ACCIDENT

Aircraft Type and Registration:	Pitts S-1S, G-BOXV
No & Type of Engines:	1 Superior XP-IO-360-A1HC3 piston engine
Year of Manufacture:	1984 (Serial no: 7-0433)
Date & Time (UTC):	26 August 2022 at 0904 hrs
Location:	Shobdon Airfield, Herefordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Destroyed
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	1,978 hours (of which 530 were on type) Last 90 days - 26 hours Last 28 days - 8 hours
Information Source:	AAIB Field Investigation

Synopsis

During an aerobatic practice flight, G-BOXV was seen to enter a climbing vertical rolling manoeuvre from approximately 420 ft agl. The aircraft yawed right at the top of the manoeuvre which apexed at approximately 1,100 ft agl. During the right yaw, an uncommanded autorotative right roll developed and the aircraft entered a steep nose-down spiral dive. As the pilot attempted to pull out of the ensuing dive, the aircraft experienced an accelerated stall and a rolling departure to the right. At that point there was insufficient height remaining in which to effect a safe recovery and the aircraft struck the ground. The pilot was fatally injured in the accident.

No causal or contributory technical issues were identified during the post-accident examination of the aircraft.

The investigation found that the entry conditions to the initial climbing manoeuvre gave little or no safety margin when the aircraft began to dynamically diverge from the expected flight path at the apex. Entering the manoeuvre with more height and/or speed would likely have increased the pilot's chances of avoiding the loss of control and/or being able to recover from it safely.

Generic guidance for aerobatic pilots is contained in CAA Safety Sense Leaflet 19 – '*Aerobatics*'.[1]

Footnote

[1] https://publicapps.caa.co.uk/docs/33/20130121SSL19.pdf [accessed 7 February 2022].

History of the flight

The accident occurred on the first of two aerobatic practice flights the pilot had planned to undertake in the overhead of Shobdon Airfield (Shobdon) on 26 August 2022. While the second flight was to be a rehearsal of the display sequence the pilot intended to fly at a private event on 28 August, the investigation did not find evidence as to the pilot's detailed intentions for the accident flight.

G-BOXV took off from Runway 26 at approximately 0900 hrs. The pilot turned left on departure and climbed to position the aircraft south of the runway before commencing his aerobatic manoeuvring. Mobile phone video taken by an eyewitness showed the aircraft completing three distinct aerobatic manoeuvre combinations before, when approaching the eastern end of the airfield, it pulled up into a vertical climb from approximately 420 ±50 ft agl on a broadly easterly heading. While the aircraft did not stay in the video frame for all the subsequent manoeuvring, it could be seen that the aircraft was rolled left through approximately 450° as it climbed. The nature of the rolling motion indicated the pilot likely had some left rudder applied during the roll because G-BOXV's longitudinal axis was not closely aligned with the aircraft's upward flight path (Figure 1).

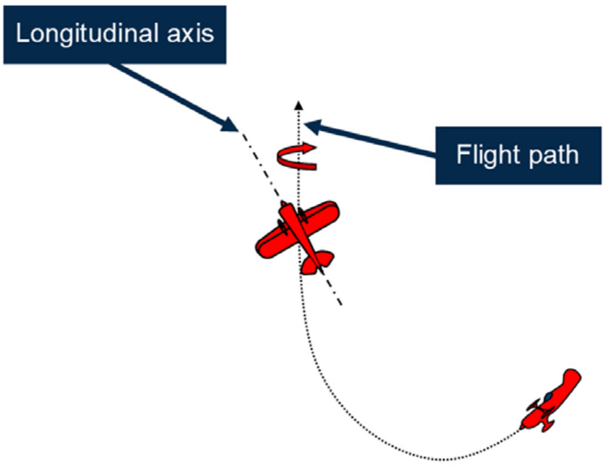

Figure 1
Pull up into vertical roll
(not to scale)

The aircraft continued climbing until reaching an estimated apex height of 1,100 ±200 ft agl. At the top of the manoeuvre G-BOXV was banked to approximately 90° right wing low with the nose 30°- 45° above the horizon. The nose of the aircraft then dropped progressively lower while the bank was maintained (Figure 2). During the transition from nose-up to nose-down, G-BOXV's nose appeared to fall more due to gravity than as the result of significant rudder application generating the right yaw.

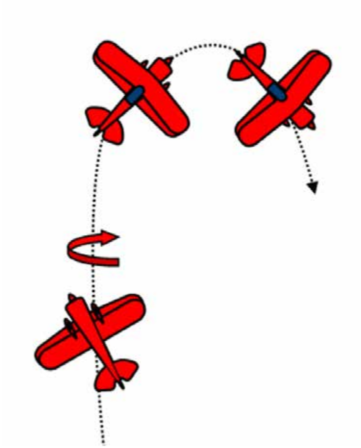

Figure 2
Apex of the climbing manoeuvre
(not to scale)

As the nose dropped through an estimated 45° nose-down, the aircraft began rolling right and the nose dropped further to approximately 80° nose-down (Figure 3). The aircraft continued rolling right, passing 360° of roll in approximately 2½ seconds. Audio recording from the mobile telephone footage corroborated eyewitness evidence that the engine rpm reduced, likely to idle, shortly after the aircraft began rolling during the descent.

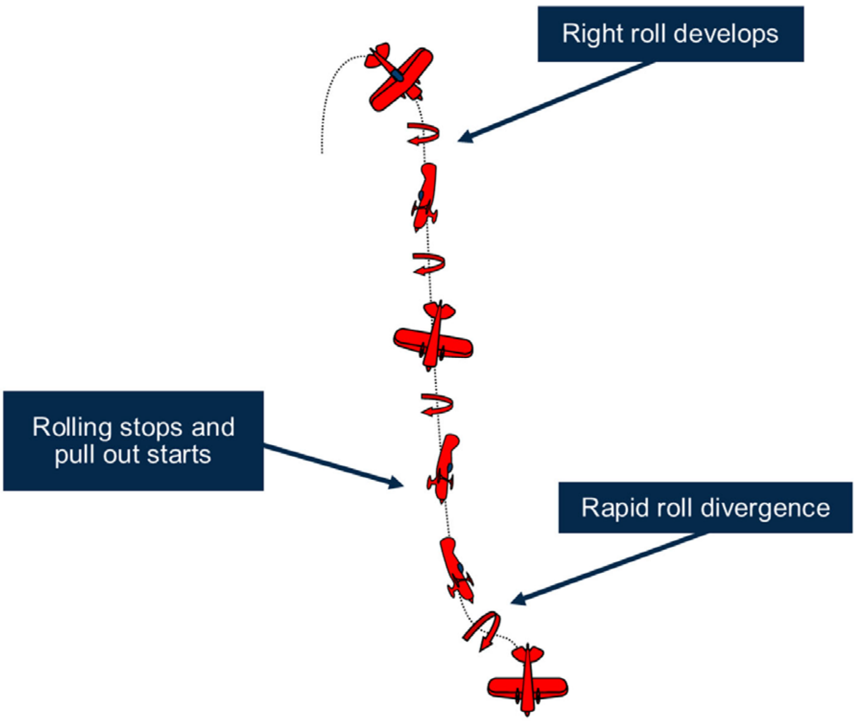

Figure 3
Downwards flight path
(not to scale)

Video footage showed the aircraft stopped rolling after approximately 1¼ turns, at which point it was pointing vertically down, if not slightly inverted. At this stage G-BOXV was approximately 400 ft agl. As the roll stopped, the aircraft's pitch attitude started to decrease, and the pilot appeared to be attempting to pull out of the dive. This pitching motion continued only briefly, stopping abruptly just before the aircraft diverged rapidly in roll to the right from about 200-250 ft agl (Figure 3). The divergent right roll continued until the aircraft struck the ground in an almost vertical attitude, just over two seconds later.

From the apex of the climb to impact with the ground took approximately 9 seconds, and only 7 seconds from the roll starting as the aircraft's attitude passed through 45° nose-down.

The airfield fire and rescue crew approached the accident site less than 3 minutes from the alarm being raised and, shortly thereafter, began fighting what remained of the intense post-crash fire. The pilot did not survive the initial impact.

Accident site

The aircraft struck the ground in a recently harvested and drilled crop field approximately 130 m south of the threshold of Runway 26 at Shobdon (Figure 4). An intense post-impact fire destroyed most of the aircraft.

Ground markings indicated that the aircraft struck the ground at a near vertical attitude, with the upper wing facing east. It then bounced and came to rest, upright, with the aircraft pointing in an east-south-east direction. The wings, which were of fabric covered wooden spar construction, were consumed by the post-impact fire and the fabric that covered the steel spaceframe fuselage was also consumed. One of the blades of the two-bladed fixed pitch propeller had cut into the ground and fractured at the hub. This portion of the propeller remained at the impact location; the other blade remained attached to the hub.

Continuity was confirmed for the aileron and elevator controls. The right rudder cable was also continuous, but the left rudder cable was found to have fractured close to the pilot's seat.

Recorded information

No sources of recorded data were recovered from the aircraft. The aircraft was not tracked by radar or other aircraft tracking networks.

The location of the cameras that recorded the three videos of the accident used in this investigation are shown in Figure 4.

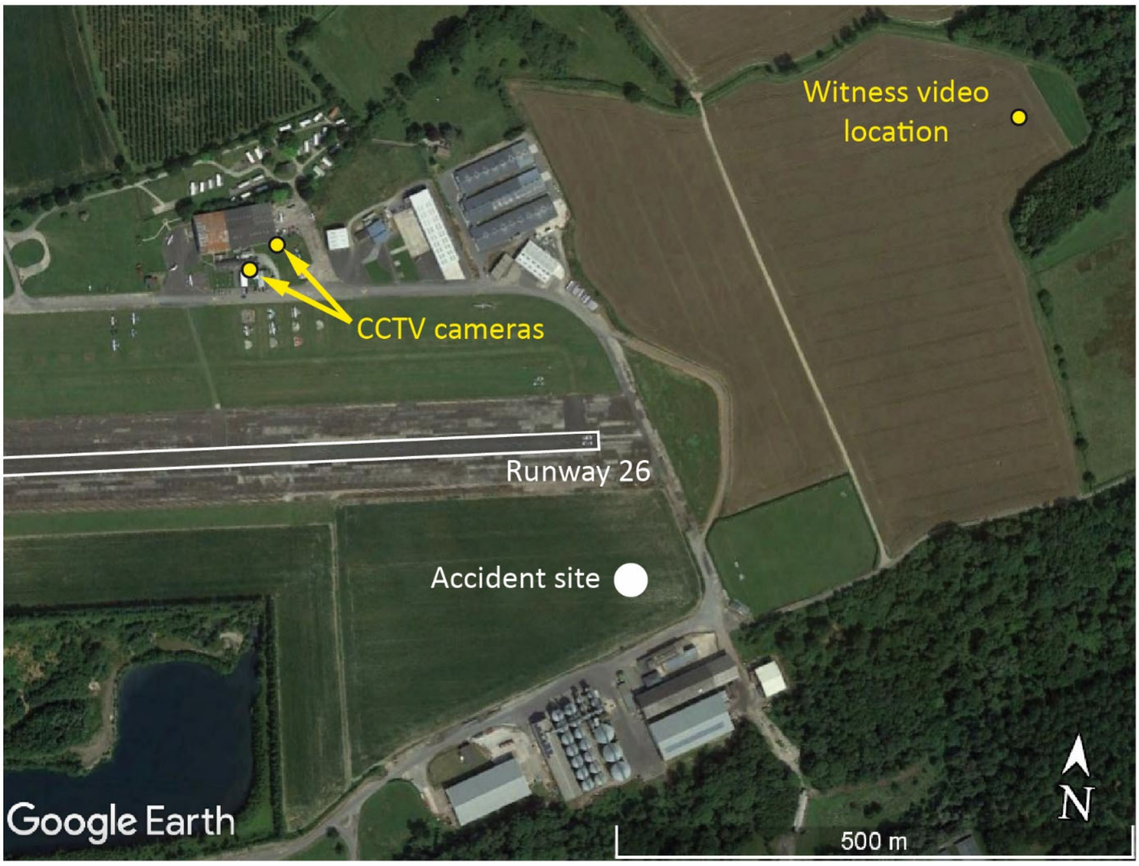

Figure 4
Sources of video recordings

CCTV cameras captured the lower parts of some of the manoeuvres and the impact with the ground. The field of view of the CCTV cameras did not extend up enough to capture higher parts of the manoeuvres flown, including the final accident manoeuvre. Figure 5 shows the final descent captured on CCTV.

A witness in a field to the north-east of the accident site recorded a video using their mobile phone. The aircraft was not always in frame as the phone was panned but it did capture most of the final manoeuvre. A difficulty with determining the flight path of the aircraft from this video is that, during a large part of the manoeuvre, the background was entirely made of cloud with few features to show how the camera was panning. Software tools were used to pattern match large areas of cloud to model the camera orientation when ground features were not in view. The limitations of this, and the assumptions required for estimating distance to the aircraft when it was in view of only one camera, have been accounted for in the error margins for the apex height stated earlier in this report.

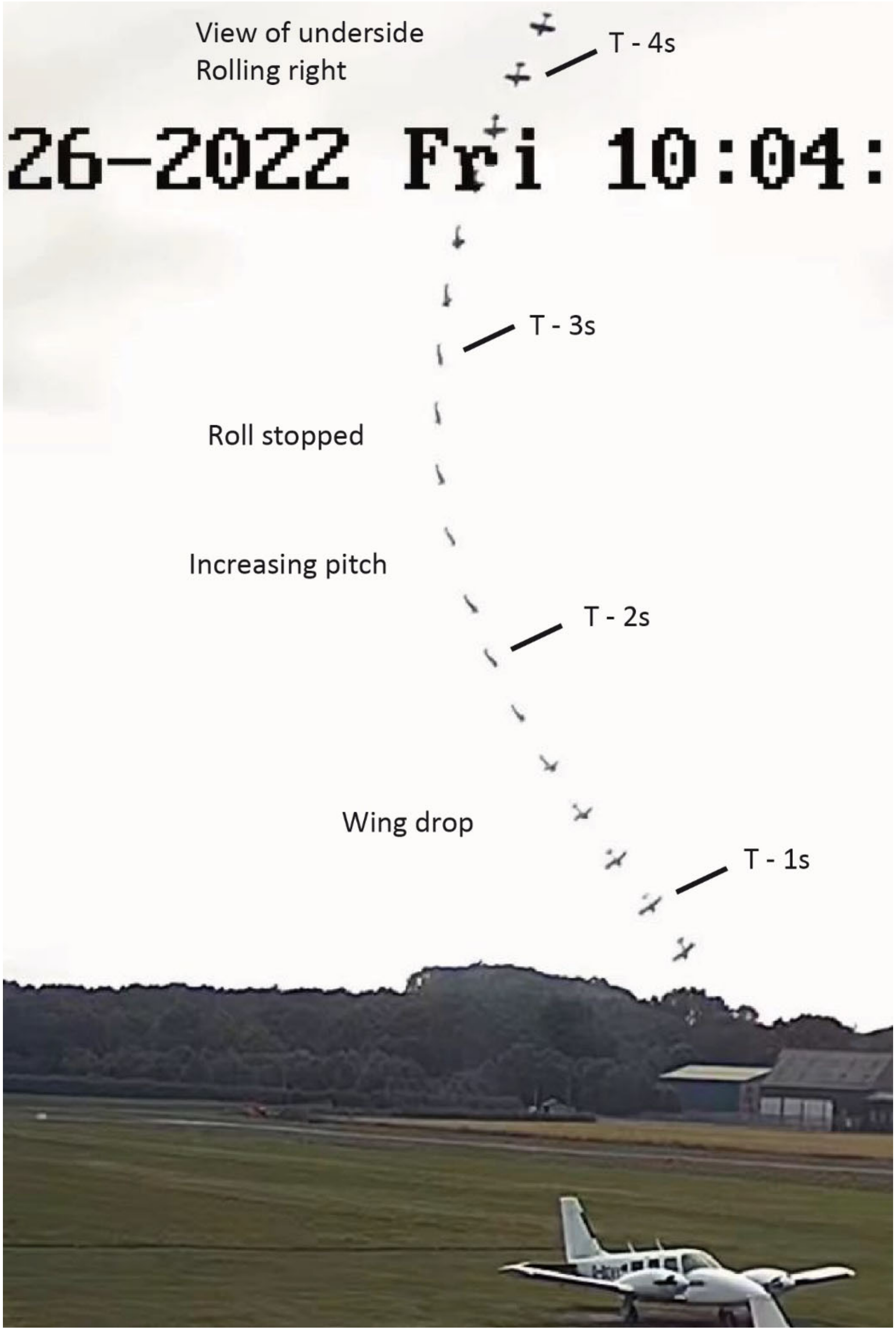

Figure 5

Compound image of cropped CCTV snapshots 0.2 seconds apart until 0.8 seconds before contact with the ground

The mobile phone video also captured the sound of the propeller (Figure 6). The frequency of the recorded tone is related to the speed of the propeller but is also affected by doppler shift due to the aircraft moving towards or away from the recording device. In this case the frequency shift was predominantly due to the initial speed of the aircraft at the start of the manoeuvre being largely towards the recording position. With fixed pitch propellers, such as the one in use, the speed of the propeller is affected by airspeed and the throttle position.

The audio recorded a sharp drop in propeller speed which, after factoring in the time taken for the sound to travel from the aircraft to the mobile phone, was about six seconds before impact. No sound of the impact was identified as the audio was swamped at this point by voices at the recording location.

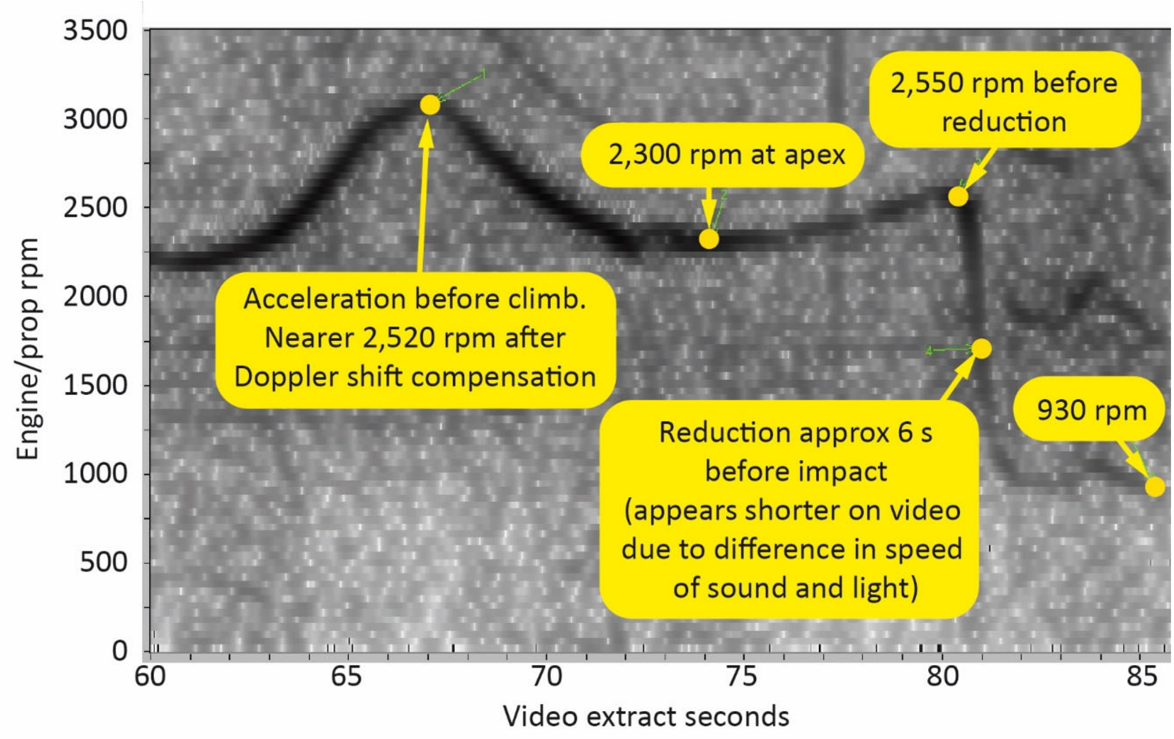

Figure 6

Spectrum analysis of the audio track of the mobile phone recording showing tone due to propeller blade noise. Scale halved to reflect propeller rpm rather than blade passes per minute

Aircraft information

The Pitts Special S-1S is a single seat, light aerobatic biplane built for competition aerobatics. Its wings are of wooden spar and ribs construction, with the fuselage made of a steel spaceframe. The wings and fuselage are covered in doped fabric. The aircraft has conventional flight controls with ailerons positioned on both upper and lower wings.

G-BOXV was built in the USA in 1984 and transferred to the UK register in 1990. The pilot purchased the aircraft in 2003, at which time it had accrued 230 flying hours. In January 2019, the original Lycoming engine was replaced with a new Superior XP-IO-360-A1HC3 engine. The fixed pitch MT-propeller which had been fitted in 2010 was retained. At the time of the accident the aircraft had flown 666 hours, with the engine accruing 54 hours. The aircraft had a valid Permit to Fly which had been revalidated in May 2022.

Aircraft examination

The aircraft wreckage was transported to the AAIB facility in Farnborough for further examination. The fractured rudder cable was removed from the aircraft and examined in a laboratory. This examination determined that the fracture had occurred because of loading associated with impact-related airframe distortion in combination with heating from the post-accident fire and did not pre-exist the accident sequence.

Examination of the remainder of the aircraft, including the engine, found no indication of damage that existed before the accident, but the extensive damage, caused by the intense post-accident fire, meant a complete assessment of the aircraft was not possible.

Survivability

The pilot was wearing a parachute but, with limited time and height available to him from the point at which the aircraft started rolling after the final manoeuvre apex, abandoning the aircraft would not have been an option. The forces exerted on the pilot during the impact resulted in injuries that were not survivable.

Weight and balance

The investigation was not able to ascertain the exact fuel load on board G-BOXV at the time of the accident. Weight and balance calculations confirmed that the aircraft would have been within its approved weight and CG envelope with the fuel tank full, empty or at any level in between.

Aircraft performance

Spinning, autorotation and spiral dives

Spins are preceded by a stall which can be from straight or accelerated flight. Once the wing has stalled, the phenomenon that develops and sustains a spin is autorotation. Autorotation can be defined as a self-sustaining rotational motion, initially in roll but may result in significant yaw depending on the nature of the spin, for example, in a flat spin the autorotation would be wholly yaw.

The main differences between a spin and a spiral dive are that spins can be erratic as they develop, and they are associated with a low indicated airspeed and significant yaw. Spiral dives tend to have higher and increasing airspeeds, low levels of yaw and, with the aircraft not being in a stalled condition, they are generally smoother than a spin.

Pitts Special spinning characteristics

The following information regarding height loss during spinning had been provided to a previous AAIB investigation into an accident involving a two-seat Pitts Special aircraft (G-ODDS[2]) in 2019.

Footnote

[2] AAIB investigation to Pitts S-2A Pitts Special, G-ODDS - GOV.UK (www.gov.uk) [accessed 9 November 2022].

> '[assuming] *that a conventional technique to induce and maintain a spin was used, ie full rudder and control column held fully back with ailerons neutral… the manufacturer indicated that a 10-turn upright spin incurred a height loss of 3,400 ft in an elapsed time of 32 seconds. Therefore, each spin rotation takes approximately three seconds and incurs a loss of 340 ft with a rate of descent of approximately 6,800 fpm.*
>
> *The manufacturer advised that, with full opposite rudder deflection and neutral (or released) control column, it would take approximately 500 ft to stop the rotation and then another 500 ft to level flight with a 4 g acceleration.'*

The G-ODDS report also contained the following observation regarding spin recovery technique:

> *'…if in-spin aileron was maintained during the recovery the aircraft could potentially enter another spin, possibly inverted, in the opposite direction.'*

Pitts Special pilots who spoke to the G-BOXV investigation reported that, in an erect spin, the aircraft would adopt a "relatively flat" 30°-50° nose-down attitude while the airspeed would remain "low and stable." The manufacturer's information indicated that it would take 500 ft to stop the rotation from a fully developed spin at 6,800 fpm rate of descent. One pilot reported that, for a single turn spin before the rate of descent had built significantly, he found it possible to effect recovery to level flight in approximately 500 ft from initiating spin recovery action.

Meteorology

The weather at the time of the accident was benign. There was good visibility with a distinct horizon at low level, the wind was calm, and the cloud base was broken[3] at 2,500-3,000 ft.

Airfield accident response

Because aerobatic practices in the airfield overhead were not routinely permitted at Shobdon, the local procedures had not included any requirement for an enhanced level of standby posture for the on-site fire and rescue assets. While not included in the airfield procedures, shortly after G-BOXV took off, the Airfield Manager and on-duty Flight Information Service Officer (FISO) independently thought it prudent to put the fire crew on '*local standby*' as they would for a first solo flight. Consequently, the lead fire fighter had already donned protective clothing and was able to board the response vehicle, parked in front of the ATC building, within one minute of the alarm being raised. The second firefighter saw the impact while he was mowing the grass at the western end of the airfield and immediately drove back to join the rescue vehicle. The fire crew arrived on scene within three minutes of the accident occurring. In light of this accident, it was decided that the airfield fire and rescue service would, in future, be brought to immediate readiness for any aerobatic practices in the overhead as well as for first solo flights.

Footnote

[3] Five to seven eighths coverage.

The combined operations team had recently updated the airfield incident response plan. Their previous experience was that, in stressful situations, standard sequential checklists were not always easy to follow, and their unidirectional flow pattern meant that, if steps in the process were missed, the slip was less likely to be caught and rectified. As a counter to this, they had developed a three-phase matrix response aide-memoire with key action priorities for each phase forming a circular flow chart (Figure 7).

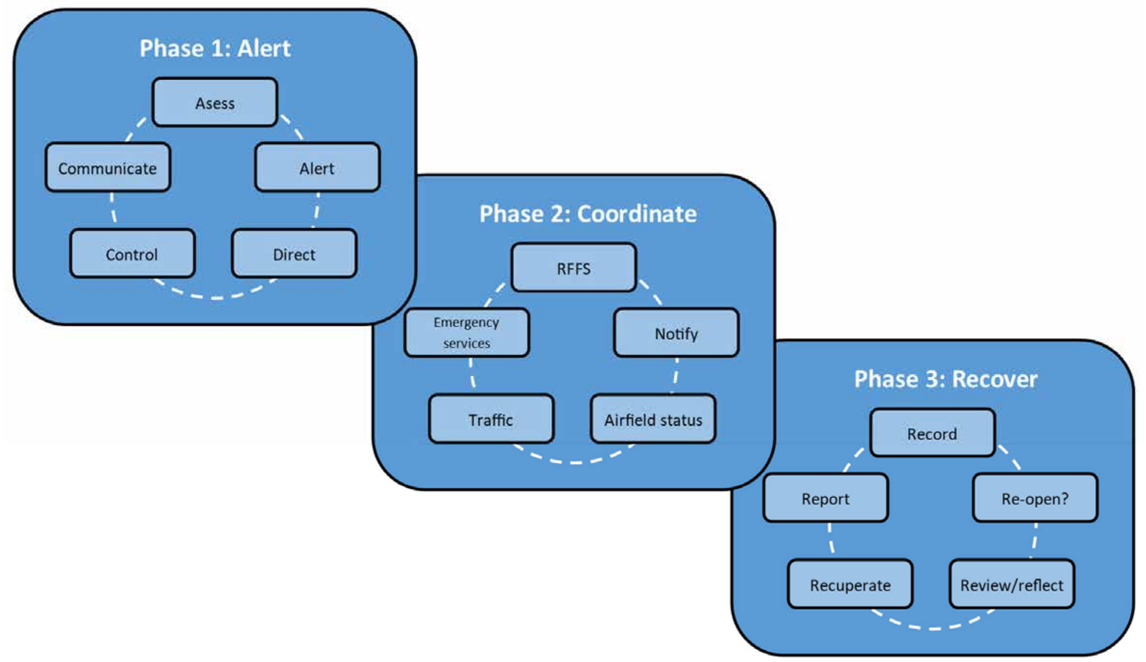

Figure 7

Overview of airfield incident response matrix (used with permission)

Within each action priority area, amplifying notes were provided as further prompts to the person coordinating the response. The matrix had been successfully trialled during a recent simulated emergency at Shobdon. Airfield personnel judged that the revised incident response matrix as well as their recent training had left them well prepared for the challenges posed by this accident.

Personnel

The pilot was a commercial pilot's licence holder with a Flying Instructor rating. He was an Intermediate Category competition aerobatics pilot and a qualified Upset Prevention and Recovery Training (UPRT) instructor. Before the accident flight, he last flew G-BOXV in an aerobatic competition on 21 May 2022 and had flown one further aerobatic practice in the aircraft on 9 July 2022. Between 9 July and 26 August, the pilot had undertaken 13 UPRT training flights as the instructor in a Slingsby T67M-200 Firefly aircraft.

The pilot's Class 1 aviation medical was valid, and the post-mortem could find no evidence of any chronic or acute medical condition that might have been causal or contributory to the accident.

Other information

Planned aerobatic manoeuvres/sequence

Documentation provided to the investigation indicated that, for his second planned flight, the pilot intended anchoring his display over a datum south of the runway (Figure 8). During the accident flight, the pilot began aerobatic manoeuvring south and west of this display area. The way the manoeuvres progressed suggested the pilot could have been using them to warm up while re-positioning the aircraft closer to his intended datum.

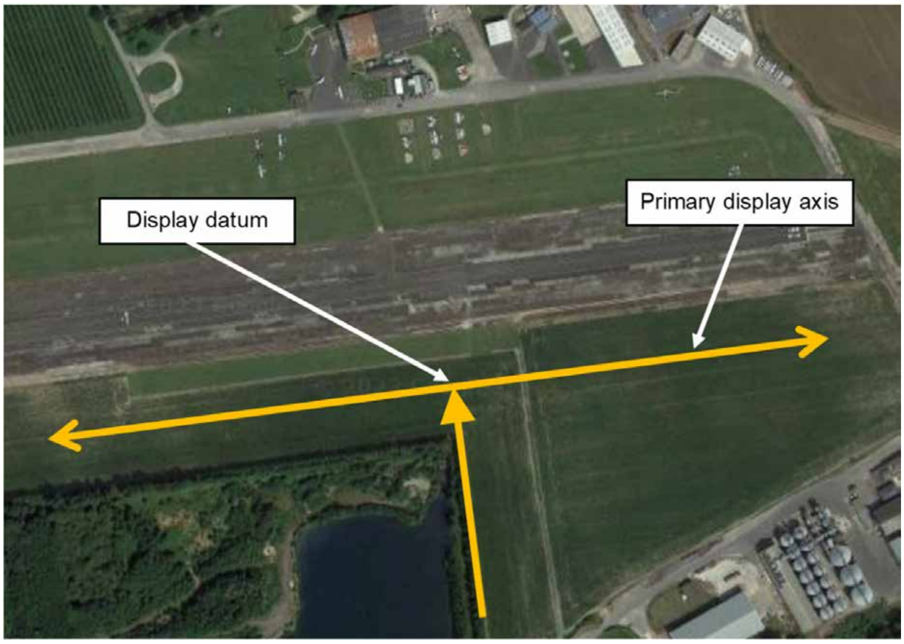

Figure 8

Primary display axis and datum for the pilot's second planned flight
(Imagery ©2023 Bluesky, Infoterra Ltd & COWI A/S, CNES / Airbus, Getmapping plc, Maxar Technologies)

The investigation consulted several pilots who had expert knowledge of the aircraft type and/or knowledge of the pilot's handling style and approach to flying to try and establish where the accident manoeuvre diverged from the pilot's intent.

The AAIB obtained evidence of two different aerobatic sequences the pilot was known to fly, one for aerobatic competitions and one for displays. Neither written sequence correlated to the sequence of manoeuvres captured on the mobile phone video of the accident flight.

The closest comparable manoeuvres to that immediately preceding the accident were the '*Avalanche*' and '*Reverse half Cuban*' from his display sequence and a 180° vertical roll followed by a 1½ turn spin from his competition sequence (Figure 9). Annotations on a copy of the pilot's competition sequence indicated he used 2,500 ft agl as a target entry height for the spin and that, in contrast to the accident manoeuvre, it was preceded by decelerating level and erect flight to generate the required stall conditions for entry. While all three manoeuvres began with climbing rolls ±45° from the vertical, none of them included a 450° upwards roll followed by a tight descending spiral.

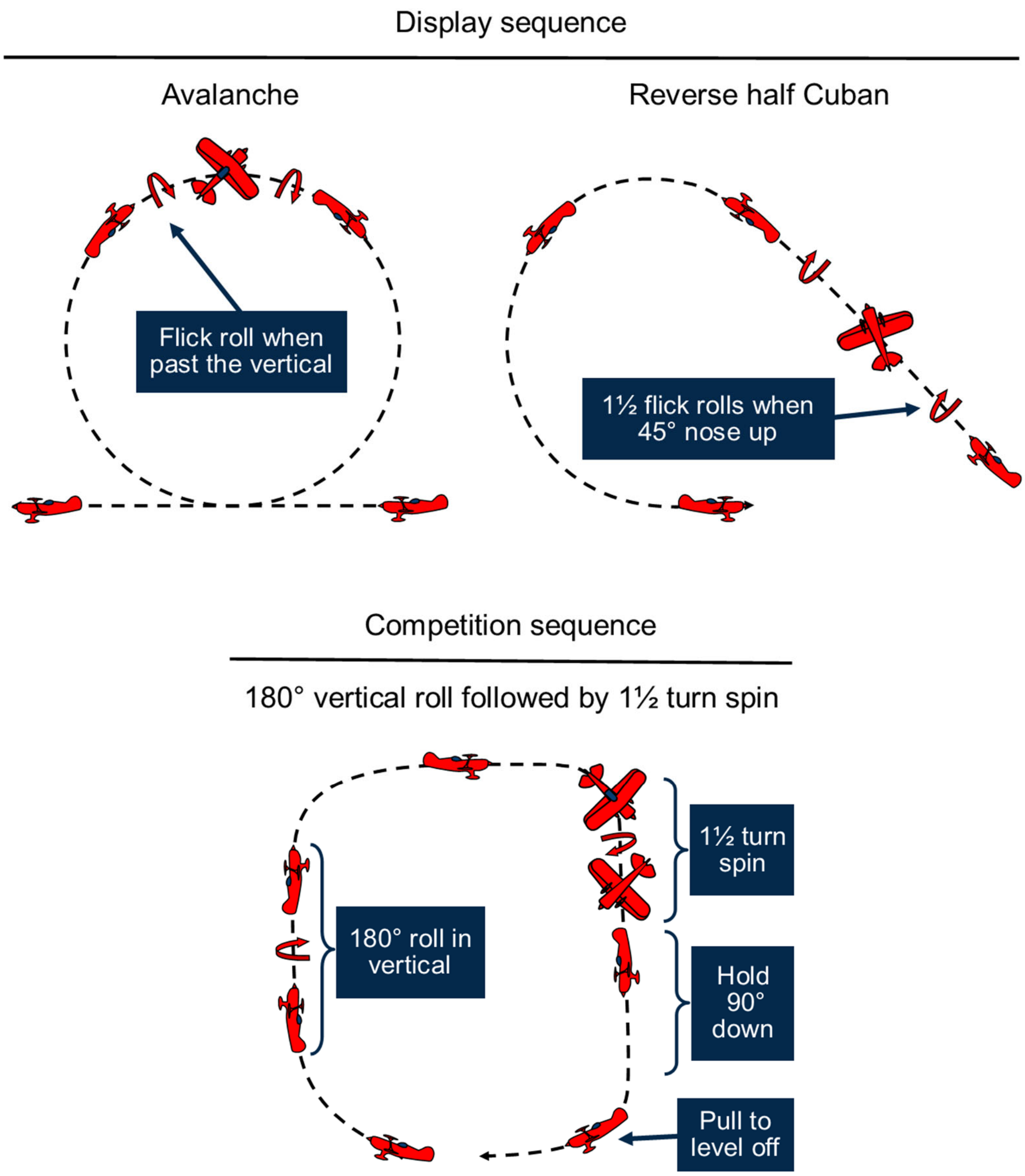

Figure 9

Closest comparable manoeuvres from the pilot's known aerobatic sequences (not to scale)

While no supporting documentation could be found, the investigation was provided with video footage taken on 1 August 2020 of the pilot flying a climbing manoeuvre like that which preceded the accident. This video showed the aircraft pulling up into the vertical before rolling left through 450°. This roll, like the one in the accident manoeuvre, was off-axis to the left and finished with a steeply banked 'knife-edge' over the top. As the aircraft's nose dropped below the horizon, the pilot held the pitch attitude at approximately 45° nose-down with the aircraft inverted for about one second before rolling erect and continuing the 45° descent. In the August 2020 video, the transition from nose-up to nose-down was more dynamic than on the accident flight; visually, the aircraft appeared to have more airspeed approaching the apex and the right yaw looked more positively controlled. Additionally, on the accident flight the aircraft remained close to 90° angle of bank as the nose dropped, while for the August 2020 manoeuvre, the bank angle was closer to 120°, thus requiring less yaw but more pitch to bring the nose down to the desired angle. A simplistic comparison of the accident manoeuvre with the one from 1 August 2020 is shown at Figure 10.

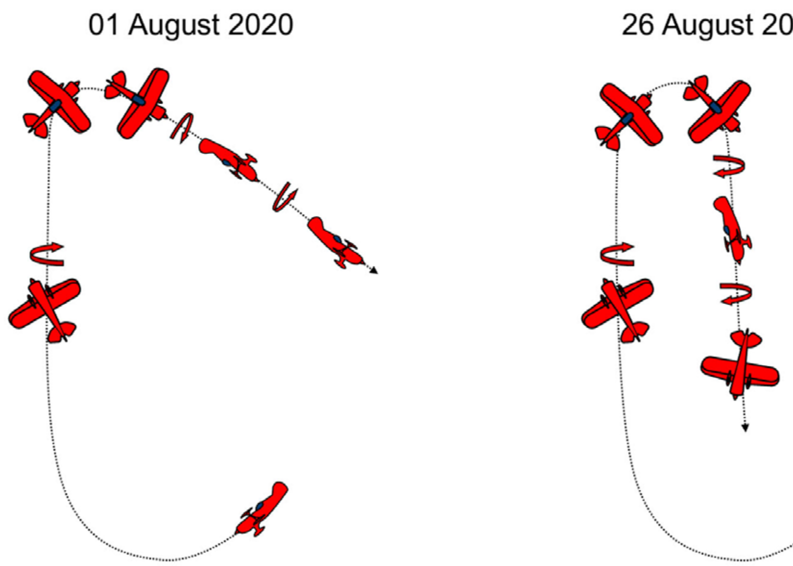

Figure 10

Comparison of 1 August 2020 manoeuvre and accident manoeuvre
(not to scale)

Background noise from another aircraft on the August 2020 video interfered with G-BOXV's engine note, thus making any spectral audio analysis inconclusive. It was not possible to determine if the August 2020 manoeuvre was flown with a higher power setting than on the accident flight.

The accident pilot normally flew to a minimum 1,000 ft agl base height during competition flying and would use 500 ft agl as his minimum height for displays.

UPRT syllabus

Multiple individual manoeuvres would be demonstrated and practised on each of the three flights comprising the UPRT airborne syllabus that the pilot regularly delivered. A consolidated list of the individual exercises for each flight is reproduced at Table 1 from a copy of the pilot's kneeboard aide-memoire that he used when teaching the course. Elements with direct read across to the accident manoeuvre are shown in bold.

UPRT Exercise 1	UPRT Exercise 2	UPRT Exercise 3
▪ Steep turns ▪ Unaccelerated stall ▪ Slow flight ▪ **Spiral dive** ▪ **Recovery from nose low upset** ▪ Stalls: nose high/low, secondary ▪ Maximum rate turn ▪ Stall in maximum rate turn	▪ Energy trading demonstration ▪ Zero G flight to demonstrate flight below VS with no stall symptoms ▪ Jammed controls: ▪ Ailerons ▪ Elevator ▪ Recovery from nose high upset ▪ **Roll/yaw to lower nose and recover from nose high upset** ▪ Demo UPRT3 aerobatic manoeuvres ▪ Recovery from inverted flight ▪ **Recovery from incipient spin**	▪ Recovery from nose high upsets by centring controls ▪ Stalling in balanced turn ▪ Stalling in skidding turn ▪ Demo ineffectiveness of ailerons to counter wing drop ▪ Vertical accelerated stall ▪ **Practice recovery from upsets various attitudes: surprise & startle** ▪ Nose high ▪ Nose low ▪ **Stalls (1G and accelerated)**

Table 1

Consolidated reproduction from the pilot's kneeboard aide-memoire for the UPRT syllabus

Analysis

At the time of the accident G-BOXV had a valid Permit to Fly and was operating within the manufacturer's defined weight and balance envelope. Although extensive fire damage prevented a detailed reconstruction of the aircraft, examination of the wreckage identified that, prior to the accident, the primary flying controls were correctly connected and free from restriction. The engine was in good condition with no indications of low or poor performance. It is therefore likely that there were no technical issues with the aircraft which affected its ability to fly normally during the accident flight.

The accident pilot was correctly licenced and qualified for the intended flight. In his role as an UPRT instructor, albeit in pre-planned training scenarios, he regularly demonstrated how to recover an aircraft from unusual attitudes, incipient spins, spiral dives, and accelerated stalls. He was an experienced aerobatic pilot who had successfully flown G-BOXV in competitions and public displays for many years.

The investigation did not find evidence of the pilot suffering from any chronic or acute medical issue that might have been causal or contributory to the accident.

Accident manoeuvre

From analysing the video evidence taken in August 2020 and August 2022, and in the absence of the pilot's known aerobatic sequences containing any comparable manoeuvres, the investigation deemed it likely the pilot was attempting a similar manoeuvre to that seen in the 2020 video. If that was the case, the aircraft departed from the pilot's intended flight path as the nose dropped below the horizon at the top of the final climb.

Based on witness testimony, if the pilot had intended to spin the aircraft after the climb, it is likely he would have planned on doing so higher and from level flight, using a more controlled and conventional technique. Given the Pitts Special's spinning characteristics as explained to the investigation, of low sustained airspeed and comparatively shallow nose-down attitude, the investigation determined that G-BOXV entered an autorotative spiral dive after the final apex, rather than a spin.

Visually, the apex of the accident manoeuvre was less dynamic than that seen on the August 2020 video. This suggests that the aircraft was slower as it transitioned from climb to descent. The reasons for this could be one or a combination of the following (when compared with the August 2020 manoeuvre):

- A larger rudder pedal input during the upward roll leading to greater off-axis yaw angle and therefore higher resultant drag and faster speed decay.
- A lower power setting leading to faster speed decay in the climb.
- A lower entry speed leading to lower airspeed at the apex.
- A slower rate of roll meaning it took longer to complete 450° roll, thereby resulting in a higher than intended climb and slower apex airspeed.

The low apex airspeed would have reduced the pilot's aerodynamic control over the aircraft's flight path leaving him less able to positively position the aircraft as it transitioned from nose-up to nose-down. With little or no observed pitch rate, the aircraft would have had a low angle of attack and did not appear to be stalled over the top of the manoeuvre. Being close to 90° angle of bank, the aircraft was yawing right as the nose dropped so the left (outer) wing would have been moving faster and producing more lift than the right wing. This resulting aerodynamic asymmetry appears to have developed into an autorotative right roll.

With the right wing producing less lift, its ailerons would have been unable to generate enough counterbalancing rolling force, even assuming the pilot had applied full left aileron to oppose the roll. The autorotative roll developed rapidly and the aircraft's nose dropped steeply as it did so. In an un-stalled condition and subject to autorotation, G-BOXV quickly became established in a steep nose-down spiral dive with the aircraft accelerating despite the pilot's apparent selection of idle power.

As the aircraft's speed increased in the descent, its ailerons would have become more effective, and the pilot managed to stop the roll after approximately 1¼ turns. However, by the time the roll stopped, the aircraft was very low and in a steep nose-down attitude. That the aircraft started to pitch out of the steep dive led the investigation to conclude the pilot was active on the controls throughout the attempted recovery. With limited height remaining and a high rate of descent, it is likely that the rapidly approaching ground prompted the pilot to pull as hard as possible to recover from the dive. The observed sudden reduction in pitch rate was indicative of an accelerated stall as the g-loading increased. The rapid roll divergence could have resulted from a residual rudder or aileron input at the point of the stall. Based on the video evidence, even if the initial pitch rate acceleration had been maintained, it is unlikely recovery could have been completed successfully in the remaining height available.

Height considerations

The investigation was not able to determine why the aircraft appears to have been committed to the vertical climb from below the pilot's reported minimum base height for aerobatic manoeuvring.

Based on the manufacturer's flight trials and pilot reports, the minimum height loss in a single turn spin followed by an expeditious recovery to level flight would be somewhere between 500 and 1,000 ft agl. Even from 1,300 ft agl, the upper tolerance of the photogrammetry-derived apex, there would have been little or no contingency height for a single turn spin and recovery if working to an assumed 500 ft base height. The pilot's notes on his competition sequence indicated he used 1,500 ft above base height as the target entry height for a 1½ turn spin. The investigation concluded that the pilot had not intended to spin after the vertical rolling manoeuvre.

A spin is a stalled manoeuvre with a relatively low nose-down attitude and low airspeed when compared with the spiral dive experienced by G-BOXV. The steeper attitude and increasing airspeed, despite the engine being at low power, would have resulted in a higher rate of descent than if spinning. Based on the time between apex and impact, the estimated average rate of descent would have been 8,700 fpm from a maximum height of 1,300 ft agl and 6,000 fpm from 900 ft agl[4]. Taken from the start of the autorotative roll these figures would be 1,000-1,500 fpm higher. The investigation thought it unlikely the pilot intended entering a steep spiral dive after the manoeuvre apex.

Without supporting evidence, the investigation was unable to determine if any of the aerobatic manoeuvres seen on the accident flight were flown with specific entry and safety parameters in mind. One expert witness observed that the manoeuvres appeared to follow a less structured flow than he would have expected from a planned sequence.

Conclusion

The accident occurred after control was lost when an autorotative roll developed as the aircraft yawed at the top of a vertical climb. Low airspeed during the yaw would have reduced the aerodynamic control available to the pilot such that he could not prevent the aircraft entering the subsequent spiral dive. The entry conditions to the manoeuvre gave little or no safety margin when the aircraft began to dynamically diverge from the expected flight path. While the pilot was able to regain control of the aircraft, by the time he did so there was insufficient height remaining in which to effect a safe recovery.

While the investigation could not determine why the pilot was unable to prevent the aircraft from entering the spiral dive, starting the climb with more height and/or speed would likely

Footnote

[4] Based on the photogrammetry-derived apex height of 1,100 ±200 ft agl.

have increased the pilot's chances of avoiding the loss of control and/or being able to recover from it safely. The investigation was not able to determine what the pilot's contingency criteria were, but this accident serves as a reminder that conducting low level aerobatics comes with inherent risks when manoeuvres, planned or unplanned, do not proceed as expected.

Generic guidance for aerobatic pilots is contained in CAA Safety Sense Leaflet 19 – '*Aerobatics*.'

Published: 3 May 2023.