ACCIDENT

Aircraft Type and Registration:	Rans S6-ESD (Modified) Coyote II, G-MYES
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	1992 (Serial no: PFA 204-12254)
Date & Time (UTC):	30 May 2016 at 1557 hrs
Location:	Near Shifnal Airfield, Shropshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	UK National Private Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	185 hours (of which 8 were on type) Last 90 days - 13 hours Last 28 days - 10 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was manoeuvring in the circuit at Shifnal Airfield, having flown there from its base near Market Drayton. While appearing to reposition for an approach to land on Runway 28, the aircraft was observed to stall and possibly enter a spin. It did not recover before striking the ground in a field to the east of the airfield. The pilot and his passenger were both fatally injured.

A review of records revealed that sixteen Rans S6 accidents, involving stalls and/or spins, have been investigated in the UK by the AAIB since 1994. As a result, the Light Aircraft Association (LAA) is conducting a review of accident data, on this and similar types of microlight, and a flight test program, to determine factors that may have contributed to this accident history.

History of the flight

The aircraft was on a flight from its base at Longford, near Market Drayton, to Shifnal, a grass airfield run by a flying club. The pilot/owner was in the left seat and a passenger was in the right. After departure from Longford's north-easterly runway, the aircraft flew around the northern edge of Market Drayton and then turned south towards Shifnal Airfield. It tracked down the west side of Shifnal Airfield, before turning and approaching the airfield's overhead from the south-west.

Club members at Shifnal reported that, because the wind was from the north, Runway 36 was in use, which visiting pilots would have been advised about when obtaining PPR (prior

permission required) before arriving at the airfield. However, the landing 'T' in the signal square indicated that Runway 28 was in use. Whether the pilot attempted to obtain prior permission was not established but there was no record of him doing so. There was no other traffic near Shifnal Airfield at the time of G-MYES' arrival.

The aircraft turned on to the right hand downwind leg for Runway 28, from the crosswind leg, and witnesses (club members) noticed that the aircraft was lower and closer to the airfield than normal for that circuit. The aircraft appeared to be following the railway line which runs just north of the airfield.

The club had a loudspeaker connected to a radio transceiver, tuned to the airfield frequency, which was audible outside the club house. Two witnesses, who were outside, recalled hearing a "downwind" report from G-MYES on the flying club's radio and at the end of the downwind leg the aircraft was observed turning right towards the final approach leg for Runway 28. As the base turn continued, the aircraft flew through the Runway 28 extended centreline. It then rolled wings level and headed towards the airfield, although noticeably south of the normal final approach path and near one of the local noise-sensitive areas.

The aircraft then made a further turn onto an easterly heading but witnesses did not agree on the direction of the turn. One witness described the turn as being "quite steep" and at a low speed. During the turn, the aircraft was observed to roll abruptly, in a manner suggesting a wing-drop stall, from which it recovered. Then, a little further from the airfield, still on an easterly track and at low height, the aircraft banked left and appeared to enter a spin, descending from the witnesses' view. Realising that impact with the ground was inevitable, the witnesses rapidly made their way towards the aircraft, while telephoning the emergency services.

Another witness, not at the airfield, had a clear view of the field into which the aircraft descended and saw the final part of the descent. He described the aircraft being pitched nose-down, approximately 80°, and turning through at least 300°.

The wreckage was found in the field, with both occupants having sustained fatal injuries.

Meteorology

The Met Office provided an aftercast of conditions affecting Shifnal Airfield at the time of the accident. Their summary stated:

> *'Weather conditions at the location of the incident were generally benign, with no significant weather or low cloud being reported in the vicinity. Winds were north-easterly at around 10 KT, and visibilities were greater than 10 KM. There was scattered fair weather cumulus and stratocumulus in the area, with the occasional patch of more broken cloud. Cloud bases were no lower than 3000 feet. The general air temperature was between plus 18 °C and 19 °C, with dew points of plus 9 °C to 11 °C. The weather conditions were consistent with those forecast by the F215 chart and the Birmingham TAF.'*

The METAR at 1550 hrs for Birmingham Airport, 27 nm east-south-east of Shifnal, stated that the wind was from 020° at 13 kt, and the automatic METAR for RAF Shawbury, 12 nm north-west of Shifnal, stated that the wind was from 020° at 9 kt.

The pilot

The pilot, an experienced aircraft engineer, began learning to fly, on three-axis microlights, in February 2012. He flew solo for the first time after 40 hours of dual training, of which approximately 25 hours were in the circuit, and passed the skill test for issue of a National Private Pilot's Licence (NPPL), with the rating to fly microlights, in December 2013, after accruing 76 hours. The pilot's microlight rating was revalidated on 9 December 2015, valid to 31 November 2017. At the time of the accident, he had accumulated a total of 185 flying hours, of which 132 were in command. His log book indicated that all his flying was conducted in three-axis microlights.

The previous owner of G-MYES had demonstrated the aircraft to the pilot before they then conducted a 30-minute flight together on 25 March 2016, with the previous owner occupying the left seat and the pilot in the right seat. During that flight, the previous owner reminded the pilot, who took control for parts of the flight, of the need to co-ordinate turns with rudder. He also demonstrated a stall. In the circuit, on the base turn, he took control from the pilot when he became concerned about the aircraft's speed.

The pair conducted another 30-minute flight on 23 April 2016, after the pilot had purchased the aircraft, with the pilot in the left seat and the previous owner in the right seat. This flight included general handling, two stalls, one with flap up and one with full flap, and circuits. On the first approach in the circuit, the previous owner became concerned that the speed was too low and took control. There were two further landings, which were uneventful.

The pilot then flew the aircraft to his base near Market Drayton and began flying it regularly. The pilot's log book showed that he had undertaken 13 flights in G-MYES, including those with the previous owner, totalling 7 hours and 45 mins of flying time on type. There was no evidence he had flown any other Rans S6 aircraft.

The pilot had signed an appropriate medical declaration and was reportedly in good health.

Previous visits to Shifnal

The pilot's log book showed that he had visited Shifnal on four previous occasions, in April and September 2014 and January 2015. Historical wind information suggested that on three of those flights, Runway 28 may have been in use. Since the flight in 2015, he had flown to 20 other destinations from his base at Longford.

The passenger

The passenger was also a member of the flying club at Longford and flew a different type of three-axis microlight. He and the pilot had flown as passengers in each other's aircraft previously. The passenger had not, according to available evidence, flown a Rans S6 as pilot.

Medical information

Post-mortem examinations were carried out on both the aircraft's occupants by a pathologist, who reported that there was no evidence of underlying disease in the pilot or the passenger and that each had died from multiple injuries. Toxicology tests revealed no evidence of any substance that could have contributed to the accident. It was also reported that, whilst no evidence of incapacitation was found, the possibility could not be fully ruled out.

The pilot held a valid Medical Declaration.

Airfield information

The airfield at Shifnal is unlicensed and operated by a flying club, which welcomes visiting aircraft. The airfield has a grass surface with two runways, orientated 10/28 and 18/36, respectively. A windsock is positioned south-east of the intersection of the two runways and a signal square had been laid out north of the Runway 28 threshold.

The flying club publishes instructions on its website, including maps and diagrams of circuit procedures, as well as information that prior permission is *'strictly'* required by visiting pilots. The airfield is within the Shawbury Area of Intense Aerial Activity and the flying club is keen to co-ordinate their activities with any military flying.

There are a number of noise-sensitive areas around the airfield, notably a small group of buildings to the east, just south of the extended centreline for Runway 28.

The flying club website

One image on the flying club website shows the airfield, runways, and noise-sensitive areas, together with the circuit patterns and two 'gates' through which aircraft should depart the circuit (Figure 1).

The image shows two line features north of the airfield, a railway line and the A464 trunk road (Priorslee Road). It also highlights an area to the north and east of the A464, which is to be avoided, and indicates that the circuit should be flown parallel to, but south of, the A464.

The flying club website also features an image of the airfield layout, with the railway line shown to the north, without the circuit pattern being depicted (Figure 2).

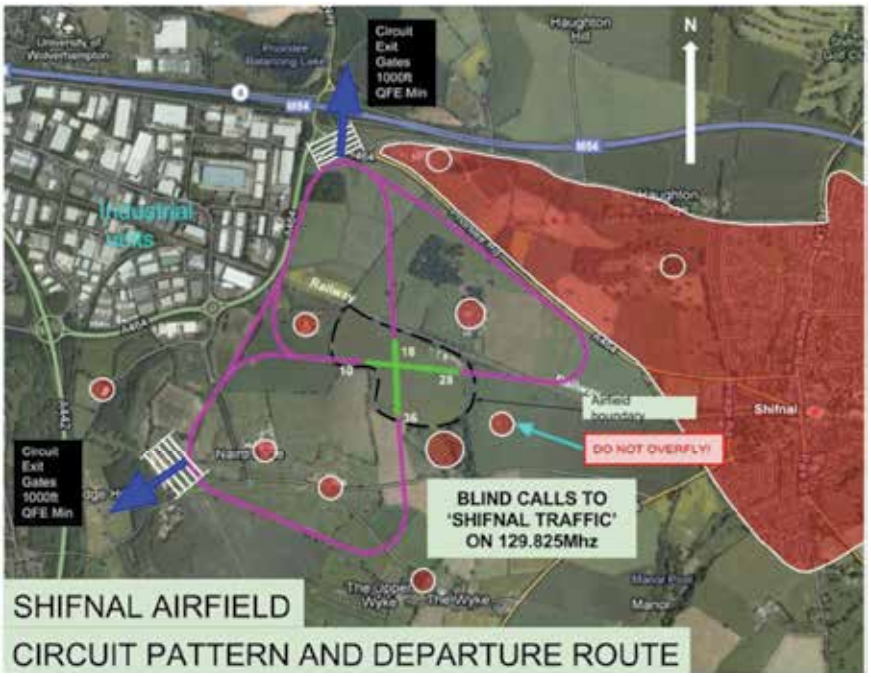


Figure 1

The website image of the circuit and noise-sensitive areas, annotated 'DO NOT OVERFLY!'

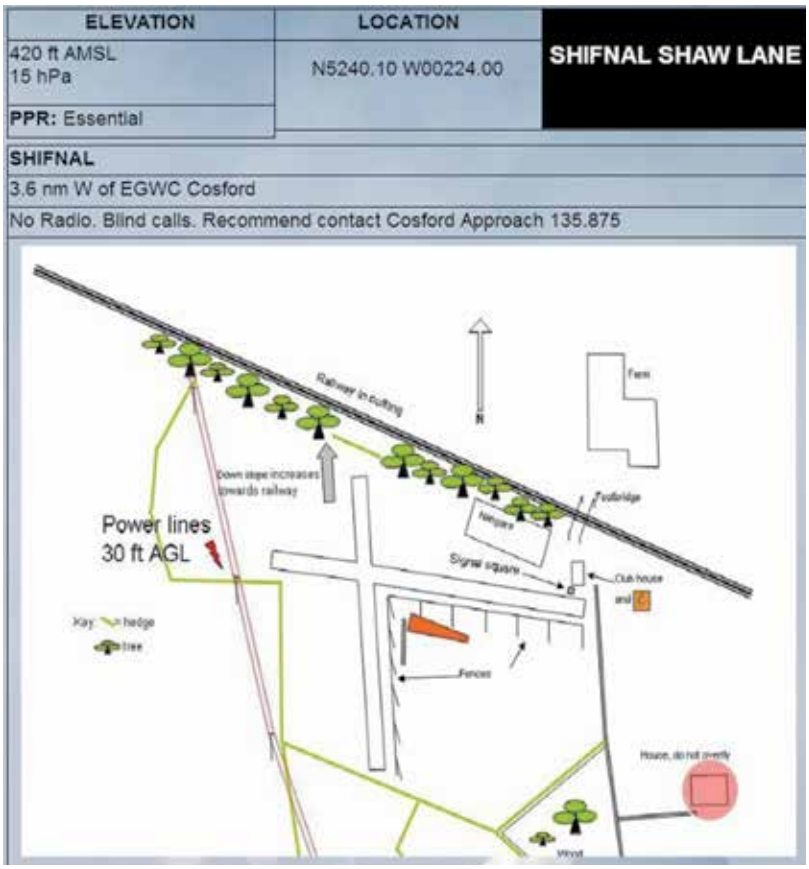


Figure 2

The website depiction of the airfield, showing the railway line to the north

Information in a commercially published airfield guide

Similar information about the airfield was also available in a commercially published airfield guide. When an AAIB investigator visited Longford, the day after the accident, a copy of this guide was on the briefing table in the club caravan, open at the pages for Shifnal (Figure 3).

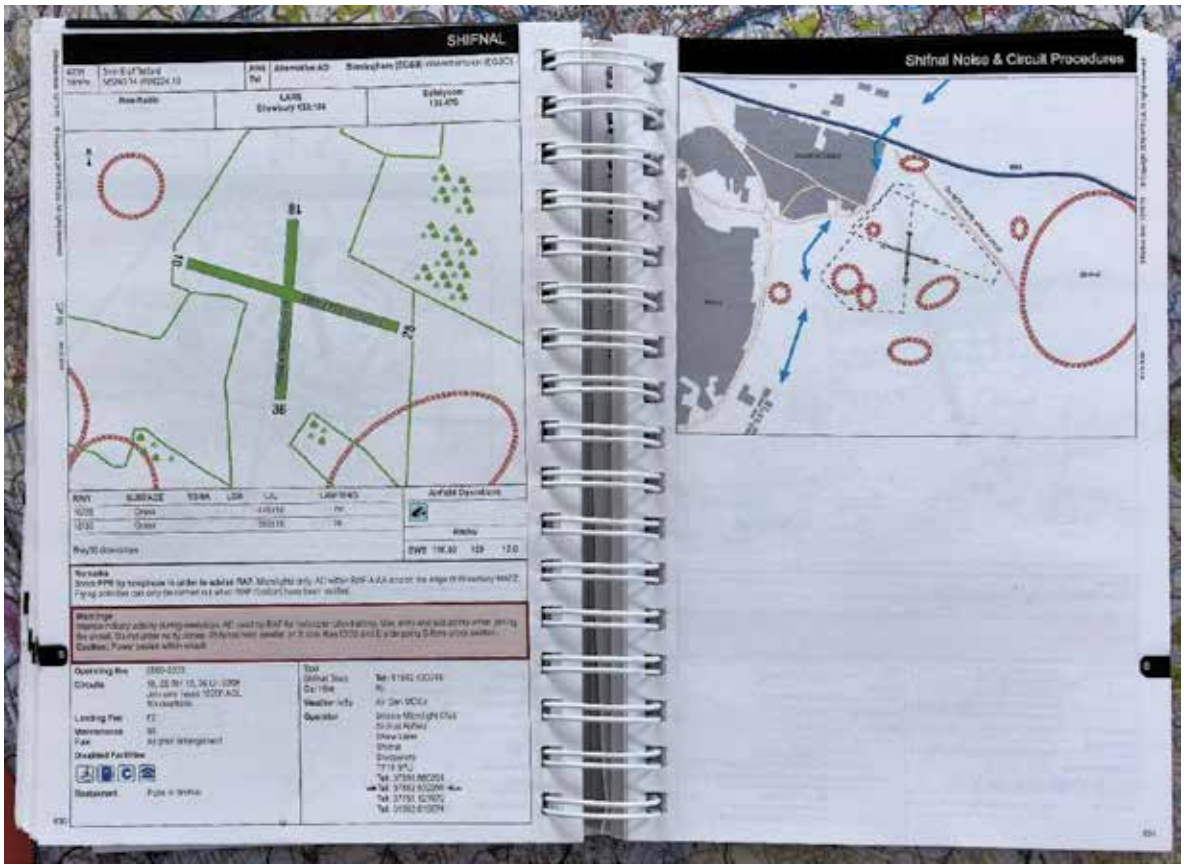


Figure 3

The information on Shifnal Airfield, and its noise and circuit procedures, in the commercially published airfield guide

The 'Noise and Circuit Procedures' chart (Figure 4) in this guide showed one hachured line north of the airfield, which the circuit parallels, but, although it followed the line of the A464 trunk road, the guide did not indicate whether it was a road, railway, or other line feature.

The guide also stated that the airfield is *'strictly PPR'*.

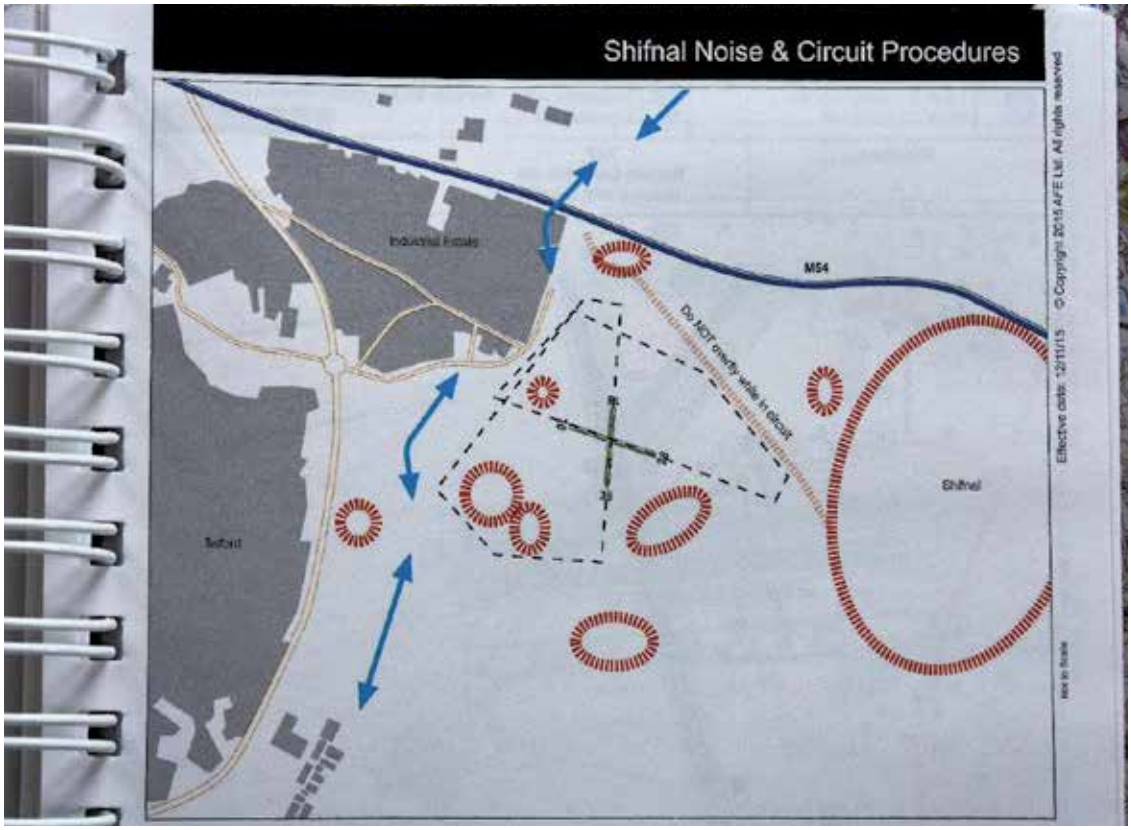


Figure 4

The Noise and Circuit Procedures chart from the guide

In addition, the guide contained a warning about its content under the heading ***'Important'***:

> *'The* [name of the flight guide] *2016 (the "Guide") is a guide only and it is not intended to be taken as an authoritative document. …. before flight, any owner and user of the Guide should contact the operator of all departure and destination airfield(s) to check that* [sic] *the extent to which any published information set out in Aviation Publications and/or this Guide is still in force and the extent to which it has been changed, supplemented, or amended. If an owner's or user's departure or destination is an unlicensed airfield, such a check with the operator must be undertaken before flight as any changes relating to information concerning such an airfield may not be contained in any Aviation Publication….'*

Pilot's notes and guidance

Pilot's notes

The *'LAA Type Acceptance Data Sheet TADS 204 Rans S6-ES'* states *'A set of pilot's notes for the Rans S6-ES are included in the build manual'.*

The UK agent for Rans aircraft informed the AAIB that all Rans S6 aircraft in the UK were kit-built aircraft and that, historically, the manufacturer did not issue pilot's notes with kit-built

aircraft, due to variations in build standard and different regulatory oversight regimes. However, it did issue a set of pilot's notes for factory-built aircraft in the USA.

Amongst the aircraft documents retrieved by investigators was a set of *'Rans S6-ES Coyote II Pilots notes',* which bore the manufacturer's logo. The Rans agent did not recognise this document, which appeared to have been written or modified by a Rans S6 pilot or owner as some text was written in the first person. Further, the notes were relevant to a Rotax-engined Rans S6-ES, not one fitted with a Jabiru 2200A engine.

Guidance

Guidance and advice on the signs and symptoms of stalling and spinning and on stall avoidance is provided in the CAA *'Handling Sense Leaflet 2',* entitled *'Stall/Spin Awareness'.* This leaflet is available from the CAA website[1].

Recorded information

Sources of recorded information

Recorded information was available from a tablet computer[2], portable GPS unit[3], smartphone[4], Closed-Circuit Television (CCTV) recorded at Shifnal Airfield and ground-based primary[5] radar (without altitude information) from Manchester Airport. The tablet computer and portable GPS were owned by the pilot of the aircraft and the smartphone by the passenger.

The smartphone contained a hand-held video recording, made by the passenger, as the aircraft departed from Longford. The recording started shortly before the aircraft lined up for takeoff on the north-easterly runway and ended just over three minutes later, as the aircraft approached the town of Market Drayton, when it was at an altitude of about 1,000 ft amsl. The ASI was in view and indicating zero when the aircraft was stationary on the ground. However, once the aircraft started to move, the camera angle changed to a view outside the cockpit. The pilot's portable GPS unit was installed on the left side of the instrument panel and his tablet computer in the lower centre of the instrument panel. The pilot, in the left seat, was flying the aircraft throughout the period of the video.

The portable GPS unit was operating during the accident flight and had recorded GPS-derived position, altitude, track and ground speed at a nominal rate of once every 60 seconds. The first data point was recorded at 1536:13 hrs and the final data point at 1556:30 hrs.

Footnote

1 https://publicapps.caa.co.uk/docs/33/ga_srg_09webHSL02.pdf
2 Apple-manufactured iPad mini model A1550, operating an Airbox Aerospace Ltd Runway HD flight navigation software application.
3 Airbox Aerospace Ltd-manufactured Aware 1. This device shoes the aircraft's horizontal position on a moving map display that includes topographical features, airports and waypoints as an aid to navigation.
4 Samsung manufactured Galaxy model SM-J500FN.
5 The aircraft transponder had not been selected by the pilot to transmit secondary radar Mode A (squawk code) or Mode C (altitude) information.

The tablet computer contained a flight plan[6] for a direct route between Longford and Shifnal Airfield, which is located just over 14 nm to the south-south-east (a track of 160°) from Longford. No GPS track log was recorded for the accident flight on the tablet computer.

GPS track logs were available for previous flights from both the portable GPS unit and tablet computer. None of these previous records contained flights to Shifnal.

The radar data commenced at 1537:27 hrs, shortly after the aircraft had taken off, and ended at 1552:54 hrs.

The RTF frequency in use at Shifnal Airfield was not recorded.

Summary of recorded data

Figure 5 shows the GPS track of the flight from Longford to Shifnal and Figure 6 the final two GPS points during the approach.

The radar and GPS tracks correlated closely, corroborating the relative accuracy of the two independent data sources.

The aircraft took off at 1536 hrs from the north-easterly runway at Longford. The recording on the smartphone of the takeoff and initial climb showed nothing unusual. Shortly after, the aircraft made a right turn onto a southerly heading, whilst climbing initially to about 1,700 ft amsl. As the aircraft approached the town of Donnington, it then climbed progressively. At 1552 hrs, on a southerly track, the aircraft passed just less than half a mile to the west of Shifnal Airfield. During the next three minutes, the aircraft was recorded operating in an area 0.5 nm to the south-west of Shifnal Airfield, during which it descended from a peak recorded altitude of 1,967 ft amsl to 1,050 ft amsl (600 ft agl).

Shortly after, footage from the CCTV showed the aircraft joining the crosswind leg for the (right hand) circuit to Runway 28 at Shifnal Airfield. It then turned on to the downwind leg, before disappearing out of camera view. As the aircraft turned onto the downwind leg, it was recorded by the GPS as being at an altitude of 990 ft amsl (585 ft agl). The CCTV corroborated witness accounts that the aircraft had turned to fly approximately overhead the adjacent railway track.

At 1556:30 hrs, the last GPS data point was recorded. This indicated that the aircraft was at an altitude of 628 ft amsl (290 ft agl), on a track of 148°M, with a groundspeed of 56 mph (an estimated indicated airspeed of 51 mph (44 KIAS) based on the METAR for Shawbury). The aircraft was 670 m from the threshold of Runway 28 and 300 m from the accident site. Analysis of the tablet computer indicated that the aircraft struck the ground shortly after, at about 1557 hrs.

Footnote

[6] A GPS flight plan consists of sequentially ordered waypoints to assist in lateral navigation. A typical flight plan consists of the departure and destination airport, with intermediate waypoints such as radio navigation beacons or topographical features, if required. If a flight plan is selected, the GPS displays a track line on the moving map display that the pilot can follow.

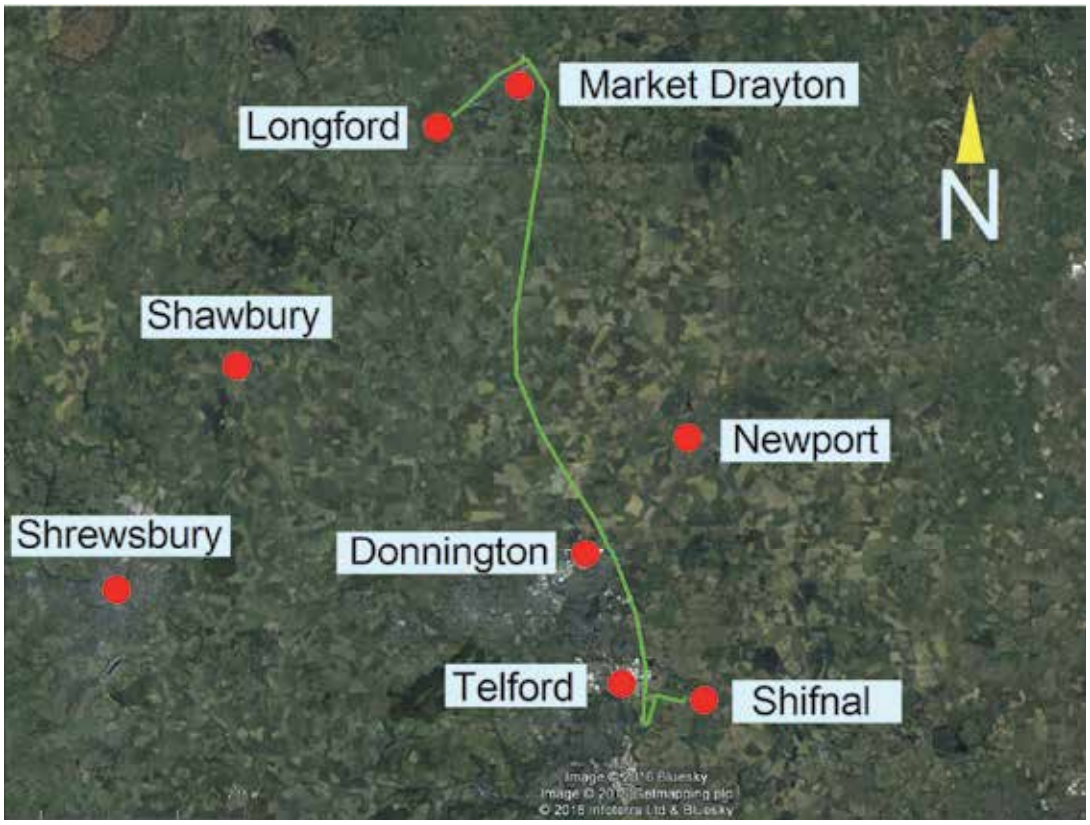


Figure 5

GPS track of flight from Longford

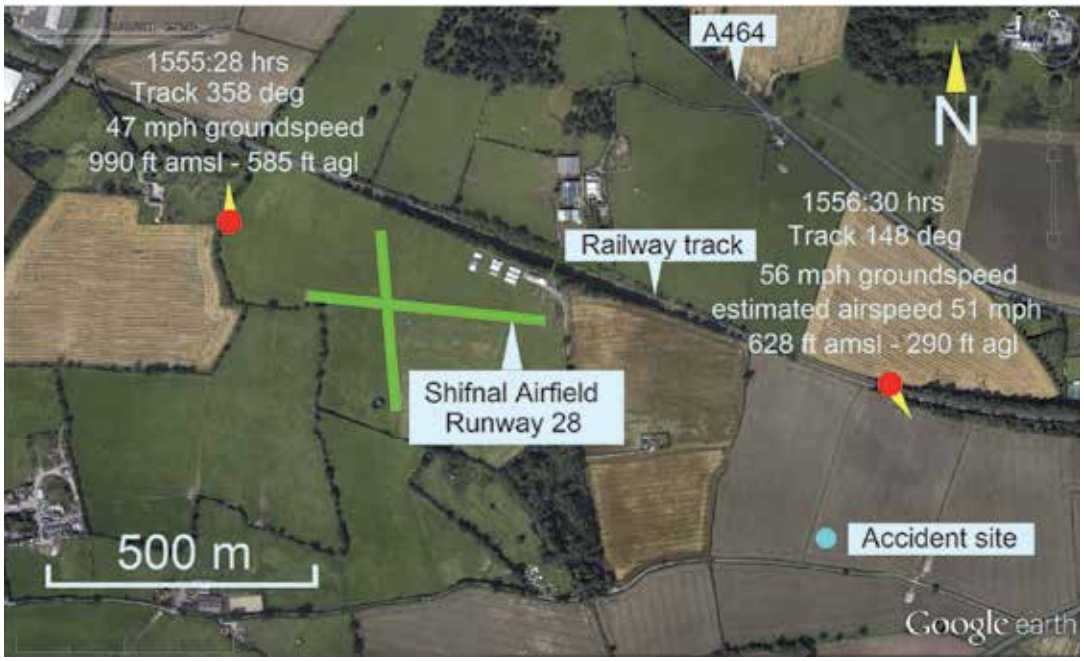


Figure 6

Final GPS points during approach to Shifnal

Description of the aircraft

The Rans S6 is a high-wing, strut-braced microlight aircraft with two side-by-side seats. The airframe is mainly of bolted and riveted aluminium tube construction, with the forward fuselage structure consisting of a welded tubular steel cage. The entire airframe is covered with pre-sewn polyester fabric envelopes.

G-MYES, constructed from a kit in 1992, was originally built as a Rans S6-ESD variant. However, the aircraft's records indicated that in 2001 it was reconfigured to increase the performance and raise the maximum gross weight from 386 kg to 450 kg. The aircraft variant was subsequently designated as a Rans S6-ESD (Modified) Coyote II and was considered structurally and aerodynamically equivalent to the Rans S6-ES variant. The aircraft had completed approximately 2,144 flight hours since it was built.

It was fitted with a Jabiru 2200A four-stroke engine[7] driving a two-bladed wooden propeller. The engine was constructed in 2000 and had achieved approximately 1,203 operating hours. The records indicated that the engine had previously experienced a number of stoppages and power loss events; the most recent of these occurred in August 2008. Following this event the fuel filter was cleaned and no further problems were experienced.

The LAA Permit-to-Fly was valid until 9 August 2016.

On-site examination

The aircraft had crashed in a gently sloping barley field approximately 683 m south-east of the Runway 28 threshold at Shifnal, in an upright but steep nose-down attitude with an impact heading of approximately 225°.

The engine and nosewheel had made indentations in the ground, although the main landing gear had not made contact, indicating an approximate 70° to 80° nose-down attitude. An area of undisturbed crop between the initial impact mark and the wreckage, indicated that the aircraft had bounced approximately 5 m forward and to the left of the initial impact point, before coming to rest. There were no other ground marks. However, the right wing had flattened the crop at the initial impact point, indicating that the aircraft was in a right-wing-low attitude at impact. The impression made by the right wing in the crop was parallel to and approximately 5 m from the wing's final position. This, together with the absence of any evidence of rotational marks on the ground or in the crop, indicated that the aircraft was not spinning at impact.

One propeller blade had broken off in the impact and fragmented into multiple pieces, almost all of which were found at the initial impact point. The other blade remained attached and intact. Neither blade displayed substantial evidence of leading edge damage nor chord-wise scuffing. This, together with the concentrated distribution of fragments of the damaged blade, was indicative of a lack of propeller rotation, or rotation at low power, at impact.

Footnote

[7] A number of power plants are available for this type of aircraft. G-MYES was originally equipped with a Rotax 503 engine when it was first built, however it was modified with a Jabiru 2200A engine in 2001 at the same time the aircraft was configured from an –ESD to –ES variant.

The front of the aircraft, including the engine compartment, windscreen and cabin roof area had sustained severe damage in the impact. The fuselage aft of the cockpit and the empennage had remained relatively intact, although many of the tubular structural members were broken. The wings were largely undamaged but the wing lift struts on both sides were damaged.

The aircraft was equipped with a single polythene fuel tank, with an approximate capacity of 40 litres, located in the rear fuselage behind the seats. It was noted that the fuel selector was in the ON position. Approximately 37 litres (28 kg) of motor gasoline was drained from the fuel tank.

Following on-site inspection, the wreckage was recovered to the AAIB's facility at Farnborough for a detailed examination.

Detailed examination of the wreckage

Airframe

The examination confirmed that the operating system for the primary flying controls was intact prior to the accident, although substantial disruption occurred during the impact.

It was not possible to ascertain the trim state of the aircraft due to disruption of the elevator control and bungee trim system. The aircraft was fitted with a fixed metal trim tab on the left elevator, a rudimentary aluminium plate, which was bent down approximately 90° to the elevator surface; this appeared to be an excessive angle. The position of the trim tab was not considered to be related to impact loads, as the aircraft tail did not contact the ground during the impact. The previous owner could not recall the approximate angle at which the trim tab had been set, and had never adjusted it, but did not believe it had been as much as 90°.

Airspeed indication

The aircraft was not equipped with a stall warning system. The pitot probe, which projected from the left wing leading edge was broken during the impact. The plastic tubing connecting the pitot tube to the ASI was free from obstruction, however its integrity had been compromised in two places. One area of damage was in the region where the tube routed through cockpit structure, which had sustained significant damage during the impact. The appearance of the damage indicated that it had been pierced by something sharp, and the damage was considered to be impact-related. The second area of damage was a tear immediately adjacent to where the tube expanded over the metal port on the back of the ASI. The damage was examined visually and microscopically. Gouges and scoring on the external surface, together with the direction of the tear suggested that this damage was also most likely impact-related. Had this damage existed pre-impact, the size of the hole resulting from the tear would have caused a substantial leak of pitot pressure to the ASI, causing a large under-read and possible fluctuation of the needle.

The plastic hose was removed and the ASI was tested by applying air pressure. The needle responded correctly across the relevant speed range, however a leak of air pressure from

the unit was observed. The ASI case was intact but it is possible the leak was a result of damage to the internal mechanism. Had the instrument leak been present before the accident it may have manifested itself as an under-read; that is, the ASI may have displayed a speed lower than the actual airspeed of the aircraft.

Flaps

The flaps are operated by a 'handbrake'-style lever, located between the seats, which is connected to a series of Teleflex cables running to the flap surfaces. The flap lever is mounted between two metal plates, into which are machined four detents. The selected flap position is maintained by a spring-loaded retractable lock-bar, operated by a push-button release on the end of the lever, which engages in the detents. The first detent corresponds to the fully retracted position (flap lever fully down) and the remaining three detents correspond to 11°, 20° and 43° of flap extension respectively. The geometry of the detents is such that it prevents the flap lever from being lowered unless the release button is pressed, but allows the lock-bar to ride up out of its detent and snap into the next detent when the lever is raised. Therefore, the post-impact position of the lever alone may not be a reliable indication of the flap setting prior to impact, due to the potential for it to be driven upwards by impact forces.

The flap operating system was intact, except for bending deformation on the right hand metal plate of the mechanism, indicative of a lateral impact. The flap lever was aligned with the second detent but the retractable lock-bar wasn't properly seated in the detent. Impact deformation of the fuselage structure below and immediately forward of the flap lever suggested that parts of the control stick torque tube and seat structure could have been driven upwards during the impact, moving the flap lever, before relaxing back to a position clear of the lever. However, closer examination of the flap lever mechanism revealed a witness mark on the second detent, consistent with the shape of the retractable lock-bar, suggesting the flap lever was in the second detent (ie one stage of flap (11°) selected) at the time of impact.

Engine controls and indications

The engine rpm indicator was intact and the needle indicated approximately 1,250 rpm. The choke lever was fully in. The right magneto switch was in the ON position but disruption to the left magneto switch meant it was not possible to determine its pre-impact position. The carburettor heat control was partly dislodged from the instrument panel and it was not possible to ascertain whether carburettor heat had been applied at the time of impact.

The throttle cable is actuated by the throttle lever, which is mounted at floor level immediately forward of the seats. This area of the cockpit sustained substantial disruption and it was not possible to ascertain any useful information from the throttle lever position.

Engine

The engine was subjected to a strip-inspection at a Jabiru overhaul facility. The examination also included ancillary components, such as the mechanical fuel pump, oil pump, carburettor and the ignition system.

Disassembly of the engine revealed that it had not been subject to overhaul since installation. The crank case and crank shaft were in good condition. However, cylinder compression checks showed that cylinders No 1 and 3 had poor compression ratios, with some leakage from the exhaust and inlet valves. Minor cracks were found on the cylinder heads of cylinders No 1 and 2. The Jabiru specialist considered that the engine would run with these defects but that they did not reflect a good state of repair. The oil was drained from the engine; it was black and dirty and did not have the appearance of oil that had recently been changed. The spark plugs appeared to be new, clean and with an appropriate firing gap.

The throttle cable terminated in a solid linkage which was mounted on a bracket attached to the carburettor. The throttle cable exhibited a 90° bend, caused by impact loads (Figure 7), and the mounting bracket was deformed. In order to confirm the pre-impact position of the throttle valve, the throttle linkage was detached from the mounting bracket and the bracket was straightened. When the throttle linkage was re-mounted on the bracket, its position corresponded to the butterfly valve being fully closed. This indicated that the throttle was closed at impact.

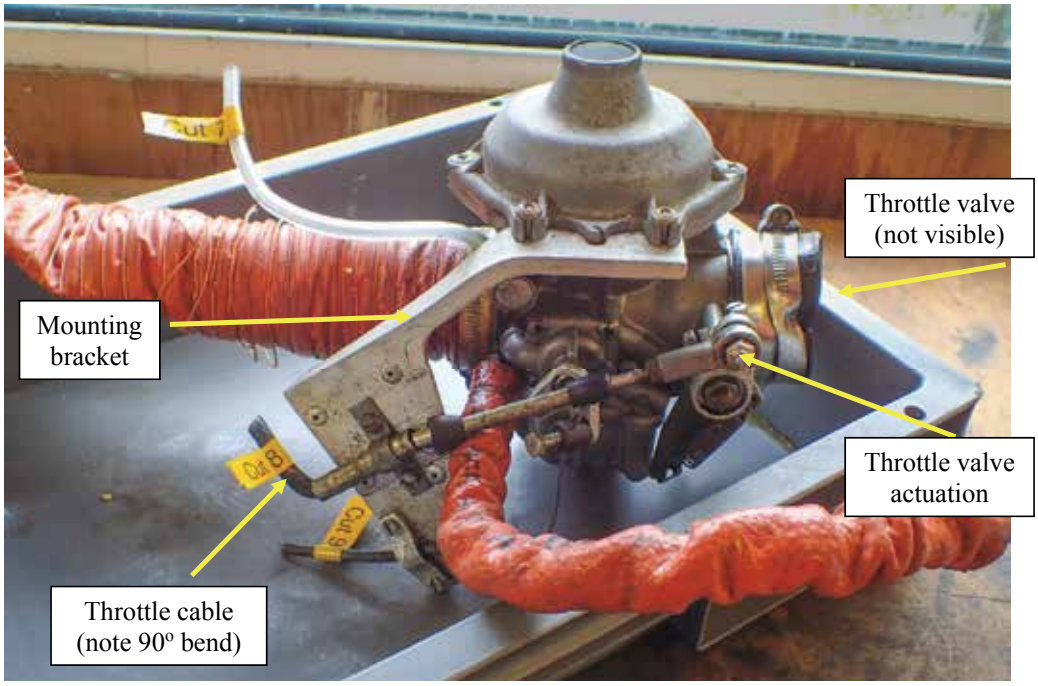


Figure 7

The carburettor

Examination of the carburettor confirmed that the choke was in the OFF position. There was a small amount of fuel in the carburettor fuel bowl and some small particles of debris. Some corrosion was evident on the main jet holder and, when examined under a microscope, solidified oily residue was evident on the internal bore. However, the main needle jet itself was clean and free from debris. The idle jet also exhibited some oily residue; this is not uncommon as oil can seep into the carburettor when the engine is shut down. The rubber of the inlet manifold and fuel inlet hoses had lost all its flexibility, consistent with age-related degradation.

Carburettor icing

The CAA *'Safety Sense leaflet 14*', on *'Piston Engine Icing*[8]*'*, describes carburettor icing and its effect on engine performance as follows:

> *'…carburettor (carb) icing* [is] *caused by a combination of the sudden temperature drop due to fuel vaporisation and pressure reduction as the mixture passes through the carburettor venturi and past the throttle valve.*
>
> *If the temperature drop brings the air below its dew point, condensation results, and if the drop brings the mixture temperature below freezing, the condensed water will form ice on the surfaces of the carburettor. This ice gradually blocks the venturi, which upsets the fuel/air ratio causing a progressive, smooth loss of power and slowly 'strangles' the engine.'*

The leaflet incorporates a graph of temperature and dew point (Figure 8), depicting the probability of carburettor icing at various power settings. In the reported conditions, the graph shows that moderate icing could be expected at cruise power, and serious icing at descent power.

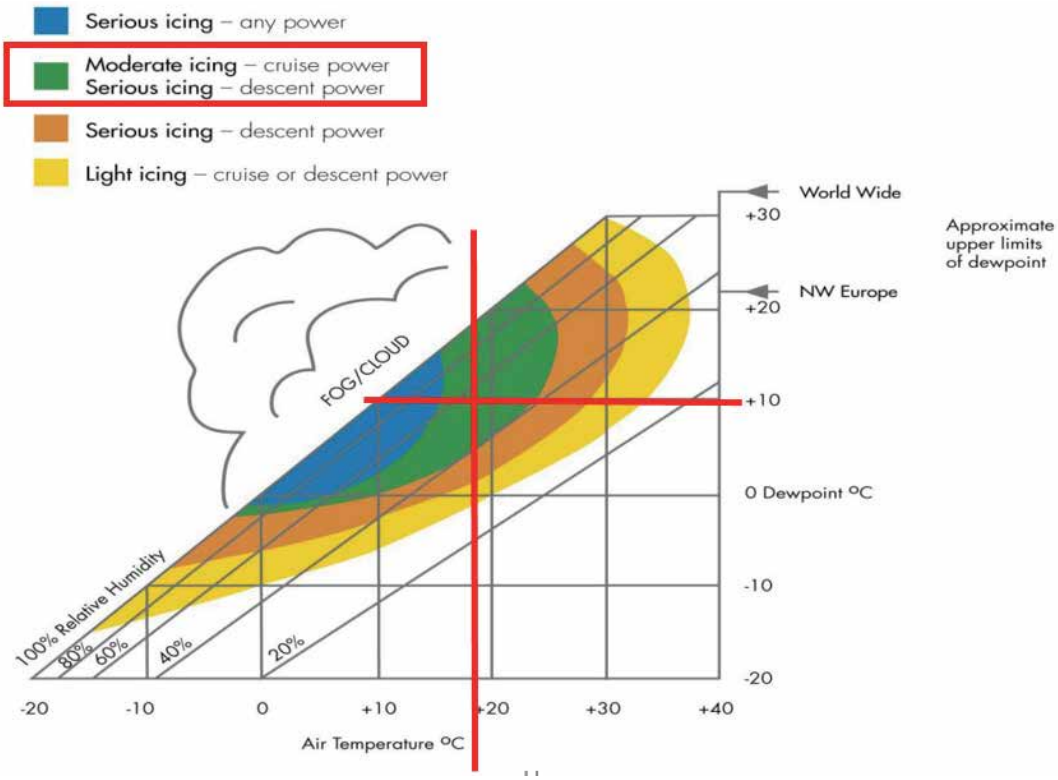


Figure 8

CAA Chart showing probability of carburettor icing; the red lines show the approximate values of temperature and dew point at the time of the accident

Footnote

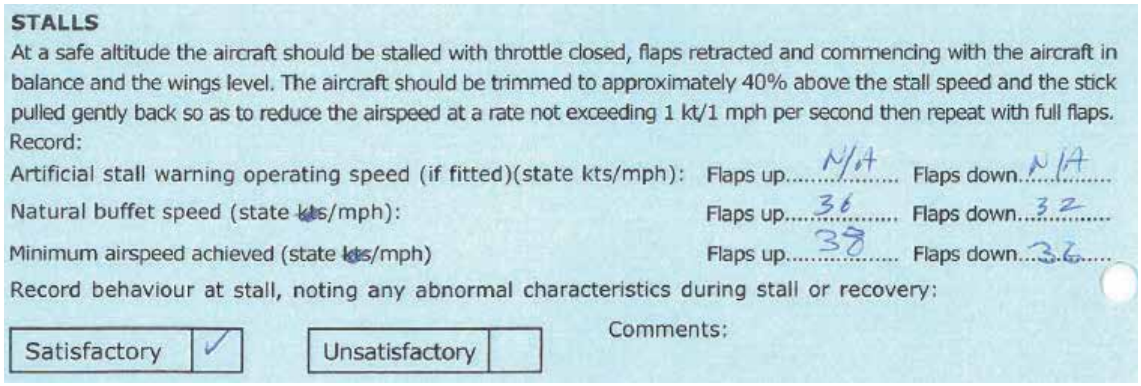
[8] http://publicapps.caa.co.uk/docs/33/20130121SSL14.pdf

Weight and Balance

The Rans S6-ESD (Modified) has a Maximum Takeoff Weight (MTOW) of 450 kg and a maximum empty weight of 268 kg. The last weight & balance report for G-MYES was produced in June 2014 and listed the aircraft empty weight as 238.8 kg. This information, together with the occupant, fuel and baggage weights was used to calculate the weight and balance of the aircraft at the time of the accident. The weight and balance was determined to be within the aircraft manufacturer's limits.

Maintenance

The check flight for the last Permit-to-Fly Certificate of Validity renewal was performed on 7 August 2015 by an LAA Inspector. The flight test report noted the onset of buffet in a stall as occurring at 36 mph (31 KIAS), with flaps up, and 32 mph (28 KIAS) with flaps down. The minimum airspeed achieved was noted as being 38 and 36 mph, respectively (Figure 9). There were no additional comments regarding the stall characteristics of the aircraft.


STALLS

At a safe altitude the aircraft should be stalled with throttle closed, flaps retracted and commencing with the aircraft in balance and the wings level. The aircraft should be trimmed to approximately 40% above the stall speed and the stick pulled gently back so as to reduce the airspeed at a rate not exceeding 1 kt/1 mph per second then repeat with full flaps.

Record:

Artificial stall warning operating speed (if fitted)(state kts/mph): Flaps up N/A Flaps down N/A

Natural buffet speed (state kts/mph): Flaps up 36 Flaps down 32

Minimum airspeed achieved (state kts/mph) Flaps up 38 Flaps down 36

Record behaviour at stall, noting any abnormal characteristics during stall or recovery:

Satisfactory ✓ Unsatisfactory

Comments:

Figure 9

Extract from check flight report

The LAA Inspector who conducted the check flight explained that he had probably made an error, and entered the figures for the 'minimum speed achieved' on the 'natural buffet speed' line and vice versa. If so, the onset of buffet in a stall occurred at 38 mph and 36 mph, with the flaps up and flaps extended, respectively.

Since acquiring the aircraft in April 2016, the pilot had made numerous searches on the internet (using his iPad) for information regarding the Jabiru 2200 engine. These included searches on 23 and 24 May 2016 relating to '*spark plug gaps'*, '*spark plug torque loading*', '*starter motor'*, '*overhaul*', '*fuel pump gasket*' and '*fuel pump seal'*. An entry in the aircraft log book on 22 May 2016, relating to a 25 minute flight, stated: '*Local flight to warm eng* [engine] *oil for change'*. The subsequent entry on 27 May 2016 stated: '*G/run* [Ground run] *for leak check satis* [satisfactory]. *Flight check post oil /plugs /filter cx*[9]' suggesting that the pilot had replaced the engine oil, oil filter and spark plugs.

Footnote

[9] The abbreviation 'cx' is often used in aircraft logbooks to mean 'check' but it can also mean 'change'. As the logbook entry for the previous flight indicated the pilot's intention to change the oil, it is considered that in this instance it means 'change'.

Previous events

A review of other Rans S6 (all variants) accidents investigated by the AAIB was carried out during the investigation. Details of those which were considered to involve stalling and/or spinning are as follows, in reverse chronological order:

Date	Registration	Location	Extract from AAIB report	Result
26/8/16	G-MYLD	Near Cobham, Kent	Following an engine problem, *'the aircraft stalled into trees'.*	No injuries Damage to propeller, engine mounting, cockpit frame and wings
5/7/15	G-CDVF	Shifnal Airfield, Shropshire	Following an engine problem, the '*aircraft lost height and struck the ground in a steep nose-down attitude*'.	2 seriously injured Aircraft substantially damaged
22/8/14	G-BYOU	Mount Airey Airstrip, South Cave, East Yorkshire	*'Shortly after takeoff the engine stopped and the aircraft stalled.'*	1 seriously injured Aircraft damaged beyond economic repair
28/8/13	G-MYSP	Redhill Aerodrome, Surrey	'[the aircraft] *was climbing away after a touch-and-go landing when the aircraft's engine was heard to falter. The aircraft was seen to slow in a climbing attitude before stalling and entering a vertical dive from which it did not recover.'*	1 fatality Aircraft destroyed
14/7/13	G-BYMV	Near Stoke Golding Airfield, Leicestershire	*'Witness evidence suggests that the aircraft entered a stall followed by an incipient spin after entering the circuit.'*	2 fatalities Aircraft destroyed
24/8/12	G-MZCA	Private airstrip 13 nm south-south-east of Norwich	*'The aircraft became low and slow on final approach to a grass airstrip. A go-around was initiated but the aircraft appeared to stall and rolled to the right.'*	Aircraft significantly damaged

Date	Registration	Location	Extract from AAIB report	Result
14/2/09	G-BZYL	Brimpton airstrip near Aldermaston, Berkshire	*'Following a 'touch-and-go'… the aircraft appeared to stall.'*	1 seriously injured Aircraft destroyed
10/5/08	G-MYBA	Chilbolton, Hampshire	*'The aircraft stalled and crashed shortly after becoming airborne.'*	Aircraft extensively damaged
28/3/05	G-CCNB	Weston Park near Shifnal, Shropshire	*'During a go-around, the aircraft stalled and crashed…'*	2 aircraft occupants suffered minor injuries; a member of the public was seriously injured Aircraft substantially damaged
25/3/05	G-CBAZ	Middlewich, Cheshire	*'…the aircraft's behaviour after takeoff indicated that it had… suffered a stall…'*	The pilot suffered a minor injury Aircraft extensively damaged
24/12/03	G-CCNH	Felixkirk, North Yorkshire	*'Shortly after takeoff, at less than 50 feet agl, the aircraft developed a left roll that the pilot could not correct even with the application of full opposite aileron.'* See note 1	Both wings and fuselage damaged
6/5/00	G-MZDG	Barton Aerodrome, Manchester	*'The initial climb was normal until at about 200 feet agl when the aircraft's left wing dropped, probably due to turbulence. In attempting to regain full control, the handling pilot, who was inexperienced, stalled the aircraft'*	Landing gear collapsed, propeller smashed, engine shock-loaded and cockpit area structure distorted
6/10/99	G-MYLA	Monewden, Suffolk	*'The aircraft wing then stalled and it had entered the initial phase of auto-rotation when it hit the ground'.*	1 fatality Aircraft destroyed

Date	Registration	Location	Extract from AAIB report	Result
4/7/99	G-MWRK	Near Easingwold, Yorkshire	*'…the engine went completely quiet as the aircraft passed over the farm buildings adjacent to the house. It then entered a right turn and descended out of sight. A few seconds later* [the witness] *heard a "dull thud". She ran across the farm yard and saw…* [the] *aircraft in a nose-down attitude "with its tail in the air'* See Note 2.	1 seriously injured Aircraft destroyed
13/10/94	G-MWUN	Penrith, Cumbria	*'…the pilot considered that all the symptoms indicated that a stall was occurring… the aircraft …* [the aircraft] *hit the ground at about 40° to 45°, with the engine and the nosewheel taking the full impact'.*	2 occupants suffered minor injuries Aircraft destroyed

Note 1: This is symptomatic of a stall with a wing-drop
Note 2: This description is consistent with an accident resulting from a stall

In summary, including G-MYES, this represents sixteen accidents involving stalling and/or spinning, resulting in six fatalities, six serious injuries and five minor injuries since 1999.

Since 1989, CAA data indicates that the size of the UK fleet of Rans S6 aircraft (all variants) has been as follows:

Year	Total registered at 31 DEC	Total hours flown by the fleet during the year
1989	1	0
1990	8	246
1991	19	423
1992	37	866
1993	61	2,249
1994	70	4,517
1995	80	2,977
1996	96	3,683
1997	108	4,208
1998	121	3,988

Year	Total registered at 31 DEC	Total hours flown by the fleet during the year
1999	137	4,748
2000	147	4,251
2001	157	5,440
2002	163	7,024
2003	171	6,838
2004	184	5,809
2005	185	5,973
2006	187	5,603
2007	187	6,943
2008	191	4,993
2009	187	5,615
2010	185	4,857
2011	180	4,827
2012	176	3,712
2013	173	3,605
2014	166	3,436
2015	163	1,184
Total fleet hours		**108,013**
Mean fleet size		**131 aircraft**

At the time of writing, the UK fleet comprised 161 Rans S6 aircraft.

Analysis

Operations

The flight seemed to be routine and the aircraft was serviceable, with sufficient fuel. The weather conditions were suitable, with the surface wind favouring a landing on Runway 36 at Shifnal Airfield.

The pilot was appropriately qualified and had accrued a total of 185 hours, of which 7 hours and 45 minutes were logged as being on the Rans S-6, including 1 hour of flying with the previous owner. During these flights, the previous owner had reportedly intervened twice, when he became concerned about the airspeed on final approach, and had pointed out the importance of the correct use of rudder during turns.

Information about the destination, Shifnal Airfield, was available to the pilot in the commercial flight guide which was found open at the page for Shifnal in the club caravan at Longford the day after the accident. The entry included the requirement for PPR, as did the Shifnal flying club website. It is not known whether the pilot attempted to obtain prior permission but there was no record of him doing so. If he had contacted the flying club at Shifnal, he would have been advised that Runway 36 was in use.

The pilot had visited Shifnal previously, possibly when Runway 28 was in use, but it was not established how he had flown the circuit on those occasions. He had visited 20 other airfields since his last visit to Shifnal.

In the absence of a PPR briefing, the pilot probably did not know that Runway 36 was in use. The prevailing conditions, as indicated by the windsock, favoured Runway 36 but the signal square indicated that Runway 28 was active. On arrival, the aircraft flew just west of the airfield, on a southerly track, and entered the circuit through the south-west gate. This route positioned the aircraft on the dead side of the Runway 28 circuit. As witnessed, the aircraft then flew a downwind leg for Runway 28, closer to the runway than normal, and, concurrently, the pilot made a 'downwind' radio transmission.

It is not known why the aircraft flew the downwind leg closer to the airfield than seemed normal. The radio transmission, which the pilot made downwind, did not include any mention of a problem. The pilot may have been following the railway line, instead of the A464 road, as the line feature to use to remain south of the avoid area. This would explain the proximity of the aircraft's downwind track to the airfield and, consequently, the reason for the aircraft's low height.

At the conclusion of the base turn, the aircraft was displaced south of Runway 28's extended centreline, which might be expected given the northerly wind and the proximity of the downwind leg to the airfield. The aircraft then broke off the approach, did not go around, and turned on to an easterly track, away from the airfield, possibly to re-position for the final approach to Runway 28.

Manoeuvring in the final approach area

The wing-drop observed by witnesses was indicative of flight at an angle of attack which was close to the stall. An initial recovery appeared to have been achieved but, at a height of approximately 290 ft agl, the aircraft seemed to enter a spin from which it did not recover. There was some evidence, from the engineering investigation, to suggest that spin recovery had been initiated, as there were no rotational marks on the ground or in the crop at the accident site and the aircraft had struck the surface in a steep nose-down attitude.

Airfield information

The various charts for the airfield showed one or both of the two line features north of the airfield; the railway line and the A464 trunk road. They were similarly orientated, running east-south-east or south-east, and both are near the northern airfield boundary. In the commercial flight guide, the hachured line which delineated the boundary of the downwind leg was not annotated as a road or railway. However, the flying club website did show that the A464 was the line feature to remain south of on the downwind leg.

The warning included in the commercial flight guide set out the limitations of the information it included and reminded pilots, planning to land at unlicensed airfields, to contact the airfield operator in advance.

Medical information

The post-mortem examinations found no evidence of underlying disease and concluded that the pilot and passenger had suffered fatal injuries. Toxicology tests also revealed no evidence of any substance that could have contributed to the accident. While there was no evidence that the accident was the result of some form of incapacitation, the possibility could not be ruled out fully.

Pilot's notes

The provenance of the pilot's notes found with the aircraft documentation could not be established. The LAA TADS 204 for the Rans S6-ES indicated that a set of pilot's notes is included in the original build manual for each aircraft. However, the UK Rans sales agent commented that the manufacturer did not issue pilot's notes with kit-built aircraft, due to variations in the build standard and different regulatory oversight regimes, although it did provide them with factory-built aircraft in the USA. In addition, the original build manual may not always reflect the actual configuration of an aircraft, especially if the aircraft has been modified or re-engined. The LAA has, therefore, committed to produce appropriate pilot's notes, as described in the 'Safety Action' section later in this report.

Engineering

It was not possible to make any assessment of spin direction from observation of the aircraft wreckage and ground marks. However, it was established that the aircraft had struck the surface in a steep nose-down attitude in a field about 700 m to the south-east of Shifnal Airfield.

The investigation did not identify any pre-accident mechanical defects in the aircraft, or its flight controls, which could have contributed to a departure from controlled flight. The fixed-trim tab on the elevator was observed to be bent down approximately 90° to the elevator surface. The LAA commented that, had the aircraft flown with such an extreme deflection on the trim tab, the effect would have been similar to that with a normally deflected tab but that it would cause additional drag. It did not consider that the additional drag would have had a significant effect on the aircraft handling or performance.

While the investigation identified a tear in the plastic tube of the pitot system and a pressure leak in the ASI, such anomalies, had they existed before the accident, would probably have resulted in the ASI significantly under-reading ie the aircraft's speed would have been greater than that indicated. This would have been evident to the pilot.

Examination of the engine, propeller and ground marks indicated that the engine was operating with low, or no, power at the point of impact. In particular, it was determined that the throttle was closed at the time of impact, although it was not possible to establish why.

The possibility of carburettor icing causing a reduction or loss of engine power could not be dismissed. In the prevailing conditions, moderate carburettor icing could have occurred at cruise power and serious carburettor icing at descent power. If carburettor ice had built up during the descent and circuit, it could have caused a lack of power during

the final manoeuvres. The transient nature of carburettor ice makes it difficult to identify as a causal factor.

Alternatively, a reduction or loss of engine power may have occurred for some other, undetermined, reason. A number of anomalies were noted with the engine during detailed examination, which may have affected engine efficiency or performance. So, although there were no conclusive findings from the engine examination, the possibility of an engine stoppage or power loss, for reasons other than carburettor icing, could not be ruled out.

The oil drained from the engine did not have the appearance of oil that had recently been changed, yet the logbook indicated that this procedure had been carried out by the pilot a few days prior to the accident. Conversely, the spark plugs, which were recorded as being changed at the same time, appeared new. A review of earlier logbook entries did not identify any oil changes in the preceding few years. It is possible that previous owners were not in the habit of recording engine oil changes in the logbook, or it may be that an oil change had not been carried out for some time. If so, the fresh oil may have quickly become dirty by mixing with the remains of the old oil in the engine.

Safety Action

As a result of the rate of stall/spin accidents involving Rans S6 aircraft in the UK, the LAA has undertaken to conduct a safety review encompassing the following aspects:

- *'Complete a review of accident data with the type to date, including consideration of the aircraft configuration, weights and cg positions, mission and pilot profiles of those involved, including a comparison with the accident data for similar types of microlight*
- *Carry out a flight test program on at least two representative examples, to investigate possible handling, performance or other factors that might contribute to an elevated accident rate, - including in particular:*
    - *Longitudinal stability*
    - *Ability to trim (in pitch)*
    - *Longitudinal and lateral/directional trim changes with changes in power and configuration (ie flap position)*
    - *Directional stability and control, including contributing effects of adverse yaw with aileron input, and any contributing ergonomic aspects*
    - *Pre-stall warning*
    - *Stall characteristics*
    - *Ease of operation of controls*
    - *Adequacy of low-speed stall recovery/climb performance at different weights and centre of gravity positions*

- *Behaviour in a simulated engine failure*
- *Instrumentation - in particular adequacy of indication of airspeed and slip'*

The LAA has advised that the applicable paragraphs of BCAR Section S, both current and extant at the time the type was introduced to the UK, are being used as the basis for this evaluation. The results of the safety review will be communicated to all Rans S6 pilots within the LAA membership

The LAA has also undertaken to produce a series of pilot's notes for the Rans S6, tailored to each airframe/engine combination on the UK fleet, on completion of the flight tests. The relevant Rans S6 TADS will be updated accordingly.

Flying club

Recognising the possibility of future confusion, the flying club at Shifnal Airfield reported that it had removed the landing T and signal square, to prevent incorrect signals being displayed.

Conclusions

The aircraft appeared to be manoeuvring at low speed in the circuit at Shifnal Airfield, having flown there from its base near Market Drayton. While apparently repositioning for an approach to land on Runway 28, the active runway indicated by the signal square, the aircraft was observed to stall and possibly enter a spin. It did not recover before striking the surface in a steep nose-down attitude in a field to the south-east of the airfield. On impact, the engine was operating at low, or no, power. Although there were no conclusive findings from the engine examination, the possibility of an engine stoppage or power loss, due to carburettor icing or other reasons, could not be ruled out.

Shifnal Airfield advises visiting pilots that prior permission is required (PPR) before arrival, however, there was no evidence that the pilot had contacted the airfield. Had he done so, he would have been advised that Runway 36 was in use.

The pilot had recently bought the aircraft and had accrued about 8 hours on the type, flying this aircraft. It was reported that, during two flights on G-MYES with the previous owner, he, the previous owner, had taken control from the pilot when he became concerned about the aircraft's speed.

The post-mortem examination found no evidence of underlying disease or substance that could have contributed to the accident and concluded that the pilot and passenger had suffered fatal injuries. While there was no evidence that the accident was the result of some form of incapacitation, the possibility could not be ruled out.

A review of records revealed that sixteen Rans S6 accidents have been investigated in the UK by the AAIB since 1994. As a result, the LAA is conducting a review of accident data on the aircraft type, including a comparison with the accident data for similar types

of microlight, and a flight test program to investigate factors that might contribute to this aircraft's accident rate. It has also committed to produce a series of pilot's notes applicable to Rans S6 aircraft of the various configurations existent in the UK.

Advice on the awareness of stalling and spinning in general aviation is provided in the CAA's *'Handling Sense Leaflet 2'*[10], entitled *'Stall/Spin Awareness'*, which is available on the CAA website.

Footnote

[10] https://publicapps.caa.co.uk/docs/33/ga_srg_09webHSL02.pdf