



Australian Government
Australian Transport Safety Bureau

Loss of control involving scale-replica Spitfire, VH-VSF

near Parafield Airport, SA | 17 March 2013



Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2013-051
Final – 28 January 2014

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Publishing information

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Addendum

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Safety summary

What happened

On 17 March 2013, the owner-pilot of an amateur-built scale-replica Spitfire aircraft (VH-VSF) was participating in an air display at Parafield Airport, South Australia. The pilot performed a number of airborne passes above the runways in various directions and completed the display with a slow speed pass at 400 ft with the landing gear and some wing flap extended.

Towards the end of this pass the pilot radioed the tower to coordinate a landing and accepted runway 21 Left with an 11 kt crosswind. By now the pilot had turned right and the Spitfire was near the extended runway centreline and 1 km from the runway threshold at a slow speed. A left turn was then observed and, soon after, a wing dropped and the aircraft entered a steep descent. The aircraft crashed in a factory car park, fatally injuring the pilot and substantially damaging the aircraft.

What the ATSB found

The ATSB found that while coordinating a landing clearance with air traffic control and flying a low level circuit with a close downwind and base in turbulent conditions, the pilot inadvertently allowed the airspeed to decay. In the subsequent turn (downwind) to adjust the circuit the aircraft aerodynamically stalled, descended steeply, and impacted the ground.

The aircraft was prone to aerodynamically stall with little or no aerodynamic precursors and it was not fitted with a stall warning device, increasing the risk of inadvertent stall.

Safety message

Flying in an air display is different to normal operations and places additional demands on a pilot. Pilots who participate in air displays should consider the demands involved and to the extent possible ensure that the complete sequence, including landing, is planned and rehearsed.

Although amateur-built aircraft operated in the experimental category are not required to be fitted with a stall warning device (preferably with aural output), owner-pilots should consider the benefits of such devices as a last line of defence against stalling.

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The occurrence

On 17 March 2013, the owner of a scale-replica Spitfire Mk XXVI, registered VH-VSF, was scheduled to participate in an antique and classic aircraft air display at Parafield Airport, South Australia. The owner had built the Spitfire from a kit and operated it as an amateur-built aircraft in the experimental airworthiness category.

On the morning of the air display the owner flew the Spitfire to Parafield Airport from Murray Bridge aerodrome, 62 km to the south-east. After a 20-minute flight the owner landed at Parafield at 0817 Central Daylight-savings Time¹ and parked the Spitfire in the static display area. In addition to the static displays, various aircraft were scheduled to be flown in the air display including the Spitfire at 1400.

About an hour before the Spitfire air display, the pilot visited the control tower to request a briefing on the wind conditions. A controller advised him that the south-easterly wind was producing up to 15 kt crosswind on runways 21 Left and Right at an average 10 to 12 kt. The pilot said he was aware of turbulence being experienced in the circuit and the controller confirmed that this was usual with a south-easterly wind as it generated mechanical turbulence over the hills to the east of the airport. The pilot had expressed concern about the crosswind for take-off and landing but advised air display personnel that he was happy to proceed with the flight as scheduled.

At 1338, the tower cleared the Spitfire pilot for engine start, and a few minutes later cleared the pilot to taxi to the run-up area. At 1349 the pilot was cleared for take-off on runway 21 Right.

From data recorded by the onboard Global Positioning System (GPS), it was derived that the aircraft was airborne at 1350. The pilot climbed on the southerly heading then conducted a right teardrop turn to reverse direction and fly along the runway for the first fly-past of the Spitfire display. During the reversal turn the Spitfire reached a height of 1,360 ft at a ground speed of 97 kt, and on the fly-past descended to 400 ft at a maximum speed of 160 kt.

Passing abeam the main viewing area the pilot veered to the right and climbed then turned left to reverse direction for another fly-past along the runway. During this reversal the Spitfire reached 1,240 ft at a ground speed of 129 kt and on the pass descended to 778 ft at 149 kt. The pilot followed this general pattern (with one pass along runway 08 Left) to conduct a total of seven fly-pasts (Figure 1) with no aerobatics.

¹ Central Daylight-savings Time (CDT) was Coordinated Universal Time (UTC) +10.5 hours.

Figure 1: Spitfire GPS data of air display flight transposed onto satellite image



Source: Google Earth and GPS track data overlaid by ATSB

On the seventh fly-past the pilot was heading northward along runway 03 and descended to as low as 320 ft at 90 kt ground speed. For this pass the landing gear was down and some wing flap between 10° and 15° was extended (Figure 2). Witnesses did not notice anything unusual about the aircraft during this sequence.

Figure 2: Spitfire on seventh and last flypast



Source: Air display spectator, reproduced with permission

Soon after passing the main viewing area, at 1356:28, the Spitfire pilot transmitted that he was ready for landing and asked if runway 21 Left or Right were still favourable in relation to crosswind. The tower controller advised that the wind was halfway between runways 08 and 21 and cleared the pilot to track as required to join final for runway 21 Left (21L). The controller added that the crosswind at the time was showing as 11 kt. The pilot accepted the assigned runway.

During this radio exchange the pilot veered slight left then turned to the right while climbing slightly. The turn progressed through about 60° so that the Spitfire was now on an easterly heading at 480 ft and 56 kt ground speed, near the extended centreline of runway 21L, and about 1,000 m from the runway threshold (Figure 3).

By the time the pilot had made his last transmission at 1356:51 to accept the assigned runway, the direction of turn had changed to the left and the height peaked at 550 ft. As the turn progressed, groundspeed reduced to about 55 kt and a slight descent was noted. (The last recorded data points were of uncertain validity due to the limitations of some GPS devices in unusual flight conditions)

Figure 3: Spitfire GPS data re air display flight transposed onto satellite image (last fly-past and accident sequence highlighted red and prior display highlighted blue) with key events annotated



Source: Google Earth with track data and summary data overlaid by the ATSB

A significant number of witnesses recalled that the aircraft appeared to be flying very slowly prior to an abrupt left turn away from the runway. The left wing of the aircraft was observed to drop as the aircraft rolled into a steep nose-down descent. Some witnesses noticed a degree of spiralling before the aircraft descended out of sight.

The aerodrome controller witnessed the aircraft descending out of sight and instigated the aerodrome emergency response. A short time later the wreckage of the aircraft was located by emergency services in a factory car park about 1.5 km north of the runway 21L threshold. The pilot sustained fatal injuries and the aircraft was substantially damaged by impact forces.

Context

Pilot information

The pilot held a Private Pilot (Aeroplane) Licence issued in 1992 with the requisite Class 2 Medical Certificate and the necessary endorsements for operation of the replica Spitfire. He had logged a total of 1,665 hours flight experience, 190 of which were in the replica Spitfire. The pilot also held a Commercial Pilot (Aeroplane) Licence issued in 1997 that was rendered inactive without a Class 1 Medical Certificate.

The pilot completed a flight review in August 2011, which was conducted in his Van's Aircraft RV-6A aircraft by an instructor at Murray Bridge. The RV-6A is an amateur-built aircraft with dual controls and side-by-side seating rather than the single control tandem seating of the Spitfire. The instructor that conducted the flight review recounted that the pilot was a careful pilot who was competent at stall recognition and recovery.

The pilot was over 65 and on medication for a few medical conditions. Although the pilot's recent health was described by a family member as excellent, renewal of his Class 2 Medical Certificate was subject to audit of specialist medical reports by the Civil Aviation Safety Authority (CASA).

The day before the air display the owner flew the replica Spitfire and RV-6A in the Murray Bridge area. The data recorded by the Spitfire GPS showed a couple of low-level passes along runways and some manoeuvring that did not correspond to the pattern subsequently employed at the air display. On late downwind and early base of the circuit to land at Murray Bridge the ground speed was around 90 kt.

On the morning of the air display the pilot woke at about 0500 and before he left home for Murray Bridge aerodrome said he was feeling fine. At Parafield Airport, in the time before the display, the pilot talked to display attendees who later reported that he appeared to be fit and well.

Meteorological information

The meteorological conditions at Parafield Airport were consistent with the aerodrome forecast of no significant weather and an easterly wind becoming a bit stronger and more southerly after 1230. When the pilot took off for the display, the surface wind (averaged over 1 minute) at Parafield was 157° True (from the south-east) at 9 kt gusting to 13 kt. During the display, the average wind direction was relatively steady but wind strength increased to be 14 kt gusting to 17 kt at about the time of the accident.

Air display information

The organisers of the air display had sought and received permission from CASA to stage the display. In the written approval CASA imposed a number of conditions on the organisers and participating pilots.

Aircraft information

The Spitfire Mk XXVI kit was manufactured in Australia by Supermarine Aircraft Pty Ltd. The aircraft was designed as an 80 per cent scale replica of the famous World War II fighter and was of conventional riveted aluminium alloy construction. Maximum take-off weight for non-aerobatic flight was 810 kg.

The owner took delivery of the kit in 2002 and constructed the aircraft during the next 4 years. A special certificate of airworthiness designating the aircraft as experimental was issued by an authorised person on 3 August 2006.

A water-cooled fuel-injected Isuzu Motors 6VE1 petrol engine capable of producing 240 brake horsepower at sea level was installed with a North West Aero propeller speed reduction unit and Ivoprop constant speed propeller. This combination was one of the power plant options supported by the kit manufacturer. For engine management the owner selected an Electronic Control Unit (ECU) that had limited use in aviation applications and was not recognised by the kit manufacturer.

As an amateur-built aircraft operated in the experimental category, the replica Spitfire was not required to satisfy any certification requirements including those relating to build consistency and aircraft handling. As a kit-built aircraft, however, it could be expected to generally conform to generic type performance data.

Operating data provided for the aircraft type listed the stall speed with wing flap retracted as 54 kt, and with wing flap and landing gear extended as 45 kt (assuming 1 g flight). In 2006, when the owner conducted the requisite flight tests to establish the actual stall speeds, he recorded that the indicated airspeeds were within 2 kt of the typical figures. At the time he noted that in the landing configuration, after initial slight buffeting and hesitation, the left wing dropped suddenly. He also noted that normal recovery techniques were effective. The aircraft was not fitted with a stall warning device, nor was it required to be.

Shortly after the stall testing, the owner conducted in-flight calibration of the airspeed indicator using reciprocal courses with GPS ground speed data and found that the indicator was under-reading by about 8 kt. On that basis, the owner recorded the actual stall speeds as 63 kt with wing flap and landing gear retracted, and 57 kt with them extended.

The replica Spitfire kit manufacturer advised that their test pilots had found the aircraft type to be stable at low speeds and that a wing drop would only occur if left or right aileron was applied. Under flight test conditions, the average height loss during stall recovery was reported to be 200 ft.

As permitted by a general authorisation issued by CASA to amateur aircraft builders, the owner performed most of the maintenance on the replica Spitfire. Maintenance records indicated that scheduled maintenance was based on Schedule 5 of the Civil Aviation Regulations. The last recorded maintenance in the logbook was described as a major service conducted in May 2012 at 167 hours total time in service. On completion of this service the owner issued a maintenance release that was current at the time of the accident and recorded the total time in service as 175 hours. No defects were endorsed on the maintenance release.

Wreckage information

Damage to the aircraft was consistent with it descending steeply into terrain at a high rate of descent in a wings-level, nose-down attitude (Figure 4). There was no evidence of in-flight structural failure. All of the aircraft's components were accounted for at the accident site, with no evidence of pre-impact damage. Continuity of the aircraft's flight and engine control systems was established and on-site evidence indicated that the engine was producing power at ground impact. The fuel tank ruptured on impact with the result that no fuel was available for testing. The engine and a number of instruments and electronic units were recovered from the accident site for technical examination.

Figure 4: Aircraft wreckage

Source: ATSB

The engine was disassembled and inspected under the supervision of the ATSB. It was found that the engine was in good condition with no mechanical defects or anomalies.

An attempt to download engine parameter data from the ECU was unsuccessful. However, the calibration program file active for the accident flight was retrieved. This calibration file was compared to the archived file active in March 2003 and some differences were noted.

The extant calibration was set for an eight cylinder engine rather than the applicable six cylinder engine as in the earlier file. Ignition output and timing was altered as was fuel delivery during high power settings. The ECU manufacturer advised that these alterations from the earlier calibration would marginally reduce engine performance and increase the risk of engine damage by an unknown amount.

The only instrument to yield useful information was the engine tachometer, which displayed a 'witness mark' adjacent to the 2,400 RPM gradation. This mark, made by indicating pointer movement at ground impact, was consistent with engine operation at low power.

Occurrence data

At the time of releasing this report, there were 17 other replica Spitfires on the CASA register and this accident was the second loss of control event involving a replica Spitfire reported to the ATSB. The first event occurred during a go around, when the aircraft stalled at low level and landed heavily off the runway. An additional event, involving a non-VH-registered replica Spitfire, was a collision with terrain that fatally injured the pilot. This was reported to be the result of a stall on approach to land.

In an analysis of accidents involving VH-registered non-factory-built aeroplanes between 1988 and 2010, the ATSB found that loss of control was attributed to 25 per cent of all amateur-built accidents compared with 19 per cent of the factory-built accidents. However, the loss of control accident rate for amateur-built aircraft was over four times higher and serious injury was three times more likely after loss of control in amateur-built aircraft accidents than for factory-built. Loss of control accidents were more likely to be from aircraft handling issues where pilots had relatively less experience on the aircraft type, and to a lesser extent, engine problems.

A copy of the ATSB aviation research report, reference number AR-2007-043(2), is available from www.atsb.gov.au.

Safety analysis

Introduction

From the witness information and accident site it is evident that the pilot lost control of the replica Spitfire and was unable to recover before impacting the ground. The observed departure from controlled flight was consistent with an aerodynamic stall and the GPS-derived airspeeds were in the stall speed region. The analysis following will review the factors in the stall and the availability of preventive measures.

Loss of control

During the last pass of the replica Spitfire display, the pilot purposely slowed the aircraft, extended some wing flap, and lowered the landing gear as part of the demonstration. This altered the aerodynamics relative to the previous passes in that the lower airspeed resulted in less airflow over the wings and consequently less lift. To compensate, the angle of the wings relative to airflow (angle of attack) needed to be increased through rearward control column movement and/or flap extension to enhance the capability of the wing to generate lift.

With a relatively high angle of attack, some flap extended, and the landing gear down, the aircraft was in a high aerodynamic drag situation that required significant engine power to maintain the desired flight path at a safe airspeed. When the pilot banked the aircraft to the right in an apparent base leg for the assigned runway, the lift generated by the wings was then at an angle and was therefore less effective in supporting the aircraft's weight. To maintain height and speed in this situation, the pilot needed to increase angle of attack and engine power.

The recorded data shows that the pilot maintained height and even climbed slightly but allowed the airspeed to decay. It is unlikely that the pilot intended to operate at such low speeds in the circuit for landing so he must have been unaware of the developing situation. This can be attributed to the pilot being focussed on coordinating a landing clearance for a suitable runway in challenging wind conditions.

Once the pilot had turned through the 60° he probably realised that the aircraft was close to the runway threshold and already on the extended centreline of the runway. This positioning in the circuit could be expected to make the task of completing the turn and aligning on the runway quite difficult. So when the aircraft entered the subsequent left turn it is likely that the pilot was readjusting the circuit for a less awkward intercept of final approach.

Whatever the reason, the left turn placed the aircraft downwind in a situation where the angle of attack was increasing due to a slight climb and airspeed that was decreasing towards the stall speed. It is evident that the angle of attack then exceeded the stall angle with a consequent drop in lift and steep descent. Although the pilot might have initiated appropriate recovery actions there was limited height available to allow those to take effect.

With the pilot busy communicating with air traffic control and trying to navigate a circuit to the assigned runway, he did not detect the decaying airspeed. Then, when a stall was imminent there were minimal aerodynamic precursors provided by the aircraft design and no stall warning devices to alert the pilot.

Although the airspeed indicator was reportedly inaccurate at slow speed, this was considered to have had little effect because the pilot was aware of it and in under-reading the indicator was showing the airspeed lower than it actually was.

The severity of any turbulence and its effect on the latter stages of the flight could not be established. It is possible that the pilot encountered turbulence that altered the local airflow relative to the wings and precipitated a stall but such conditions would only be exacerbation of an already high-risk situation.

In the context of the pilot being in an older age group and ongoing medical treatment, incapacitation was considered. This was found to be unlikely as the pilot was communicating with air traffic control up to just before the loss of control and the abrupt nature of the loss of control was not consistent with the immediate effects of pilot disablement.

Safety considerations

Flying in an air display is different to normal operations and places additional demands on a pilot. While the pilot had completed the fly-pasts that made up the display with no apparent problems, it is likely that the pilot's stress level was higher than usual and this might have adversely affected his management of the non-routine circuit. Pilots who participate in air displays should consider the demands involved and to the extent possible ensure that the complete sequence is planned and rehearsed.

While the accident occurred when the pilot was manoeuvring to land after completion of the display flying, the ATSB reviewed the assurance processes for ensuring safe outcomes during the display activity. It was noted that CASA had provided the necessary approval and imposed appropriate conditions on the organisers and participating pilots to mitigate risk.

Pilot knowledge and skill in recognising a developing stall situation and responding effectively is an essential element of flight safety in any operation. In this case, the pilot of the Spitfire held a private pilot licence and had completed flight training for a commercial pilot licence, both of which included prerequisite stall training. Following on from the training, the pilot had carried out stalls in the Spitfire as part of the post-build testing, though it was not known if he had conducted any stall practice in the Spitfire since.

In addition to pilot competence, aircraft characteristics approaching and entering a stall are important safety factors. This includes flight control forces, aerodynamic precursors such as pre-stall buffet, and aircraft behaviour post stall. In regard to those factors, this replica Spitfire was known to stall with few precursors and to drop a wing but there was no evidence that the other factors were problematic.

One of the limitations of stall training and practice is that stalls are generally expected and can follow a routine pattern. For unexpected situations that develop in a non-routine way, a pilot may be focussed on solving whatever problem is at hand and miss the available cues. This is where some form of stall warning device can be valuable as a trigger to prioritise the handling of the aircraft before the stalling angle is reached.

Although amateur-built aircraft operated in the experimental category are not required to be fitted with a stall warning device, owner-pilots should consider the benefits of such devices (preferably with aural output) as a last line of defence against stalling.

Findings

From the evidence available, the following findings are made with respect to the loss of control involving scale replica Spitfire Mk XXVI, registered VH-VSF that occurred near Parafield Airport, South Australia on 17 March 2013. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factor

- While coordinating a landing clearance with air traffic control and flying a low level circuit with a close downwind and base in turbulence, the pilot inadvertently allowed the airspeed to decay and in the subsequent turn (downwind) to adjust the circuit the aircraft aerodynamically stalled, descended steeply, and impacted the ground.

Other factor that increased risk

- The aircraft could aerodynamically stall with little or no aerodynamic precursors and it was not fitted with a stall warning device, increasing the risk of inadvertent stall.

General details

Occurrence details

Date and time:	17 March 2013 – 1357 CDT	
Occurrence category:	Accident	
Primary occurrence type:	Loss of control	
Location:	Near Parafield Airport, SA	
	Latitude: 34° 46.801' S	Longitude: 138° 38.902' E

Aircraft details

Manufacturer and model:	Amateur-built scale-replica Spitfire Mk XXVI	
Registration:	VH-VSF	
Operator:	Owner	
Serial number:	Kit No. 20	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 1 (fatal)	Passengers – N/A
Damage:	Substantial	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the witnesses
- the tower controllers
- the Civil Aviation Safety Authority (CASA)
- Supermarine Aircraft Pty Ltd
- South Australian Police.

Submissions

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

A draft of this report was provided to the Civil Aviation Safety Authority, Airservices Australia, the tower controllers, the air display organiser and Supermarine Aircraft Pty Ltd. A submission was received from Supermarine Aircraft Pty Ltd. The submission was reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (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 fare-paying passenger operations.

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

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the 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.

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Investigation

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