovery from an unintentional spin

The BRM Aero Bristell LSA AOI, section 3.7 described the recovery from unintentional spins as follows:

> There is no[t] an uncontrollable tendency of the airplane to enter into a spin provided the normal piloting techniques are used.
>
> Unintentional spin recovery technique:
>
> 1. Throttle - idle
> 2. Lateral control - ailerons neutralized
> 3. Rudder pedals - full opposite rudder
> 4. Rudder pedals - neutralize rudder immediately when rotation stops
> 5. Longitudinal control - neutralize or push forward and recover dive.

Spinning ceases only when opposing forces and moments overcome auto-rotation. Since yaw coupled with roll powers the spin, the pilot must forcibly uncouple them by applying the recommended spin recovery technique. Due to rotational inertia, spin recovery is not

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3 Aerodynamic stall: occurs when the airflow separates from the wings upper surface and becomes turbulent. It occurs at high angles of attack, typically 16–18° and results in reduced lift and increased drag.

4 Flick roll: Essentially a horizontal spin, made by slowing to spin-entry speed with engine throttled back and then applying full back stick and full rudder. Result should be a controlled very rapid 360° roll.

instantaneous. It may take several turns of the applied technique before recovery control forces finally overcome the spin stabilising forces and rotational inertia. Spins are only recoverable when the cumulative effects of the interacting variables favour recovery and there is enough altitude and therefore time to recover. Generally speaking, recovery from an incipient spin will take less time than a recovery from a fully developed spin. It is therefore vital that the correct recovery technique is implemented as soon as possible.

Pilot and passenger recollection of the attempted spin recovery

The pilot stated that the aircraft did not provide him with an aural or visual warning of an impending stall leading up to or during the accident sequence. When asked about the recovery technique following entry into a spin, the pilot confirmed that full opposite rudder was not maintained. Rather, the pilot initially applied opposite rudder to the spin and then reversed the control and noted that the spin rate increased. The pilot then moved the rudder back to the full opposite rudder position.

Analysis of the recorded data showed that the engine power was only slightly reduced following entry into the spin. Power was reapplied and then reduced to idle about 14 seconds after the spin commenced.

The passenger did not have a full recollection of the event but recalled the plane going pitch-up to a vertical position and then one rotation. The passenger remembered then saying 'opposite rudder power down' to the pilot before passing out prior to impact.

Although the passenger did not recall an audible warning when interviewed by the ATSB, they did mention hearing a beeping sound when discussing the event with their family a short time after the accident.

Light sport aircraft certification standards for spin recovery

Aircraft in the LSA category are certified to the ASTM International[5] standards. The certification process is conducted and self-certified for compliance by the manufacturer themselves, rather than by the regulating aviation authority from the state of manufacture. The LSA process relies on the manufacturer declaring that the aircraft meets all the construction and flight requirements of the LSA standards identified by them in the statement of compliance.

Aircraft certification standards for spin testing

ASTM F2245 standard specification for design and performance of light sport aeroplanes, section 4.5.9 states:

> 4.5.9 Spinning:
>
> 4.5.9.1 For airplanes placarded "no intentional spins," the airplane must be able to recover from a one turn spin or a 3-s[econd] spin, whichever takes longer, in not more than one additional turn, with the controls used in the manner normally used for recovery.

In some aircraft not approved for spinning, recovery may not be possible if the spin progresses to the developed stage.

The standard has various requirements, for example the light sport aircraft category for non-aerobatic aircraft requires the aircraft manufacturer to prove the aircraft type can recover from a one-turn spin.

CASA assessment of BRM Aero Bristell LSA spin testing

The LSA category relies solely on the aircraft manufacturer declaring that each individual aircraft meets/complies with the standard(s) that they have indicated within the statement of compliance. Each individual aircraft must have its own statement of compliance issued and

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[5] ASTM International, formally known as the American Society for Testing and Materials, provide guidance for aircraft manufacturers in design and certification standards.

signed by the aircraft manufacturer that the particular aircraft meets the identified standards. Manufacturers are not required to submit test data, or show compliance to those standards, to CASA or any other regulator.

Following a number of fatal accidents involving Bristell aircraft entering into and not recovering from spins in Australia and overseas, CASA assessed the Bristell LSA self-certification testing documentation against the ASTM certification test standards.

CASA found that there was insufficient information in the initial test data to provide assurance that the aircraft type met the ASTM standards for spin recovery. As a result, CASA requested more certification testing data from the manufacturer. The manufacturer conducted further certification flight tests in the Bristell LSA and provided that data, including video recordings of each flight sequence to CASA. CASA's assessment of the new flight testing data and further information supplied by the manufacturer was that it still did not confirm that the aircraft met the required ASTM standard for spin recovery.

Post-accident CASA guidance on spin avoidance

Due to an increase in spin-related accidents across a broad range of light aircraft types in the training environment, CASA produced guidance material in the form of an advisory circular (AC) 61-16 v1.0 titled *Spin avoidance and stall recovery training.* The AC highlights:

> …the risks associated with advanced stalling training when conducted in aircraft that are not certified for intentional spinning. It clarifies the difference between wing drop at the stall and the incipient phase of a spin and provides background for the interpretation of aircraft flight manual manoeuvre limitations with respect to spinning. It also provides guidance on acceptable methods of training and testing stalls with a wing drop and spin avoidance.

The AC provides detailed guidance for pilots, flight instructors, flight examiners and flight training organisations. The AC states that:

> The key messages in this AC that are critical for the safe conduct of advanced stalling and spinning exercises, and that all pilots instructors, operators and flight examiners should be aware of are:
>
> - A spin must not be induced in aircraft not certified or approved for intentional spinning
> - A spin must not be induced without the pilot in command holding a spinning flight activity endorsement
> - Aircraft flight manual limitations and any special procedures before conducting any exercise which may result in a spin
> - The need to comply with aeroplane centre of gravity limits
> - Wing drop at the stall for the purposes of spin avoidance training must not be induced by application of pro-spin rudder and the induction of a spin
> - Training in spin avoidance must include the recognition of symptoms associated with slow flight and approach to the stall through to recovery from stall with a wing drop
> - Recognise and manage changes in aircraft energy state
> - Spin avoidance training where a wing may drop at the stall should be undertaken through scenario-based in-flight manoeuvres:
>   - Approach configuration descending turns (base to final turn)
>   - Go-around from approach configuration (significant change in trim state)
>   - Climbing turns in departure configuration (trim changes during flap retraction and turns)
>   - Engine failure after take-off (potential out of trim condition)
>   - Turns in slow flight.

Site and wreckage examination

The ATSB conducted an examination of the accident site and wreckage (Figure 7). The examination identified that:

- the aircraft was located in relatively flat and open farmland, about 1.7 km south-east of Stawell Airport
- ground impact marks indicated that the aircraft had impacted terrain in a relatively flat, upright, counter clock-wise spin
- the flaps were in the retracted position
- there was evidence of a significant amount of fuel at the accident site and the airframe fuel filter bowl was full of fuel and free of contaminants
- the propeller blades showed rotation damage consistent with engine operation at a low power setting at impact
- elevator trim was in a neutral position
- no pre-impact defects were identified with the flight controls or aircraft structure
- all aircraft components were accounted for at the accident site.

A Garmin G3X (G3X) panel-mounted avionics unit was removed from the aircraft for detailed examination at the ATSB's technical facility in Canberra.

Figure 7: Aircraft accident site

Source: ATSB

Recorded information

G3X avionics system flight data download

The ATSB inspected the G3X unit and identified that it was visually undamaged. There was no SD card fitted to the unit. On return to Canberra, the unit was powered up with an SD card fitted (Figure 8). Data files associated with the accident flight were successfully downloaded from the memory module to the card.

Figure 8: G3X avionics unit being downloaded, showing memory card position

Source: ATSB

Flight data summary

The downloaded data recorded 86 parameters for the duration of the accident flight, from the initial taxi until impact with terrain. The flight data indicated that the aircraft and engine were operating normally throughout the flight with no anomalies identified within the data or aircraft operating systems.

Position verification

The GPS position was verified to be accurate within 2 metres by utilising the aircraft's:

- track on the parking bay, taxi ways and runway at Moorabbin Airport
- track during the touch-and-go on the runway at Bacchus Marsh Airport
- final position at the accident site.

Significant aircraft manoeuvres

The data recorded that at about 1230, while the aircraft was overhead the built-up area shown in Figure 2, it was operated significantly outside of its allowable flight envelope. This included banking to 94° while manoeuvring between 600-1,300 ft above a populated area.

At 1319, the recording captured a 91° roll to the left followed by a pitch down to 40°. The data also recorded a climbing right turn to 91° angle of bank at 1323, followed by a pitch down to 38° then a rolling left pull out turn. Whilst pulling out, the instrumentation system recorded a peak normal acceleration of 4.4 G. That loading exceeded the aircraft's positive load limit of 4 G.

From 1340, there was significant variation in the magnitude of pitch, roll and load factor, consistent with additional aerobatic manoeuvring during the final minute of the flight (Figure 9).

At 1340:36, while the aircraft was operating at:

- about 90 kt indicated airspeed
- a pitch-down angle of about 50°

- high angle of attack and positive load factor

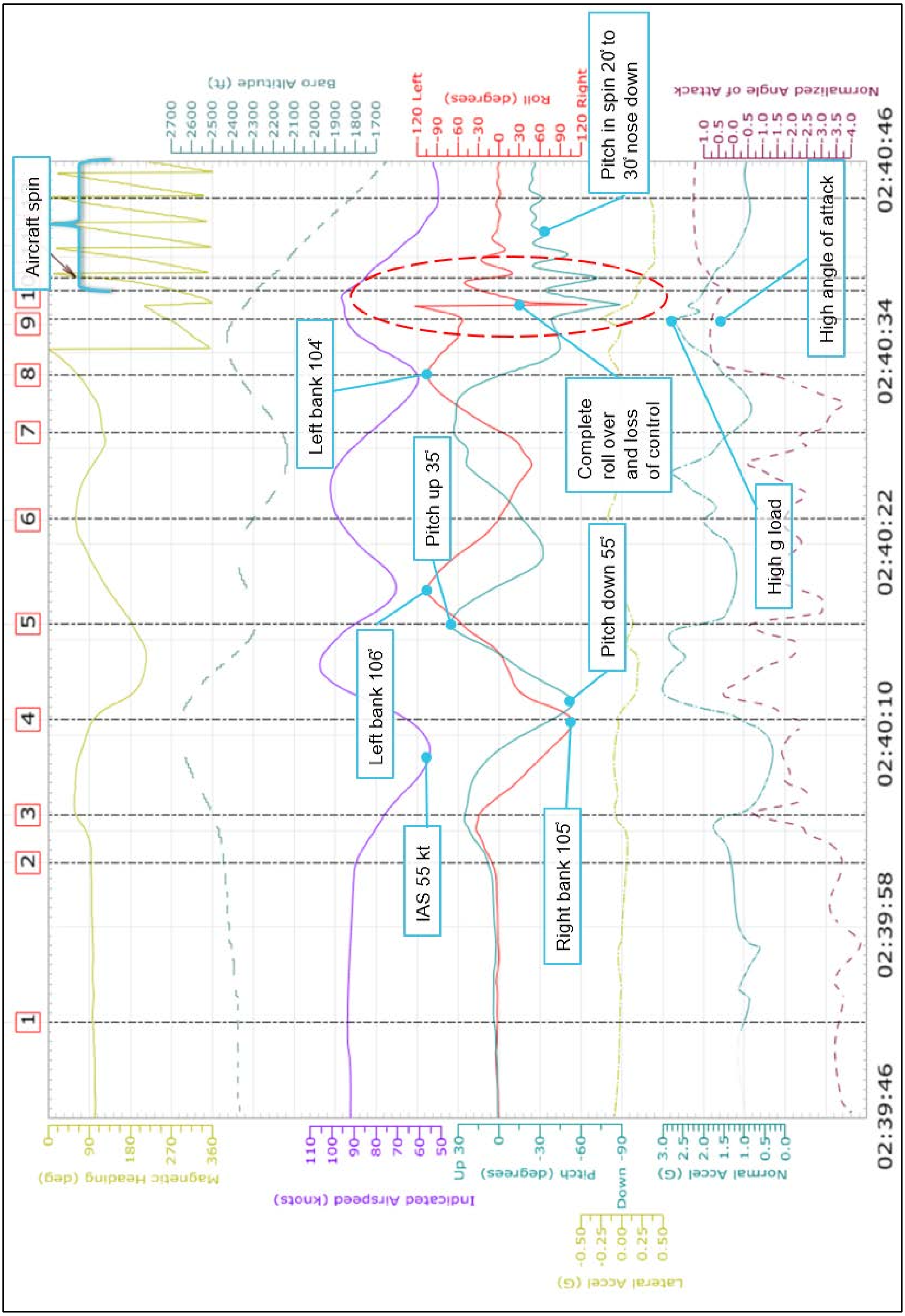
it abruptly pitched down to 90° and rolled significantly to the left. That behaviour was consistent with the aircraft experiencing an accelerated aerodynamic stall.[6]

Subsequent variation in the recorded parameters indicated that the aircraft then entered a counter-clockwise upright spin at a rotation rate of about one full turn every 1.5 seconds and a vertical descent rate of over 3,000 ft/min at the time of impact.

The engine power level remained at a constant high setting prior to the spin entry.

6 Accelerated aerodynamic stall: For an aerofoil whose angle of attack is increased rapidly, the onset of the stall can be delayed to angles in excess of the static stall angle. Once an accelerated aerodynamic stall does occur, however, it is usually more severe and more persistent than static stall. The angle of attack must be reduced to well below the static stall angle to reattach the airflow.

Figure 9: Last 60 seconds of recorded flight data parameters prior to the accident



Source: ATSB

Weight and balance information

The aircraft weight was calculated as being about 17 kg over the maximum allowable limit at take-off from Moorabbin Airport, but within the balance limits. However, the aircraft was within the weight and balance limits at the time of the accident, when the weight was adjusted for 1 hour 20 minutes of fuel consumption.

Previous accidents

BRM Aero Bristell registered 24-7954

Clyde North, Victoria

This accident was investigated by Recreational Aviation Australia. The accident investigation report is not a publically available document.

On 3 August 2017, during a training flight, a student pilot was conducting stall recovery training under supervision of an instructor at an altitude of 3,500 ft AGL. Following entry into the stall, the right wing dropped and, despite the correct instructed actions, the student pilot mishandled the stall recovery by applying opposite aileron. Although this is an intuitive response to raise the wing, it exacerbated the stall and the aircraft entered a spin.

The instructor took over control of the aircraft from the student and initiated the correct spin recovery technique using ailerons neutral and opposite rudder. Despite having 3,000 ft remaining, the instructor was unable to regain control of the aircraft before it impacted the terrain. The student pilot was fatally injured and the instructor sustained serious injuries.

BRM Aero NG5 registered G-OJCS

Belan, Co. Kildare Ireland

On 14 June 2019, during a flight with two occupants, recorded data showed that the engine power was reduced as the aircraft maintained about 3,200 ft with reducing airspeed. The aircraft then rapidly lost height and impacted the ground about 30 seconds later. The aircraft was destroyed and the two occupants were fatally injured.

The on-site examination indicated that the aircraft impacted the ground at a high vertical rate, in a nearly level attitude, whilst rotating anticlockwise about the yaw axis.

At the time of writing the accident was still under investigation by the Irish Aircraft Accident Investigation Unit.[7]

[7] AAIU preliminary report 2019-008

Safety analysis

Introduction

Examination of the aircraft and recorded flight data identified that there were no mechanical defects that contributed to the accident. Further, a review of the meteorological conditions as described by witnesses and the pilot indicated that weather was not a factor.

Evaluation of the flight data also established that the pilot engaged in aerobatic manoeuvres during the course of the flight, including just prior to the loss of control in the vicinity of Stawell Airport. This analysis will discuss the development of the accident in that context.

Aerobatic limitations

The Bristell light sport aircraft (LSA) operating instructions prohibit excessive angles of bank, aerobatics and intentional spins. This was clearly defined and the information relating to spin avoidance was also presented by way of a placard in the cockpit.

Civil aviation regulations stipulate the types of manoeuvres that are considered to be aerobatic. It also sets out the pilot training and endorsements requirements before aerobatics are to be conducted. The framework provided by these rules ensures that this hazardous activity can be performed with an acceptable level of safety.

When interviewed, the pilot demonstrated an awareness of the aircraft limitations and the requirements relating to aerobatics. Further, the pilot did not have any training or endorsements in aerobatics and did not apply for or receive permission from CASA to undertake aerobatics over a populous area. Despite that, manoeuvres meeting the definition of aerobatics were carried out during the accident flight in the form of abrupt changes in flight parameters and excessive bank and pitch.

Aerobatic manoeuvring and loss of control

Aerobatics were first conducted above a built-up area at 600-1,300 ft above ground level (AGL), and with a maximum bank angle of 94°. Had an unrecoverable loss of control occurred over such a populated area, in addition to the likely fatality of the occupants, there was a significantly increased risk of injuries or fatalities to people on the ground.

Additional aerobatics were conducted mid-flight between Bacchus Marsh and Stawell airports, with one exceeding the aircraft's flight load limitations. The aircraft was then observed by witnesses to overfly Stawell Airport before again commencing significant pitch and bank manoeuvres. During one of these manoeuvres, the aircraft experienced an accelerated aerodynamic stall and entered into an upright spin at an altitude of about 1,650 ft AGL. This progressed into a fully developed spin that continued until the aircraft impacted terrain.

Due to the accelerated nature of the spin entry and the already nose-down and banked attitude, the entry to the spin would probably have been abrupt and disorientating. The pilot reported not maintaining the correct spin recovery technique with respect to rudder input. Despite that, as discussed further below, even with immediate and sustained application of spin recovery control inputs, recovery from the spin may not have been possible.

The pilot's account of the aircraft manoeuvring during the flight, including immediately before the loss of control, did not align with either the flight data or the witness statements. The passenger only recalled fragments of information about the flight and did not recall what happened before the aircraft entered the spin.

The ATSB assessed that the recorded flight data was accurate. It clearly indicated that the aircraft was operated significantly beyond the allowable limits of both the aircraft and the pilot's qualifications, with catastrophic consequences.

Aircraft spin certification and characteristics

Non-aerobatic aircraft in the LSA category, such as the Bristell LSA, are certified to the ASTM International standards. As such, the aircraft is required to demonstrate the ability to recover from a one-turn or 3-second spin, whichever was longer, in not more than one additional turn. Recovery from a multiple-turn, fully developed spin is not required to be demonstrated.

As a consequence, there is no assurance that, even if the normal spin recovery technique was applied, that recovery from a fully developed spin is possible in the Bristell LSA aircraft.

In response to a number of fatal accidents involving Bristell aircraft entering and not recovering from spins in Australia and overseas, the Civil Aviation Safety Authority (CASA) assessed the Bristell LSA type certification testing documentation against the ASTM certification test standards. CASA found that there was insufficient information in the initial flight test data to provide assurance that the aircraft type met the ASTM standards for spin recovery. As a result, CASA requested more certification testing data from the manufacturer. The manufacturer conducted further certification flight tests in the Bristell LSA and provided that data, including video recordings of each flight sequence to CASA. CASA's assessment of the new flight testing data and other information provided after that point still did not confirm that the aircraft met the required ASTM standard for spin recovery. At the time of writing, CASA and the manufacturer were still in discussion.

In the context of this accident, as the aircraft was operated significantly outside its operating limitations, it was not possible to identify if a safety issue surrounding aircraft spin and recovery characteristics of the Bristell LSA exists.

Avionics memory and data use

There are many advantages to having recording devices installed in aircraft. These include, the use of downloaded data to monitor:

- student pilot performance
- third party aircraft usage
- engine health trends and aircraft limitation exceedances.

They also provide a significant source of evidence during the investigation of aircraft accidents.

The avionics system fitted to the accident aircraft had data storage capability and also backup storage capability by way of a secure digital (SD) card which could be fitted to the avionics system. An SD card was not fitted as standard equipment when Bristell aircraft were delivered to operators from new. Further, the operator was not aware of the additional memory card storage capability and had not installed SD cards in of their Bristell fleet. As a result, had the avionics unit memory module been damaged, then important recorded data associated with this accident could have been destroyed.

The ATSB encourages operators and owners of aircraft to, wherever possible, use on board recording capability to capture the available data parameters.

Findings

From the evidence available, the following findings are made with respect to the loss of control and collision with terrain involving a Bristell LSA aircraft, registered VH-YVX, in Stawell Victoria on 5 October 2018. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- While conducting aerobatics, the aircraft experienced an accelerated aerodynamic stall and entered into an upright spin that continued until impacted terrain.
- The pilot conducted aerobatic manoeuvres without aerobatic training, in an aircraft which prohibited such manoeuvres.

Other factors that increased risk

- During the accident flight, the pilot conducted aerobatics at low altitude over a built-up area in contravention to safe practices and the regulations. Had an unrecoverable loss of control occurred there was a significantly increased risk of injuries or fatalities to people on the ground.
- A regulatory review of the aircraft type’s self-certification flight test data and documentation by the Civil Aviation Safety Authority (ongoing at the time of writing) did not provide assurance that the aircraft type met the required standard for spin recovery.

Other findings

- The aircraft's avionics system, while capable of storing data, was not fitted with a memory card. The memory card serves as a back-up for stored data, which can be a readily accessible tool for both flying training and safety investigation.

Safety issues and actions

Proactive safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

Civil Aviation Safety Authority

During the investigation, the ATSB became aware that the Civil Aviation Safety Authority (CASA) was reviewing the BRM Aero Bristell LSA aircraft certification testing against the ASTM standards. At the time of writing, there was insufficient information available to assure CASA that the Bristell LSA aircraft met the required standard for spin recovery. Consequently, CASA has requested further information from the aircraft manufacturer.

The operator

The operator conducted a fleet-wide installation of SD cards to all aircraft capable of storing data.

General details

Occurrence details

Date and time:	05 October 2018 – 1240 EDT	
Occurrence category:	Accident	
Primary occurrence type:	Loss of control and collision with terrain	
Location:	Stawell, Victoria	
	Latitude: 37° 4.792' S	Longitude: 142° 45.415' E

Pilot details

Licence details:	Private Pilot Licence (Aeroplane), issued 13 August 2018
Endorsements:	Manual Propeller Pitch Control
Ratings:	Single engine aeroplane
Medical certificate:	Class 1 and 2, valid to 19 October 2018
Aeronautical experience:	about 160 flight hours

Aircraft details

Manufacturer and model:	BRM Aero S.R.O Bristell LSA	
Registration:	VH-YVX	
Operator:	Soar Aviation Aircraft Holding Pty Ltd	
Serial number:	284	
Type of operation:	Flight training	
Departure:	Moorabbin Vic.	
Destination:	Moorabbin Vic.	
Persons on board:	Crew – 1	Passengers – 1
Injuries:	Crew – Serious	Passengers – Serious
Aircraft damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the pilot and passenger
- witnesses and first responders to the accident
- the aircraft operator and manufacturer
- Civil Aviation Safety Authority
- Airservices Australia
- Victoria Police.

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 the pilot and passenger, the aircraft operator and manufacturer and the Civil Aviation Safety Authority.

Submissions were received from the pilot and passenger, the aircraft operator and manufacturer and the Civil Aviation Safety Authority. The submissions were 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 the ATSB's 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.

Terminology used in this report

Occurrence: accident or incident.

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

Contributing factor: a factor that, had it not occurred or existed at the time of an occurrence, then either:

(a) the occurrence would probably not have occurred; or

(b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or

(c) another contributing factor would probably not have occurred or existed.

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

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