AAIB
Air Accidents Investigation Branch

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MISCELLANEOUS

ADDENDA and CORRECTIONS

None

(ALL TIMES IN THIS BULLETIN ARE UTC)

AAIB Field Investigation Reports

A Field Investigation is an independent investigation in which AAIB investigators collect, record and analyse evidence.

The process may include, attending the scene of the accident or serious incident; interviewing witnesses; reviewing documents, procedures and practices; examining aircraft wreckage or components; and analysing recorded data.

The investigation, which can take a number of months to complete, will conclude with a published report.

ACCIDENT

Aircraft Type and Registration:	Spitfire IXT, G-LFIX
No & Type of Engines:	1 Rolls-Royce Merlin 25 piston engine
Year of Manufacture:	1944 (Serial no: ML407)
Date & Time (UTC):	15 September 2016 at 1520 hrs
Location:	Sywell Aerodrome, Northampton
Type of Flight:	Commercial Operation
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Heavy damage to propeller, minor damage to engine cowls, landing gear doors and wingtip
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	60 years
Commander's Flying Experience:	23,500 hours (of which 500 were on type) Last 90 days - 150 hours Last 28 days - 40 hours
Information Source:	AAIB Field Investigation

Synopsis

The left landing gear collapsed on the landing roll despite the pilot having selected the landing gear down and confirmed indications that it was down and locked. The aircraft subsequently left the runway and came to rest on grass beside it. The pilot and passenger vacated the aircraft uninjured.

It was subsequently discovered that the left landing gear actuator seals had failed, preventing the actuator from achieving full extension.

History of the flight

The pilot stated that he was conducting the second passenger flight in G-LFIX that day. The weather was fine with a light wind favouring Runway 03L[1]. Having re-joined the circuit downwind the pilot selected the landing gear down and felt both legs lower, then observed the illuminated DOWN lights indicating the landing gear was locked down. As there was a bright sun the pilot briefly removed his sunglasses to check that indication was not in fact glare on the indicator. A normal approach to Runway 03L was then flown.

The aircraft crossed the runway threshold at about 85 kt before landing in a 3-point attitude with no bounce or yaw and initially tracked straight for about 250 m. However, at about

Footnote

[1] Runway 03L is a concrete runway with a landing distance available of 1,000 m.

35 kt the left wing started to lower. The pilot tried to counteract this with full right aileron and full rudder as the aircraft started to yaw rapidly to the left, departing the runway onto grass beside it. The pilot switched the engine's magneto switches off as the aircraft came to rest on its nose (Figure 1). The aerodrome's RFFS were quickly on the scene.

The pilot vacated the aircraft unassisted followed by the uninjured passenger with the use of a ladder provided by the RFFS.

Figure 1
G-LFIX after the landing gear collapse

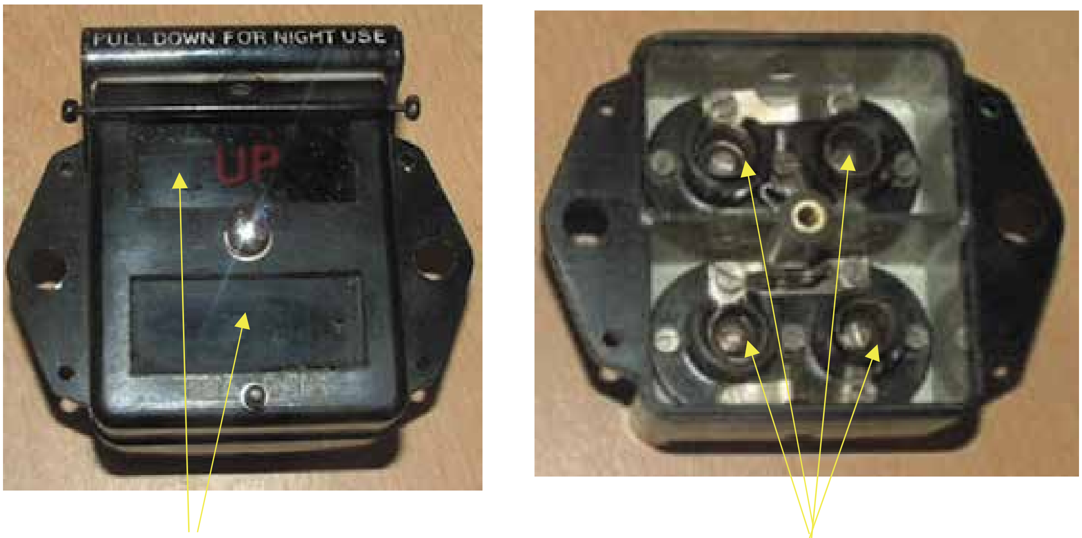
Landing gear description

The landing gear of the Spitfire Mk IX is operated by two hydraulic actuators, one for each landing gear. In both the extended and retracted position each landing gear is held in position by a spring-actuated chamfered locking pin which engages in either the down-lock lug or the up-lock lug on each landing gear.

Extension of the landing gear requires the pilot to move the selector lever out of its detent. This energises the hydraulic system and actuator, removing the load from the locking pin, and rotates the locking pin 180°. Movement of the selector lever to the DOWN detent retracts the landing gear actuator, moving the landing gear past the chamfer of the landing gear locking pin. While the landing gear is in motion DOWN appears in the landing gear status window on the landing gear selector. When each landing gear is fully extended the increase in hydraulic system pressure operates a pressure switch which causes IDLE to be displayed in the landing gear status window. In addition, when the landing gear locking pin has engaged in the down-lock lug of the landing gear, the indication circuit for that landing gear is completed.

Landing gear position indication

The Spitfire Mk IX is fitted with a landing gear position indicator on the left side of the instrument panel. The indicator consists of two black, back-illuminated panels. When the bulbs behind the panels light up the word UP is displayed in the upper panel and the word DOWN in the lower panel (Figure 2).



Indicator panel windows

Bulb positions (panel cover removed)

Figure 2

Landing gear indication panel

When both landing gear legs are locked in the down position and the respective indication circuits are made, the DOWN caption is illuminated. Two lights are fitted behind each caption to provide indication in the event of a single bulb failure.

The landing gear indication system fitted to G-LFIX had been modified so that instead of both bulbs behind the relevant caption illuminating only when both landing gear legs were in the relevant position, the left bulb in each panel would indicate the position of the left landing gear leg and the right bulb the position of the right landing gear leg. This meant that the letters 'D' and 'O' of the word DOWN in the panel would be illuminated by the left bulb and the letters 'W' and 'N' would be illuminated by the right bulb.

The operator stated that the differences between this aircraft's landing gear indicator and a conventional indicator are verbally briefed to pilots during their conversion onto the aircraft by the chief pilot.

Aircraft examination

After recovery of the aircraft by the maintenance organisation it was found that the left landing gear was difficult to force into the down and locked position. The landing gear selector was in the down position and the IDLE caption was showing in the landing gear selector window. Further inspection revealed that the landing gear had failed to lock down because the landing gear actuator ram chevron seals had failed and pieces liberated from the seals had migrated between the actuator ram and the seal support plate, jamming the actuator ram before it reached its full extension (see Figure 3).

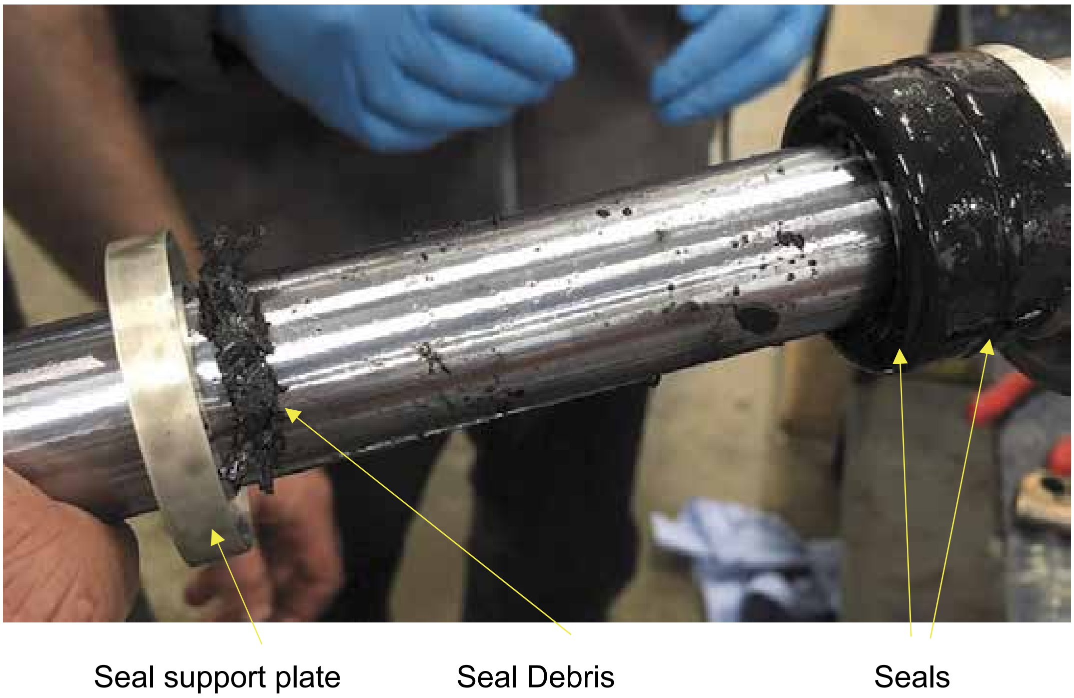


Figure 3
Seal debris on landing gear actuator ram

Each landing gear actuator is fitted with three seals. In 2013, due to a hydraulic leak, replacement seals were purchased and fitted by the maintenance organisation. As the supplier only had four new seals available, two of the original seals were refitted to the landing gear actuators. The maintenance organisation confirmed that the seals which failed were from the four purchased in 2013. The seals have an estimated life of five years.

The manufacturer of the seals was advised of the event by the aircraft's maintenance organisation, which also contacted other Spitfire operators directly to ensure they were aware of the problem. They discovered that other operators have had similar problems, but that they had not informed the seal manufacturer.

All the seals were passed to the AAIB. Examination under high powered optical microscopy confirmed that the failure of the seals had initiated in the region of the seal lip. The failure surfaces indicated that the seal lip material had been drawn between the seal and the actuator ram. Examination of the internal bore of the seals and the failure surfaces indicated that the seal failure had been progressive, with small amounts of material being liberated. The presence of this material between the seals and the hydraulic ram resulted in the release of further material which, over a number of operating cycles, produced sufficient material to jam the actuator ram within the seal pack.

Tests

Destructive and non-destructive testing was carried out on both the original and replacement (2013) seals by two independent laboratories to identify a reason for the failure of the 2013 seals. The tests did not identify a difference in either the physical properties or the chemical constituents of the seals that could have made the 2013 seals more prone to early failure.

During their investigation of the event the maintenance organisation carried out tests on the landing gear position indication system. These confirmed that the indication system was serviceable. They also showed that, in the event that the left bulb in the DOWN indictor panel did not illuminate, the indirect light produced by the bulb on the right side of the indicator was sufficient to partially illuminate the letters D and O of the DOWN indication.

Analysis

The partial collapse of the landing gear was caused by the failure of chevron seals in the left landing gear actuator, which jammed the actuator before it reached the "down and locked" position. When the actuator became jammed, the increase in pressure within the hydraulic operated the pressure switch in the landing gear selector, which resulted in the status indictor window changing from DOWN to IDLE and provided an indication to the pilot that the landing gear had completed its extension cycle. Extensive examination and material testing was unable to identify a defect within the failed seals or a change in the chemical composition of the seals purchased in 2013 that would have contributed to their failure.

No defects were found within the landing gear position indication system. The fact that the left landing gear did not achieve a locked position meant that the left light bulb in the landing gear position indicator would not have illuminated. However, tests showed that sufficient light was produced by the right bulb to illuminate the D and O of the DOWN caption.

Safety action

> In order to prevent the illumination of the complete word "DOWN" in the landing gear position indicator in the event that one landing gear has not achieved the fully locked position, the maintenance organisation modified the landing gear indicator to prevent light from either of the indicator bulbs illuminating the complete DOWN caption.

Conclusion

The collapse of the left landing gear was caused by a failure of the landing gear actuator chevron seals, which jammed the actuator before the landing gear had reached the locked position.

The reason for the failure of the chevron seals purchased in 2013 could not be determined. The modification to the landing gear indicator panel should minimise the possibility of a pilot being unaware of a failure of the landing gear to achieve a locked position.

ACCIDENT

Aircraft Type and Registration:	Sud-Aviation SE-313B Alouette II, HA-PPC
No & Type of Engines:	1 Turbomeca Artouste II C6 turboshaft engine
Year of Manufacture:	1960 (s/n 1500)
Date & Time (UTC):	17 July 2016 at 1700 hrs
Location:	Breighton Aerodrome, Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 4
Injuries:	Crew - 1 (Fatal) Passengers - 4 (Serious)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence (H)
Commander's Age:	36 years
Commander's Flying Experience:	708 hours (of which more than 164 were on type) Last 90 days - 18 hours Last 28 days - 8 hours
Information Source:	AAIB Field Investigation

Synopsis

The helicopter flew along the runway at about 30 ft agl and carried out a quick stop. Witnesses reported a nose-up pitch attitude of around 45° was attained as the helicopter flared, then, as it levelled, the rotor blades struck the tail boom. The helicopter rotated to the right through 180° and dropped vertically to the ground. Everyone on board was taken to hospital; the pilot died subsequently. No technical failure was found which could explain the accident.

History of the flight

Previous flights

The pilot kept the helicopter at a private site located 27 nm to the east of Breighton Aerodrome. On the day of the accident he flew it to Breighton, where a vintage aircraft fly-in event was taking place. From there he flew several trips in the helicopter, taking friends and acquaintances for short flights. At 1636 hrs, following a local flight with three male passengers, the helicopter returned to Breighton. The pilot flew along Runway 28 and reduced speed above the runway, before flying towards the parking area in a steep nose-down attitude at a height of 30 ft to 50 ft. Approaching the fuel pumps the helicopter levelled and taxied forwards, however it pitched nose-down momentarily a couple of times, bringing the tail boom into close proximity to the rotor disc. It landed without incident in front of the fuel pumps; photographs taken from outside the helicopter showed a steady nose-down pitch attitude of 3° in the hover and at touchdown. The helicopter was refuelled with 112 litres of fuel.

Accident flight

The passenger who subsequently occupied the left front seat of the helicopter for the accident flight had flown an aircraft as part of a display formation earlier in the day. He had just finished putting it away when he met the pilot outside the hangar. The pilot offered him a flight in HA-PPC, which he accepted, and he went into the clubhouse to advise his partner. He then went to the helicopter, where he discovered there was a passenger who he knew seated in the back. Not knowing how much fuel was on board he asked the pilot if it was still alright for him to join the flight and whether there was room for anyone else. The pilot said it was fine and the passenger returned to the clubhouse to see if anyone else wanted to come. One person agreed and then a second asked if they could join as well. The passenger escorted them both out to the helicopter and checked with the pilot to see if they could join the flight. The pilot accepted them and they boarded in to the rear cabin.

The passenger who had invited the persons from the clubhouse, who was also a qualified helicopter pilot and instructor on another type of helicopter, occupied the left front seat; dual controls were fitted. Both front seat occupants wore full four-point harnesses. The other three passengers were seated on the bench seat in the rear of the helicopter, which was equipped with lap straps only. All persons on board were wearing headsets connected to the intercom system. A pre-flight safety briefing was not given to the passengers.

At 1648 hrs, with five persons on board, the pilot started up, lifted to a hover, turned 30° to the right and took off in a north-westerly direction. The helicopter was photographed in a 3° nose-down attitude in the hover. During the climb, the pilot offered control to the front seat passenger and a formal control handover took place. The passenger flew the helicopter to the west and then around to the south, performing some general handling manoeuvres at heights of between 1,000 ft and 2,000 ft amsl, before returning towards the airfield. He then flew along the runway at a height of around 100 ft, whereupon the pilot asked if he would like to do a zoom climb and a pushover at the end of the runway; the passenger declined.

The pilot resumed control, again with a formal handover, and suggested the passenger follow him through on the controls. He zoom-climbed to around 700 ft agl, pushed over into a steep descent before levelling at 400 ft to 500 ft agl and turning into a left-hand circuit pattern. He turned onto final approach at about 100 ft agl flew along the runway at a speed of around 55 kt before carrying out a quick stop. The front seat passenger reported that the quick stop was smooth and progressive with no perceptible yaw.

The onlookers described a nose-up pitch attitude of between 45° and 55° during the quick stop. As the helicopter pitched nose-down towards a more level attitude there was an audible “crack” and a “very loud bang”. One witness described seeing the tail lifting into the rotor disc. The main rotor blades struck the tail boom and the engine exhaust cowling; the tail rotor assembly separated from the helicopter. The helicopter rotated through 180° to the right as it dropped vertically to the ground.

Several bystanders ran across to assist. The helicopter was substantially upright but leaning to the right. The engine had detached from its mounting and was lying on the ground a few metres away; the sound of it spooling down could still be heard. Both doors had come open in the accident sequence. The pilot unfastened his harness and fell sideways out of his side door, his feet were trapped under the yaw pedals and he could not escape further without assistance. The passenger in the right rear seat unfastened his lap strap and managed to get himself clear of the helicopter before collapsing to the ground; the other occupants all had to be assisted out of the wreckage. Emergency services attended the scene and the five persons on board were transferred to hospital, either by road or by air ambulance. The pilot died a few days later in hospital.

Accident site and wreckage

Actions by airfield staff

An immediate response was carried out by the airfield staff and emergency services followed by methodical post-crash management action taken by the Chief Engineer at Breighton.

Shortly after the accident, the wreckage and detached items were moved away from the main runway and covered to protect them from the elements. CCTV footage and witness detail had been retained at the airfield and passed into AAIB custody. Figure 1 shows the helicopter shortly after the accident on the airfield.

Figure 1

Helicopter wreckage

After an initial examination of the wreckage, the main rotor blades were removed and the wreckage was transported to the AAIB HQ in Farnborough for a detailed examination.

Pilot information

The pilot's full logbook records were not available for the investigation. He qualified initially for a Private Pilot's Licence (Helicopter) in 2002 with a Hughes 269 type rating, in July 2002 he added a SA341G, Gazelle, type rating and in 2007 an endorsement for a SA318/SE313, Alouette. At the time of the accident the pilot held a valid EASA PPL(H) and a Hungarian National PPL(H).

Following his purchase of HA-PPC in 2007 the aircraft logbooks recorded that 163:25 hours had been flown on the helicopter. The pilot's 'on type' experience is based on this data.

Recorded information

Recorded radar data for the period around the time of the accident was examined. Great Dun Fell radar head, 72 nm to the north-west, showed primary returns, identified as HA-PPC, manoeuvring to the west and south of the airfield. The final contact was recorded at 1656:22 hrs, 2 nm south-east of the airfield.

A rear-seat passenger took some pictures with his mobile phone during the flight and these included several taken during the first low flypast but none closer to the time of the accident.

Video evidence was obtained from two security cameras mounted on a hangar to the south of the runway which showed the helicopter manoeuvring on the previous flight and during the accident flight. The cameras covered the east and west ends of the runway, but not the centre portion where the accident occurred and therefore the accident sequence was not recorded.

A spectator who had been photographing aircraft throughout the day took a number of pictures of HA-PPC during the afternoon. He captured two sequential photographs, at 0.2 second intervals, showing disruption of the rotor head and main body of the helicopter, while it was still airborne.

Aircraft description

The SE-313B Alouette II is a lightweight utility helicopter originally designed for a variety of military and State roles. Examples of the type were used by armed forces including the British Army and although a few remain in State usage, many are now owned and flown privately.

HA-PPC first came into service in 1960 as XP967, operated by the British Army. It was transferred to the UK civil register in 1990. The pilot purchased the helicopter in 2007 and transferred it to the Hungarian register, although it continued to be based in the UK. He had flown approximately 160 hours in HA-PPC.

The helicopter airframe is made up of a tubular steel frame through which all of the major engine and transmission components can be seen. It has an enclosed cabin but the majority of its panels, including the roof, are of clear Perspex giving the pilot and passengers very good all round visibility. The helicopter can carry up to five people including the pilot and co-pilot. The helicopter is powered by a Turbomeca Artouste II single shaft gas turbine engine driving a three-blade main rotor and two-blade tail rotor via a conventional transmission system. There is a centrifugal clutch and freewheel coupling assembly between the engine and main rotor gearbox input. The tail rotor output shaft is fitted with a hydraulic rotor brake consisting of disc and caliper assembly.

The cyclic and collective flying controls consist of a system of rods, levers and bell cranks routed under the cabin floor and up behind the cabin to the fixed and rotating star assembly attached to the main rotor gearbox. The lateral and longitudinal control systems are fitted with servo units powered by a simple hydraulic system. Flying control servo assistance was an optional extra in the Alouette series of helicopters. The system consists of a main rotor gearbox-driven pump, reservoir and filters. Hydraulic pressure can be controlled by a pilot operated SERVO ON/OFF valve situated on the cabin floor alongside the co-pilot's seat.

System pressure is displayed on a gauge on the side of the instrument binnacle. The Flight Manual states that the hydraulic servo system requires the main rotor head to be fitted with hydraulic blade dampers.

The tail rotor control is transmitted via the yaw pedals into cables and pulleys running along the tail pylon into a pitch change actuation mechanism which operates through the tail rotor gearbox.

The main rotor blades consist of an extruded aluminium alloy main spar which forms the leading edge of the blade. The aerofoil section and trailing edge of the spar is constructed of thin gauge aluminium alloy, packed with a synthetic resin foam filler to give rigidity to the skin. Tip balance weights are fitted to the blades and covered by light alloy tip fairings. The blades are attached to the rotor head blade sleeves by two tapered steel bolts. The main rotor head is fitted with hydraulic piston drag dampers. In addition to the drag dampers, there are cables attached between each blade at the outer end of the blade sleeve, held in place by small articulated links. These cables are known as the blade spacing equaliser system.

Tie bars are fitted within the blade sleeve which take the centripetal loads from the main rotor blades onto the flapping hinge trunnion alleviating those loads from the blade sleeve pitch change bearings.

Fuel is held in a single 580 litre (153 US gallon/464 kg) cubic tank within the helicopter framework under the main rotor gearbox and supplied to the engine via an electrical booster pump. Of the 580 litres of fuel, 15 litres (12 kg) is considered unusable and is shown by a red marker on the fuel contents gauge scale. Low fuel is indicated by a red warning light within the fuel gauge which illuminates when there is 60 litres (48 kg) remaining. It should be noted that the fuel gauge is calibrated in US gallons and both metric and imperial weights and quantities are used in the Flight Manual performance charts.

The Alouette series of helicopters are fitted with either skids, floats or wheeled landing gear. HA-PPC was fitted with skids.

The cockpit instruments are of a conventional electro-mechanical and pneumatic design. HA-PPC was also fitted with a transponder and radio along with a Skyforce GPS. The front seats and passenger bench seat in the rear, are of a lightweight tubular construction with leather covered cushion facings on top of the original cord and canvas facings.

Flight Manual

The Operating Limitations section of the Flight Manual for the SE-313B Alouette II helicopter includes, under the title '*Manoeuvring limits',* the information:

> *'The following recommendations should be observed:*
>
> - *Over 3,000 lb* (1,361 kg) *gross weight, approach should be made at a shallow angle*
> - *Handle the aircraft gently near limit speed and reduce speed before attempting sharp manoeuvres'*

Weight and balance

The maximum all-up weight (MAUW) of the helicopter is 1,588 kg (3,500 lb) with a CG range of 274 cm to 307 cm, measured from a datum forward of the aircraft nose. The design and mechanical layout of the helicopter are such that fuel quantity is the balancing factor when flights are being planned. If a pilot is planning to carry passengers they must take into account that all persons and items in the cabin will bring the CG forward. The addition of fuel will bring the CG aft.

Table 1 shows the last two weight and balance checks recorded for HA-PPC. Following the most recent helicopter overhaul, there was in an increase in weight of 46 kg. It also shows the basic CG moving forward from 320.5 cm to 317 cm. The reason for this is discussed later in this report.

Date	Inclusions	Empty Weight	CG position (from datum)
6 Aug 12	Fire extinguisher, first aid kit, 5x seat harnesses, 5x headsets, Skyforce GPS, transponder, unusable fuel	994 kg (Note - does not include fuel tank at red warning level of 48 kg)	320.5 cm
10 Mar 16	Standard cockpit, 4x headsets, first aid kit, battery, systems filled with oils and fuel at red warning level 48kg	1,088 kg	317 cm

Table 1

Weighing record details

It was not possible to determine the precise quantity of fuel on board at the time of the accident therefore a series of weight and balance calculations were completed (Table 2). The fuel consumption at maximum weight and a cruise speed of 90 kt is approximately 175 litre/hr (140 kg/hr) and the V_{NE} at sea level is 100 kt.

	Fuel on 'red' warning	Fuel at takeoff - assuming uplift quantity of 90 kg added to 'red' level in the tank	Minimum possible fuel remaining at the time of the accident - assuming previous shutdown fuel above red warning level
Empty Weight	1,088 kg	1,088 kg	1,088 kg
Fuel	0 kg	90 kg	64 kg
Passengers & items in the cabin	424 kg	424 kg	424 kg
Total	1,512 kg	1,602 kg	1,576 kg
CG (Range 274-307 cm)	276.6 cm	278.2 cm	277.7 cm

Table 2

Weight and balance figures[1]
(Red font shows a total exceeding the maximum allowable 1,588 kg)

The CG position figures in the table shows the CG moving forward as fuel is used. The range of its movement brings it close to but does not exceed the forward CG limit.

Aircraft examination

Aircraft structure

The helicopter had landed upright on its landing skids which had left deep indentations in the surface of the grass runway. The landing skids cross bars and inclined shock absorbers had bent, bringing cabin structure into close proximity with the ground. The cabin structure was distorted, the doors had detached and the majority of the cabin Perspex transparency had fragmented.

The structure supporting the main rotor gearbox had retained its basic shape over the fuel tank but the gearbox itself had partially detached, tilted forward and leaning over to the left.

The tubular framework around and beneath the main rotor gearbox had suffered bending and fractures to the various struts and ties. The fuel tank was distorted and had split allowing the fuel to drain out on to the ground. The structures around the transmission

Footnote

1 The figures presented for the fuel load are based on the assumption that the pilot refuelled with 90 kg at the point when the red fuel low warning light illuminated at 48 kg. It is possible that there was more than 48 kg of fuel already in the tank, therefore the takeoff weight could have been more than 1,602 kg.

deck were covered in a film of oil and spattered with grease. The oil had escaped from the lubricating oil tank and its associated supply and return pipes which had been damaged during the accident.

The tubular frame tail boom was in a highly disrupted state. All three tubes which make up the triangular section of the framework had been distorted and severed approximately half way up the tail boom. The tail rotor gearbox and associated framework had detached as had the tail rotor protective skid. There was no evidence that the underside of the tail rotor skid contacted the ground during the accident sequence. The stabiliser aerofoils and cross tube were severely damaged and had also detached. The centre section of the cross tube was heavily scuffed and flattened and the inboard face of the stabiliser was badly crushed at its trailing edge.

Rotor head, blades and dampers

For identification during maintenance, the main rotor head, blades and associated components are colour coded (red, blue and yellow) and marked with tape or painted bands. All three main rotor blades had exhibited varying degrees of damage to their aerofoil skin surfaces and their tip fairings had detached. The yellow blade had suffered the worst damage and had lost the outermost upper section of aerofoil skin. One of the pieces of skin material had a scuffed transfer of grey paint on to its outer surface. The yellow blade main spar had taken on a permanent curved bend upwards and rearwards along its entire length. The red and blue blade main spars were also damaged but not to the same extent. The upper and lower skin surfaces of all three blades, from the blade root outwards, showed evidence of multi-strand steel cable strikes. The hydraulic blade damper trunnions had failed on all three blades. The yellow blade had undergone an extreme lag or 'retardation' and the blue and red blades suffered an equally extreme lead or 'advance' over-travel.

The blade spacing cables had detached between the red and yellow blades and between the red and blue blades. In each case, the articulated links which connect the eye-end to the cuff joint had broken across their attachment bolt hole. Laboratory analysis of the broken cable links show that they all failed in overload.

The rotor head assembly had witness marks at various points on the articulated joints (ie flapping and drag hinges) of all three arms and on the head boss due to over-travel about the joints. The droop restrainer ring was in place and free to move within its location slot but was compressed and misshapen in several areas around its circumference.

Cockpit controls and instruments

Despite severe distortion to the instrument binnacle, the helicopter instrumentation, switches and controls were undamaged. The barometric altimeter was set at 1020 hPa which matched the local QNH at the time of the accident. Apart from this setting no meaningful data could be gathered from any of the other instruments which had decayed to zero or null readings when electrical power was lost after the accident. The fuel shut-off cock, flow control lever and governor control lever were all in the forward MAX or OPEN positions. The adjustable stop on the governor control lever quadrant was set forward of the mid position.

Tail rotor

The two-blade tail rotor had lost the outer half of both of its blades but was still attached by its hub to the tail rotor gearbox. The pitch change links were intact and responded to a manual input to the pitch change actuation mechanism with full range and in the correct sense.

Flying controls

The flying control rods and linkages from the cyclic and collective were bent and in many cases broken behind the cabin leading up to the main rotor gearbox. Despite the damage to these control runs, continuity and operation in the correct sense could be demonstrated in the collective and cyclic control systems via the servos. The control rods mounted on the main rotor gearbox between the bell crank pivot shaft and fixed star of the swash plate assembly, through to the rotating star and into the red, yellow and blue pitch control rods were relatively intact except for a slight bend. However, the lateral control rod had fractured at the waisted portion above the eye-end adjustment thread. There was also evidence of ferrous corrosion on the eye-end thread in the same area.

The yaw pedals were intact and free to move. The control rod between the yaw pedals and control quadrant was distorted. The cables between the quadrant and the tail rotor pitch change input helix on the tail rotor gearbox had broken near to the tail boom structure disruption. However, continuity and operation in the correct sense could be demonstrated.

The hydraulic system pipes had been damaged but the majority of other system components were intact. There was fluid present in the system but there had been some leakage from the damaged pipes. Although the servo selector valve hand wheel had broken in two and was not attached to its valve, examination found the valve spindle to be fully clockwise in its open SERVO ON position.

Engine and transmission

The engine had fully detached and had come to rest next to the helicopter on the ground. The output clutch assembly was free to rotate but the core of the engine was jammed. The exhaust and its insulation cowl had also detached and there was crush damage to the diffuser. There was also a perforation to the combustion chamber. Removal of the diffuser released the tension on the rear bearing and the compressor and turbine assembly became free to rotate. Despite the accident, the engine and its ancillary equipment were in good condition. There was no evidence of foreign object debris within the engine.

Notwithstanding the detachment of the tail rotor gearbox and dislocation of the main rotor gearbox, both assemblies were undamaged, free to rotate and contained lubricating oil. The main rotor gearbox magnetic particle detection plug was free of debris. The tail rotor drive shaft, inclined shaft (tubular tail rotor drive shaft which runs beneath the engine) and freewheel unit had detached from the helicopter. The inclined shaft head had been pulled from its universal joint and the shaft which runs along the top of the tail boom had been bent and showed evidence of a torque-twist failure at the outer end. The freewheel unit worked correctly and was intact except for a small amount of distortion to its engagement splines.

The photographs taken by chance during the accident sequence show the engine and transmission shafts undergoing serious disruption and separation whilst the helicopter was still airborne.

Crashworthiness

Although the design of this helicopter predates many of the crashworthiness requirements of EASA Certification Specification 27, this helicopter absorbed most of the impact forces. The skid cross tubes deformed uniformly and the seat frames and faces absorbed the shock. The straps and harnesses retained the occupants and reduced the possibility of them being ejected from the cabin during the accident. The fuel tank split in the impact but did not burst open thereby reducing the possibility of fuel spillage as well as the likelihood of a post-crash fire.

Meteorology

Meteorological data for Breighton is not recorded but reports from persons at the airfield suggested that the weather was fine and clear with a west-south-west wind of 10 kt to 15 kt. Photographs and video recordings taken at the time of the accident showed clear skies at low level, with good visibility; the surface wind was gusty from a westerly direction.

Airfield information

Breighton is an unlicensed aerodrome situated at the south-west corner of a disused military airfield. The field elevation is 20 ft amsl. The single grass runway, orientated 10/28, is 850 m in length and 45 m in width; all circuits are to the south. A parallel tarmac taxiway is located on the south side of the runway, alongside which are various hangars and buildings, including a clubhouse. A refuelling facility is positioned in front of the clubhouse.

Organisational information

Overall condition and maintenance

Despite the damage to the helicopter the examination found it to be in good condition. The Hungarian based Continued Airworthiness Management Organisation (CAMO) had carried out a major overhaul of the helicopter and issued a Certificate of Airworthiness and Release to Service on 11 March 2016. This included the helicopter check-weigh and CG calculation. It was reported that during the major overhaul the cabin structure was replaced due to an unacceptable level of degradation of the light alloy skin in the cabin floor due to corrosion. The AAIB was informed that the replacement cabin was of German origin and this is supported by the cabin specification plate fitted on the cabin floor.

The Artouste C6 engine fitted to HA-PPC is recorded as having annual servicing and although not recorded in its Engine Log Book, a Release to Service Certificate showed that it had been overhauled in October 2005. It was due its next calendar based overhaul in October 2020. The engine manufacturer has no record of this work being carried out by any of their approved organisations.

Other information

Handling of flight controls

A non-qualified person on board an aircraft handling the flight controls for a short duration is common practice but whether it is allowable under existing regulation is not clearly specified. HA-PPC is an Annex II aircraft and is subject to national regulation in Hungary, not to EASA regulation. The Hungarian Ministry of National Development advised that a passenger cannot operate a helicopter without holding the appropriate type rating.

For EASA aircraft, Regulation (EC) No 216/2008, Article 7, states:

> *'Except when under training, a person may only act as a pilot if he or she holds a licence and a medical certificate appropriate to the operation to be performed.'*

The EASA interpretation of the phrase '*act as a pilot*' is equivalent to that defined by ICAO where '*to pilot*' is:

> *'To manipulate the flight controls of an aircraft during flight time[2].'*

EASA states:

> *'outside of a training context, a helicopter pilot without the required type-rating, and travelling as a passenger, is prohibited from manipulating the flight controls of the aircraft during flight time.'*

In the UK the interpretation for an Annex II aircraft is similar to that for an EASA aircraft.

CAA Flight safety information publication[3]

CAA Safety Sense Leaflet 02 – '*Care of Passengers*' states:

> *'The Commander of an aircraft is responsible for the safety and well-being of his passengers and the law requires a pre-flight safety briefing in any UK registered aircraft.*
>
> *This applies to ALL aircraft, including gliders, balloons, microlights and helicopters, as well as 'conventional' aeroplanes.'*

Footnote

[2] P12 of Part 1 'Definitions' in ICAO Doc 9713 'International Civil Aviation Vocabulary'.
[3] Available at: http://publicapps.caa.co.uk/modalapplication.aspx?appid=11&mode=list&type=sercat&id=21 [Accessed 13 September 2016]

Advice on the importance of the correct distribution of weight in a helicopter is provided in the FAA '*Helicopter Flying Manual, Chapter 06: Weight and Balance*[4]. For forward CG it states:

> *'This condition is easily recognized when coming to a hover following a vertical takeoff. The helicopter has a nose-low attitude, and excessive rearward displacement of the cyclic control is needed to maintain a hover in a no-wind condition. Do not continue flight in this condition, since a pilot could rapidly lose rearward cyclic control as fuel is consumed.'*

However this indicator can be disguised in strong wind conditions:

> *'A forward CG is not as obvious when hovering into a strong wind, since less rearward cyclic displacement is required than when hovering with no wind. When determining whether a critical balance condition exists, it is essential to consider the wind velocity and its relation to the rearward displacement of the cyclic control.'*

An illustration of the effect of the CG on pitch attitude is included and shown at Figure 2.

Figure 2

Illustration of the effect of CG on helicopter handling[5]

Analysis

The pilot had been inviting different people for flights during the course of the day. On this occasion, although he hadn't originally planned to, he accepted four passengers on board. The helicopter, with these four passengers and an uplifted fuel load of 90 kg, exceeded the Flight Manual limitation for maximum weight. The helicopter was also operating towards the forward limit of its CG range.

Footnote

4 Available at: https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/helicopter_flying_handbook/

5 Shown in: https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/helicopter_flying_handbook/

A safety briefing is a required part of every flight and gives the pilot an opportunity to advise the passengers of features specific to the aircraft type and indicate the emergency escape procedures. The absence of a briefing did not affect the outcome of this flight.

Weight and balance

In 2012 the helicopter empty weight was 994 kg including 12 kg (26.7 lb) unusable fuel, ie an empty fuel tank. In 2016, after a major overhaul, the helicopter was reweighed and recorded as having a weight of 1,088 kg. Taking into account this figure includes 48 kg of fuel, the resultant empty weight was 1,040 kg. The revised empty weight was 46 kg greater than the previous weighing record. This increase is likely to have been as a result of the cabin change and explains the movement of the basic CG forward from 320.5 cm to 317 cm. It is possible that the pilot overlooked these changes when he considered how many passengers he could take on a flight.

For the accident flight, the weight of the helicopter with its fitted equipment, an assumed minimum reserve (red light) fuel of 48 kg and just the pilot on board was calculated at 1,227 kg. The MAUW is 1,588 kg, thus the available payload for fuel and passengers would be 361 kg. The pilot had loaded 90 kg of fuel, giving a maximum possible available payload of 271 kg. The combined weight of the passengers and other non-essential items on board was 285 kg, an exceedence of 14 kg or greater[6]. This degree of weight exceedence was probably not significant for gentle flight manoeuvres but may have been relevant for some more dynamic manoeuvres. The information provided in the Flight Manual for operation at weights above 1,361 kg (3,000 lb) recommends a reduction in speed before '*attempting sharp manoeuvres*'. During the accident flight a zoom climb and a bunt were observed and on the previous flight the helicopter was flown towards the parking area in a steep nose-down pitch attitude before levelling.

The Flight Manual weight of 1,361 kg (3,000 lb), above which the helicopter must be handled 'gently' at higher speeds and shallow approach angles are required, for HA-PPC represents the pilot plus one hour of fuel on board with no passengers, or 30 minutes fuel with one passenger.

Effect on handling characteristics

All weight in the helicopter cabin acts to move the CG forward whereas fuel moves the CG aft. For the flight preceding the accident flight there were three male passengers on board, and less fuel than on the accident flight. The CG is likely to have been towards the forward edge of the range, leading to a nose-low attitude and rearward stick position in a zero wind hover, a situation which brings the rotor disc closer to the tail boom. Cyclic control authority is reduced, making it more difficult to reduce speed and decreasing manoeuvrability. The CCTV recordings showed that at the end of this flight the rotor disc twice came close to contacting the tail boom as the helicopter flew towards the fuel pumps.

Footnote

6 The figures presented for the fuel load are based on the assumption that the pilot refuelled with 90 kg of fuel at the point when the red fuel low warning light illuminated at 48 kg. It is possible that there was more than 48 kg of fuel already in the tank, therefore the exceedence may have been greater than 14 kg.

The helicopter was refuelled after this flight, moving the CG further aft. However, the additional load in the cabin would have brought the CG forward. The observed nose-down attitude in the hover suggests that the helicopter was operating with a forward CG which would have brought the rotor disc closer to the tail boom in flight, increasing the possibility of its contacting the tail boom.

Accident sequence

The helicopter component examination clearly shows that the main rotor disc came into contact with the tail boom structure. It is evident from the damage to the main rotor blades and their tips, along with the damage to the stabiliser and its cross tube, that the first impact was from the yellow blade closely followed by blue and the red blades in succession. The yellow blade tip missed the right stabiliser aerofoil but collided with the cross tube and on into the inboard trailing edge corner of the left stabiliser aerofoil. Figure 3 shows the damage to the stabiliser cross tube and path of the blade impact.

Figure 3

Damage to the stabiliser cross tube and path of the blade impact

This was the probable source of the “loud crack” described by the passengers and many of the witnesses. The tip fairing was crushed and detached and its deformation precisely matched the profile of the stabiliser trailing edge. In this initial impact, the cross tube was flattened and there is evidence that the yellow blade, whilst in contact with the cross tube, travelled underneath the tail rotor drive shaft and it is possible that it momentarily restricted its rotation to the extent that it twisted under torque and failed. It is also possible that the torque-twist occurred when the shaft bent as the tail rotor gearbox and its associated structure bent and separated from the tail boom. Photographic evidence shows a long section of tail rotor drive shaft, still rotating, detached from the helicopter whilst it was airborne and the torque-twist could only have happened prior to this event.

The tail structure suffered a number of main rotor blade strikes leading to complete loss of structural integrity. With an N_R[7] at approximately 360 rpm, there could have been up to 18 blade passes and potential impacts per second.

With an Alouette II helicopter at rest, it can be shown that the most likely blade tip impact point will be in the area where the stabiliser is fitted. However, it is very difficult to pull a main rotor blade down to contact this area by hand against the anti-droop ring. Nevertheless, in flight the aerodynamic and inertial forces have a large effect on the disc path and can, under extreme circumstances, allow the tip of the main rotor to come into contact with the tail structure. Potential blade impact may be exacerbated by a forward CG, which reduces the distance between the blade tip path and tail boom.

The damage to the hydraulic dampers and blade spacing cables is likely to have occurred at the first impact of the yellow blade leading to an inertial shock through the rotor head when it momentarily slowed as the yellow blade transited through the structure. Then, as this structure disintegrated, the head, which was still being driven, caused the red and blue blades to accelerate under their own inertia to over-travel with enough energy to break through the damper trunnions. The lead and lag of the damaged blades would then not be damped or controlled; the effect would be for the blades to fly out of track leading to a worsening out of phase situation between the blades. It is possible that it was during this early sequence of events that the pitch rods were damaged.

It is also early in the sequence that the inter blade cables and drag dampers suffer significant shock loading as the blades and head, still being driven from the main rotor gearbox, collided with the tail structure. The two sequential photographs show the latter stages of the sequence, by which time the disruption and deflection of the blades from their normal track and phase was so great that one of the blades collided with the engine with such force that it detached from the helicopter. This was probably the source of the “bang” described by witnesses.

The tail rotor appears to have departed the helicopter and flown upwards and forwards, suffering secondary damage after collision with the main rotor blades. This resulted in the torque rotation of the helicopter through 180º as it dropped to the ground.

The sudden deceleration when the helicopter hit the ground resulted in all three main rotor blades undergoing a violent droop whilst still rotating. The blades collided with the remains of the tail boom structure severing the already damaged tubing to leave a distinctive angular cut. It was also likely at this point that the droop restrainer ring was misshapen.

Footnote

7 N_R – Abbreviation used to represent rotor rpm in rotary wing aviation.

Finally whilst still in a drooped condition, a main rotor blade struck the cabin structure. The impact caused severe distortion to the left side door frame, instrument binnacle and fragmented the cockpit transparencies and brought the main rotor to a stop. Based on the witness evidence and the helicopter's proximity to the ground, it is estimated that this whole sequence took less than five seconds.

Observations

It was suggested by outside observers that it was possible that the accident resulted from the tail skid striking the ground. However, there is no evidence that the tail skid came into contact with the ground prior to or during the accident.

The engine manufacturer could find no records that the overhaul had been carried out by one of their approved organisations. However, the engine performance or condition was not a causal or contributory factor.

Conclusion

The helicopter was well maintained, serviceable and in good condition prior to the accident. All the damage to the helicopter's structure, its components and systems is attributable to the main rotor disc striking the tail boom structure in the vicinity of the stabiliser cross tube. There was no evidence of pre-accident defects of the flying controls or transmission system which could have led to the rotor disc colliding with the tail boom, therefore it probably occurred as result of control inputs.

The helicopter was close to or above the MAUW of 1,588 kg (3,500 lb). Also, the CG was towards the forward limit of the allowable range detailed in the Flight Manual, thus the margin of clearance of the rotor disc from the tail boom in flight may have been reduced, increasing the risk of the disc striking the tail boom.

It is probable that whilst a quick stop was carried out, coarse control inputs associated with the dynamic manoeuver caused the main rotor disc to contact the tail boom.

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).

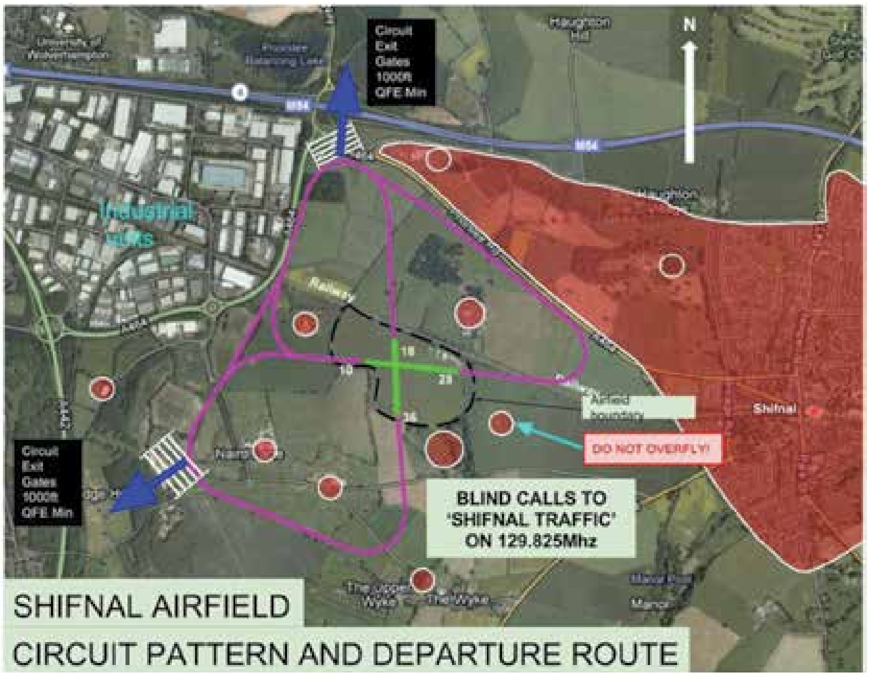


Figure 1

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

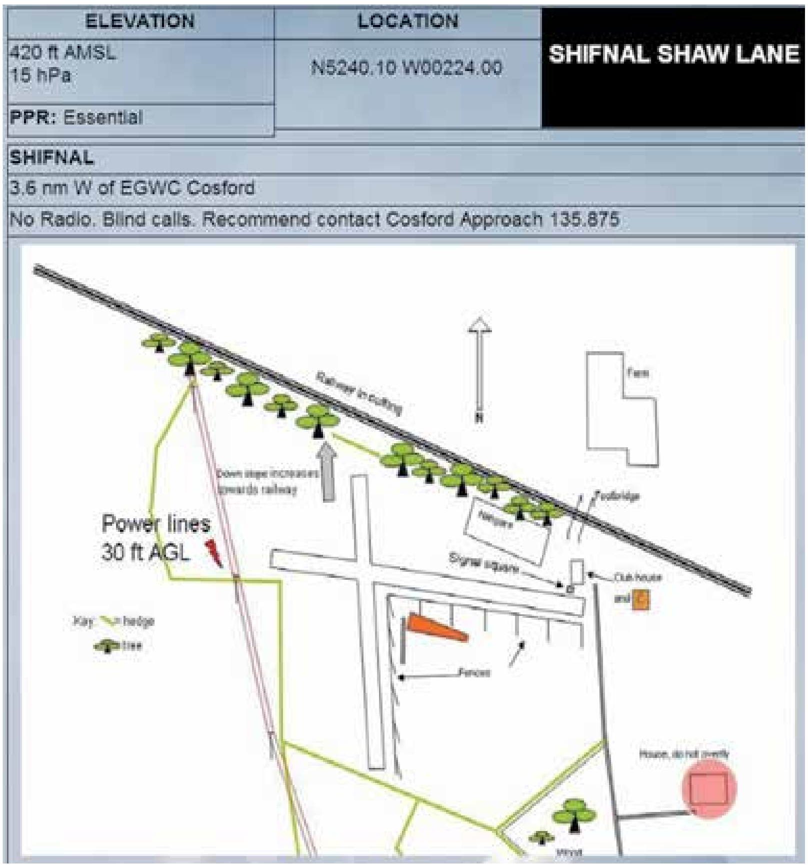


Figure 2

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).

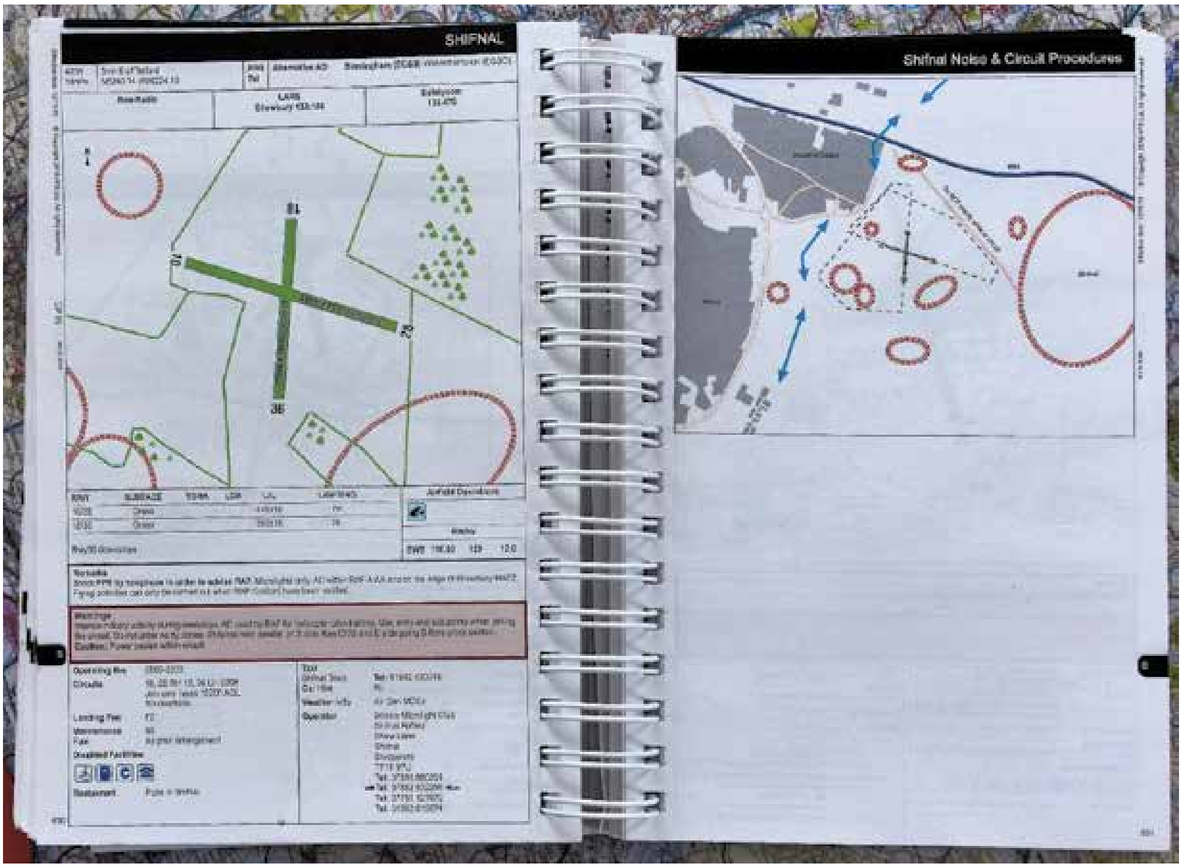


Figure 3

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'*.

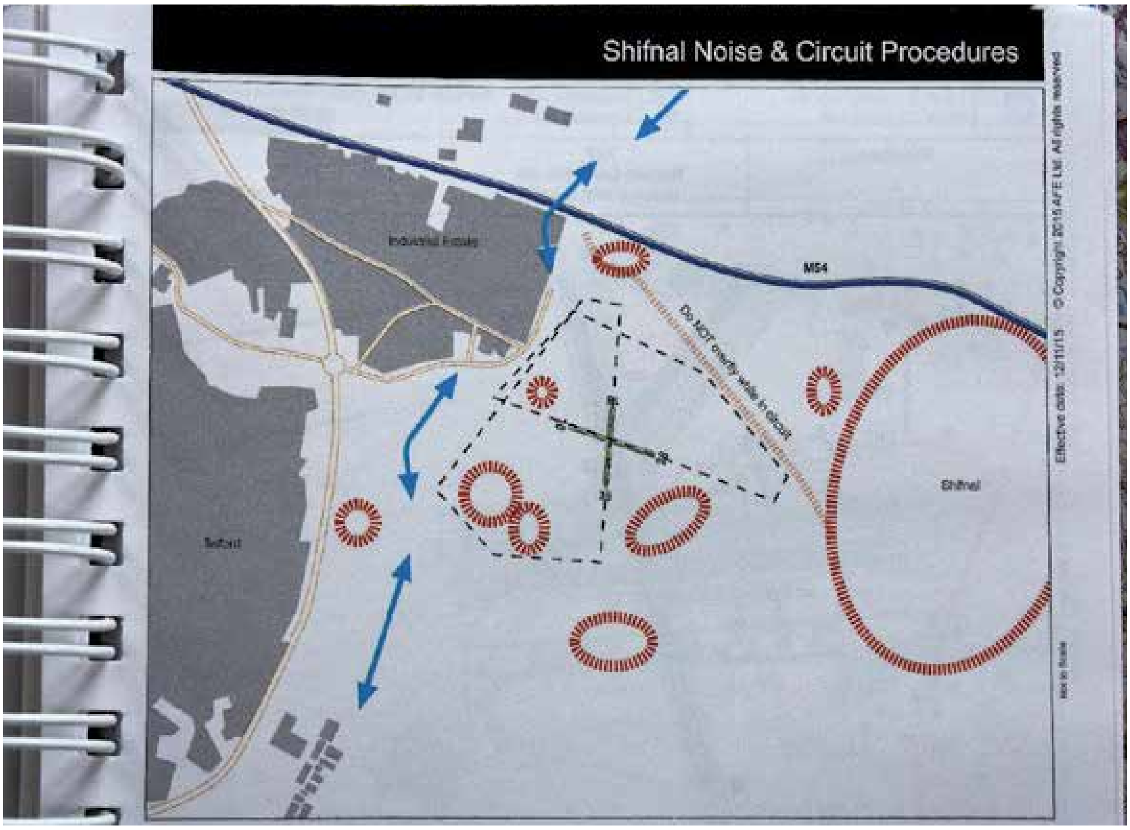


Figure 4

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.

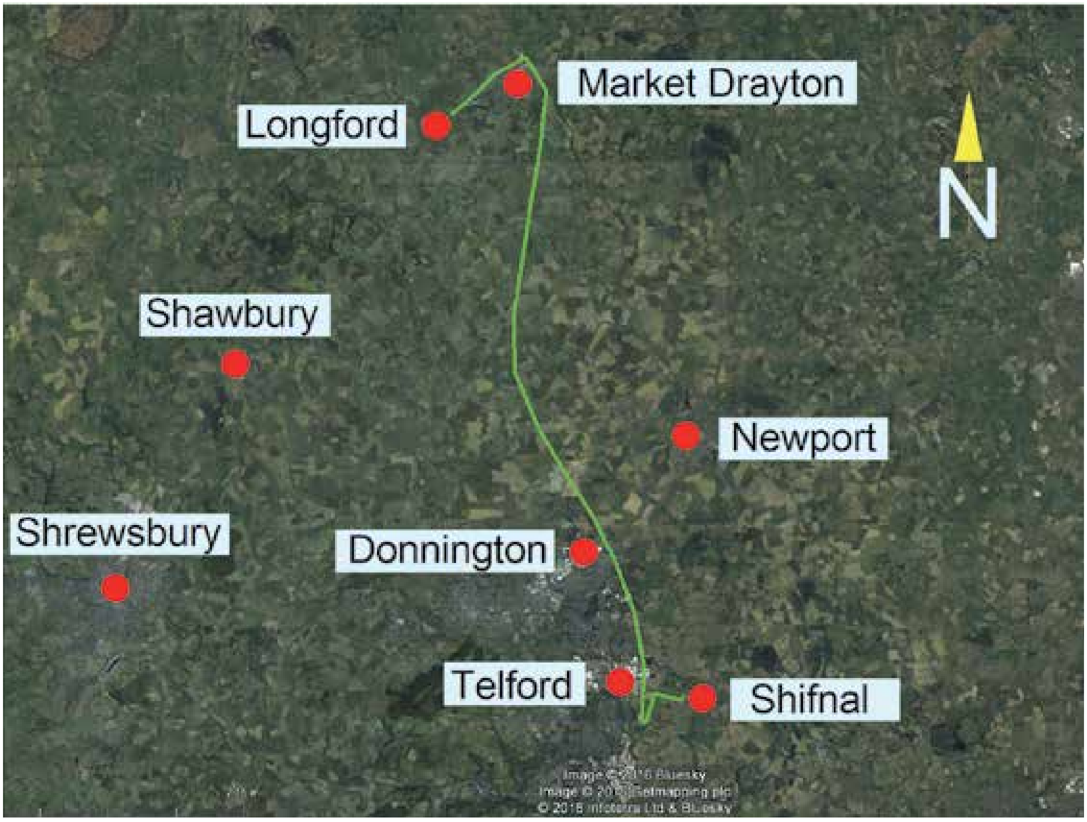


Figure 5

GPS track of flight from Longford

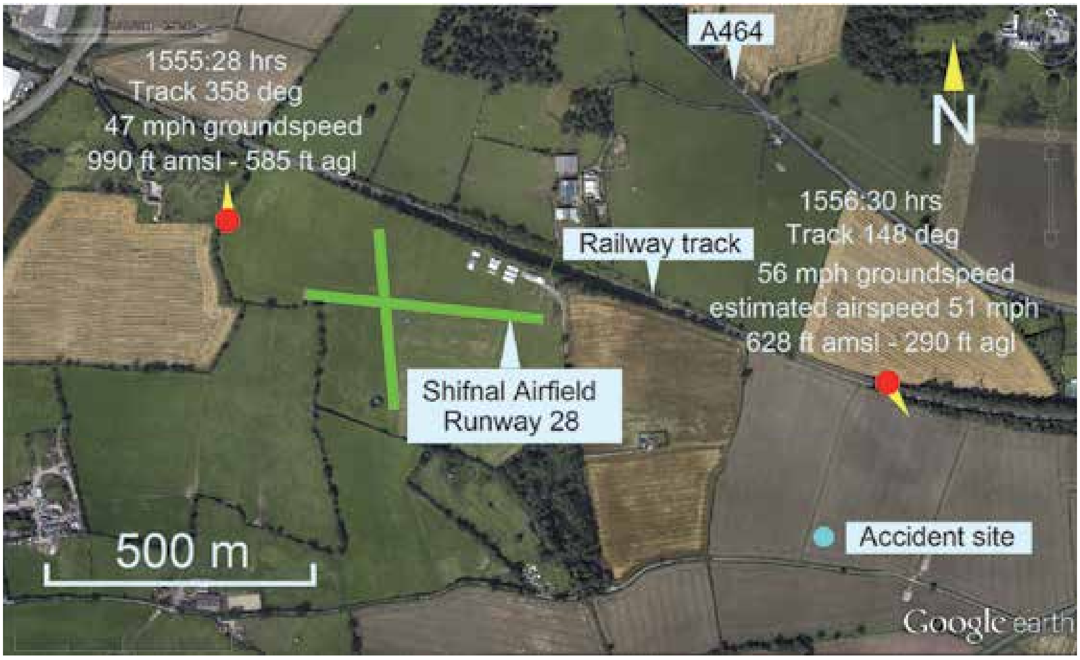


Figure 6

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 225º.

The engine and nosewheel had made indentations in the ground, although the main landing gear had not made contact, indicating an approximate 70° to 80º 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^{o} 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^{o}.

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.

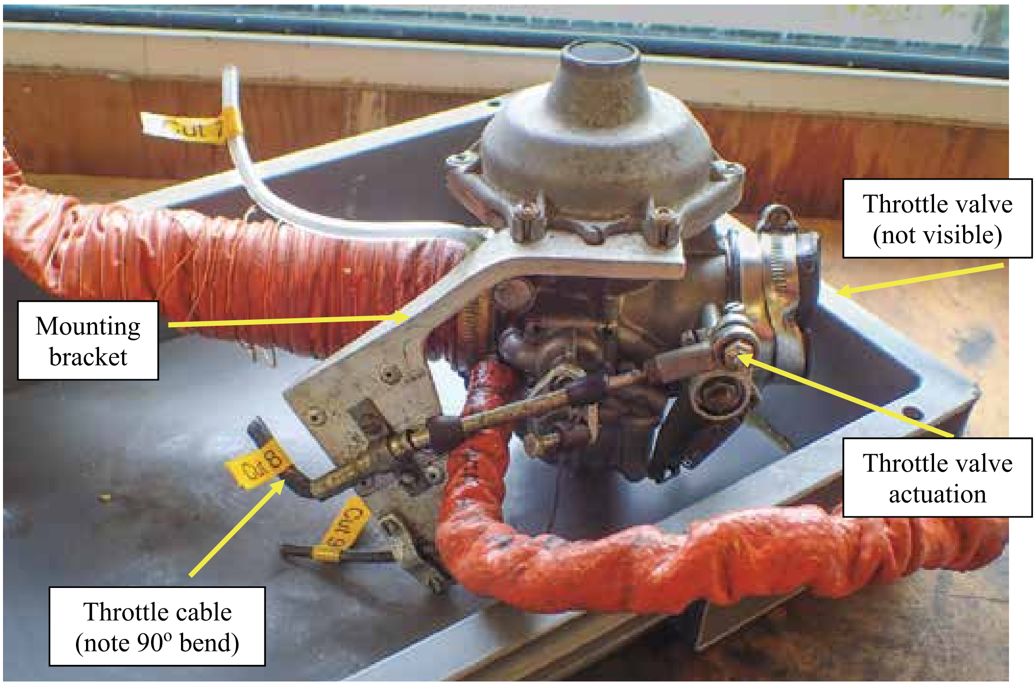


Figure 7
The carburettor

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.

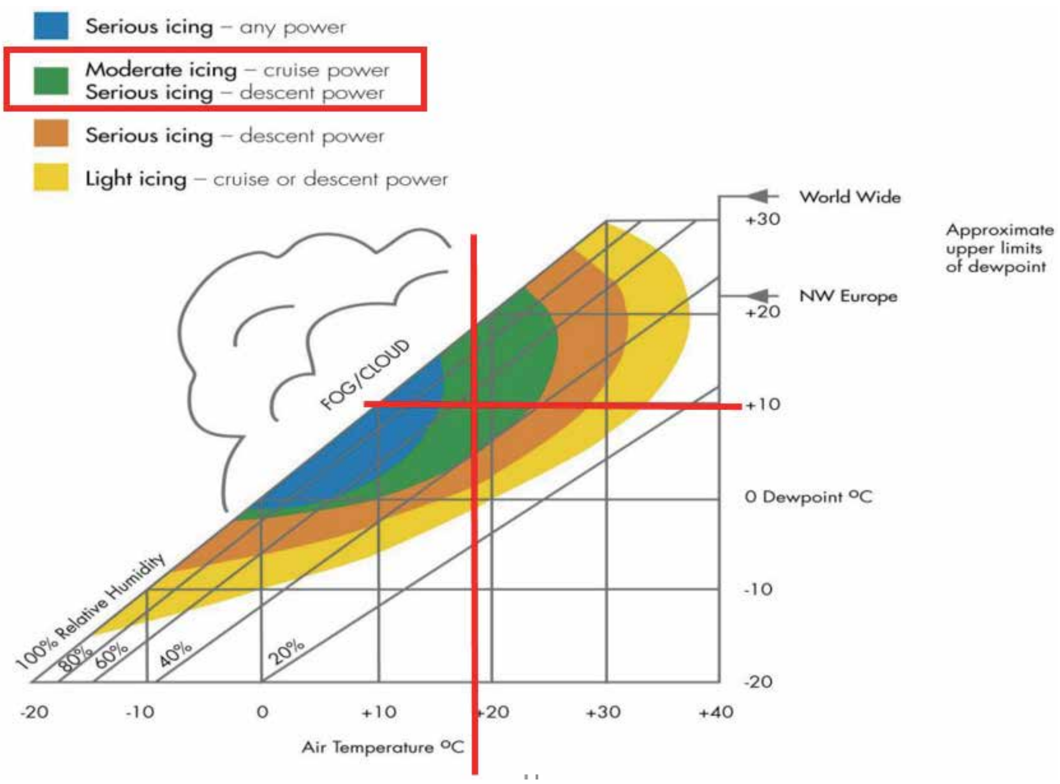


Figure 8

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

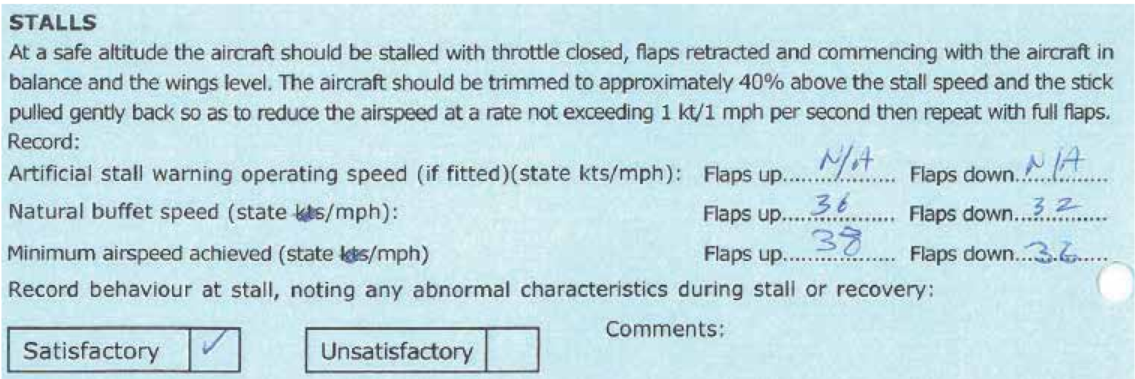
8 http://publicapps.caa.co.uk/docs/33/20130121SSL14.pdf

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

AAIB Correspondence Reports

These are reports on accidents and incidents which were not subject to a Field Investigation.

They are wholly, or largely, based on information provided by the aircraft commander in an Aircraft Accident Report Form (AARF) and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

INCIDENT

Aircraft Type and Registration:	Agusta AW139, G-VINB
No & Type of Engines:	2 Pratt & Whitney Canada PT6C-67C turboshaft engines
Year of Manufacture:	2012 (Serial no: 31398)
Date & Time (UTC):	20 January 2017 at 1627 hrs
Location:	Ravenspurn North Platform, North Sea
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	43 years
Commander's Flying Experience:	6,035 hours (of which 1,964 were on type) Last 90 days - 99 hours Last 28 days - 20 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After reporting for duty, a change in the flying programme resulted in a requirement for the crew to fly a seven-sector shuttle at short notice. Whilst the commander reviewed the technical log and discussed some issues with the engineering department, the co-pilot completed the flight planning. The initial plan was to refuel on West Sole Alpha platform but the flight crew surmised that the seven sectors could be completed with round trip fuel. While re-planning the flight, the fourth destination was incorrectly inserted as Ravenspurn North platform rather than Ravenspurn Alpha platform. The error was not noticed and the flight proceeded to land at Ravenspurn North platform, whose helideck was not manned.

History of the flight

The flight crew reported for a base duty standby period at Norwich at 1155 hrs and 1200 hrs, respectively, expecting a 1630 hrs departure. However, freezing fog in the morning had disrupted the flying programme. On arrival, the crew were informed they were required for a departure as soon as possible for a seven-sector shuttle, including refuelling and shutting down on West Sole Alpha platform. The crew then discussed the route and completed the planning accordingly. Initially, no payload information was available as the customer's flight planning sheet had not yet arrived.

When the customer's flight planning sheet was issued, which detailed the payload, the crew realised that the flight could be completed without refuelling offshore. As a result, the co-pilot re-planned the seven sectors while the commander went to review the aircraft's technical log. While doing so, he was also asked to advise the engineering department on a technical defect with another helicopter.

While re-planning, Ravenspurn Alpha was transposed to Ravenspurn North on the operator's fuel planning sheet for sector four. Once the commander returned to join the co-pilot, the crew rebriefed. The routing was correct on the customer supplied flight planning sheet but the error on the fuel planning sheet was not noticed.

The aircraft departed Norwich and the first three sectors were completed without incident. The crew then carried out a rotors-running turnaround on West Sole Alpha platform, during which they received radio calls regarding the payload on the final, seventh sector and the manifests for the fourth and fifth sectors. Whilst the co-pilot was dealing with the payload request, the commander programmed the FMS. The crew were also aware that another helicopter was inbound, to land on the helideck.

On departing the West Sole Alpha platform, the helicopter proceeded to the Ravenspurn field. The co-pilot made a radio call to request helideck availability from the Ravenspurn Field Helicopter Landing Officer (HLO) but only used the word "Ravenspurn" when providing the name of the platform on which the crew intended to land, instead of "Ravenspurn North". The HLO responded: "Ravenspurn Alpha deck is available, standing by on the north side". However, the crew did not pick up on the discrepancy between their intended destination and the clearance and carried out an approach and landing to Ravenspurn North. There was no helideck crew present, as required by the operator, and a radio call alerted the crew to the fact they had landed on Ravenspurn North rather than Ravenspurn Alpha, where they were expected (Figure 1).

Once the crew realised their mistake, they remained rotors running and requested a helideck crew, in accordance with the procedure in the operator's Operations Manual. Once the helideck crew were in place, the helicopter departed for the Ravenspurn Alpha platform.

The remaining sectors were completed without incident.

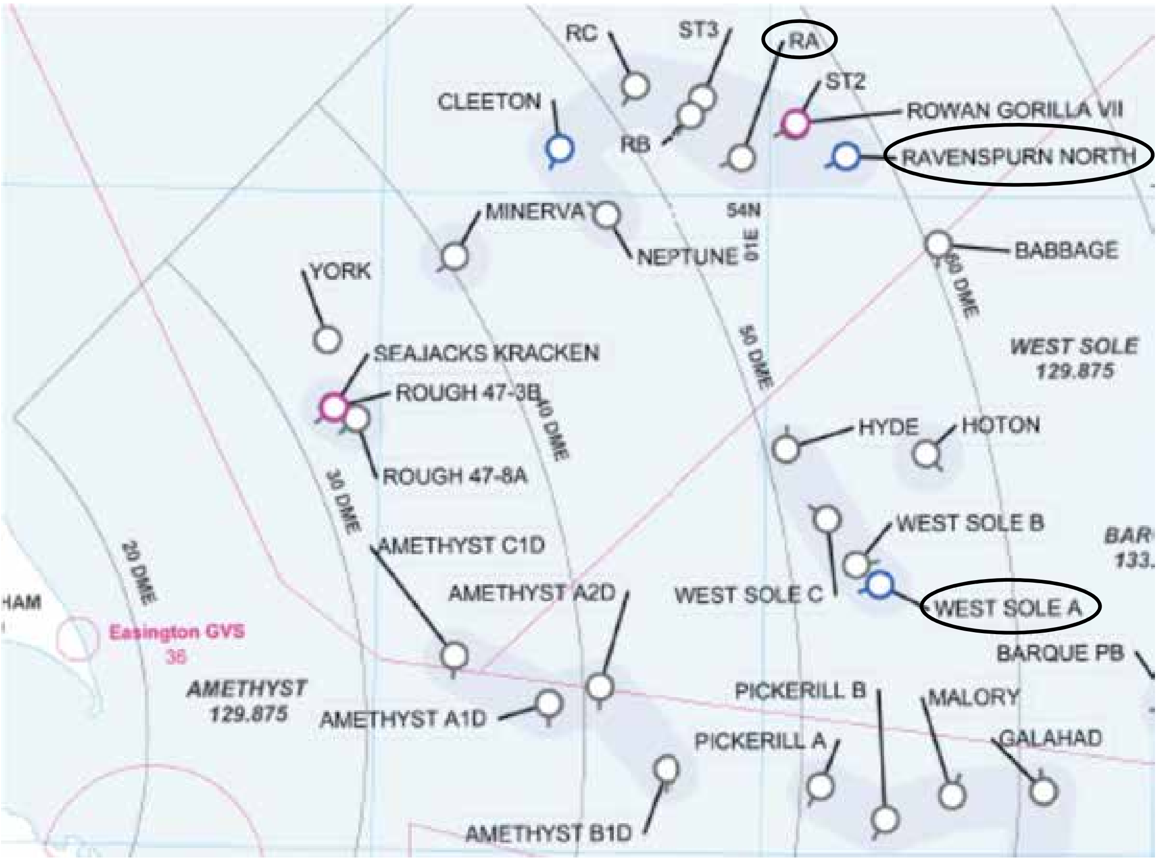
Procedures

Fuel planning is completed on the operator's AW139 flight planning software, which uses a drop-down menu for the selection of each destination. The fuel plan is supplemented by a flight planning sheet, which is supplied by the customer and lists the payload for each sector. This is generated by a system called Vantage, which companies use across the North Sea to generate payload information for operators.

The operator's flight planning software and Vantage use codes rather than the full name of platforms. However, the codes used by the operator's flight planning software, and the helicopter's systems, differ from those used by Vantage. This complicates any crosschecking of the flight plan, as a decode is required. On the operator's and helicopter's systems, the code used for Ravenspurn Alpha was RA but Vantage used RAVA. Similarly, Ravensprun North was RVN versus RAVN.

The initial plan for the seven-sector task included a shutdown and refuelling on West Sole Alpha, with the onward sectors detailed on a second flight plan. On this occasion, the flight planning sheet, with the payload information, arrived after the first fuel plan had been completed.

Once the crew had the payload information, they realised that they could complete the trip without refuelling offshore. Re-planning involved re-ordering the destinations into one flight plan, rather than the initial two. This involved the co-pilot selecting the destinations using the drop down menu and it was during this process that the destination for sector four was mis-selected as Ravenspurn North (RVN) rather than Ravenspurn Alpha (RA).



©RigMap

Figure 1

Rig map of the Ravenspurn Field (Ravenspurn Alpha is denoted as RA)

Analysis

Once the crew received their tasking for the multi-sector day, they began flight planning. They were hampered by a lack of onward payload information, which, when it did arrive, meant they could complete all the sectors without the requirement to refuel offshore. This resulted in rapid re-planning by the co-pilot, while the commander was otherwise occupied checking the helicopter's technical log and advising the engineering department about another helicopter. This lessened the time the crew had together to check the new flight plan, leading to the incorrect destination for the fourth sector not being identified. Contrary to their expectation, there was also time pressure from the moment the crew reported for duty, due to the weather which had disrupted operations that morning.

The flight crew abbreviated the name of the installation in R/T transmissions from "Ravenspurn North" to "Ravenspurn". As a result, neither the flight crew nor the HLO identified that the helicopter was heading for Ravenspurn North, which had an unmanned helideck, rather than Ravenspurn Alpha where they were expected. The HLO did use "Ravenspurn Alpha" in his transmission on the helideck availability but the discrepancy was not picked up, perhaps due to confirmation bias.

Conclusion

An error at the flight planning stage led the crew to land on an unmanned helideck. There were a number of occasions when the error could have been picked up; briefing before departure from Norwich, crosschecking the flight plan and payload information, during the radio calls with the Ravenspurn HLO and in programming the FMC. These opportunities were missed through perceived time pressure, differences in codes and possibly confirmation bias in the crew.

Once the mistake was realised, the crew correctly followed the operator's procedures, waiting on the deck with rotors running until the helideck was manned and they received permission to depart.

Safety actions

The operator carried out a prompt internal investigation into the incident and identified a number of potential safety actions. The following are of relevance to this report:

'1. *Carry out a Flight Planning Software review for robustness and ease of use.*
2. *Carry out a review of the destination nomenclatures used for planning applications and software.*
3. *Reiterate to all crews the importance of clear and unambiguous communications.*
4. *Reiterate to crews the importance of re-briefing all aspects of the flight when a significant change has been applied.'*

ACCIDENT

Aircraft Type and Registration:	Beech 76 Duchess, G-JLRW
No & Type of Engines:	2 Lycoming O-360-A1G6D piston engines
Year of Manufacture:	1979 (Serial no: ME-165)
Date & Time (UTC):	22 March 2017 at 1050 hrs
Location:	Exeter Airport, Devon
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Left pitot tube, left foot step
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	6,936 hours (of which 440 were on type) Last 90 days - 21 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and subsequent AAIB enquiries

Synopsis

The aircraft was landed on the right main and nose landing gears after the left main gear failed to extend. The lower clevis pin in the left main gear trailing link was subsequently found to be missing.

History of the flight

The instructor reported that the aircraft was engaged on a dual training flight for the purpose of obtaining a Multi-Engine Piston rating. The pilot under training carried out a full 'A' Check prior to the flight; no defects with the landing gear were noted.

The initial part of the flight was normal; however, on lowering the landing gear the left gear light failed to illuminate and the gear unsafe light remained on. Recycling the gear and changing the gear indicator light bulbs failed to resolve the problem. On returning to Exeter the emergency gear lowering procedure was attempted in accordance with the relevant checklist, but this was unsuccessful. A flypast of the tower confirmed that the left gear had not lowered.

The aircraft was flown in the local area for approximately 45 minutes whilst alternative courses of action were discussed with operations and the engineering organisation. This also allowed additional fuel to be consumed prior to landing.

With no resolution to the problem, the pilots briefed for an approach and landing with the instructor flying the aircraft. Both engines were shut down and the propellers feathered when over the Runway 26 threshold. The pilot under training positioned the propeller blades to the horizontal and isolated the fuel and electrics. Following touchdown the aircraft veered to the left, coming to a halt on the grass beside the runway. The pilots evacuated the aircraft normally.

Subsequent examination of the left main landing gear revealed that the lower clevis pin in the trailing link was missing. As the pin was not recovered, it was not possible to determine the reason for its absence.

ACCIDENT

Aircraft Type and Registration:	Jodel D119, G-AXFN
No & Type of Engines:	1 Continental Motors Corp C90-14F piston engine
Year of Manufacture:	1959 (Serial no: 980)
Date & Time (UTC):	6 May 2017 at 1120 hrs
Location:	Near Netherthorpe Airfield, Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	Private Pilot's Licence
Commander's Age:	57 years
Commander's Flying Experience:	346 hours (of which 131 were on type) Last 90 days - 6 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that the engine failed without warning as he was turning crosswind after takeoff. He declared a MAYDAY and had no option other than to attempt a forced landing in a field of rape seed. The aircraft came to rest upside down but the pilot was uninjured and able to exit using the door.

ACCIDENT

Aircraft Type and Registration:	Robin DR400/180 Regent, G-ETIV
No & Type of Engines:	1 Lycoming O-360-A3A piston engine
Year of Manufacture:	2000 (Serial no: 2454)
Date & Time (UTC):	7 December 2016 at 1327 hrs
Location:	Rochester Airport, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Right mainwheel spat severely cracked and brake unit damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	76 years
Commander's Flying Experience:	863 hours (of which 728 were on type) Last 90 days - 21 hours Last 28 days - 0 hours
Information Source:	AAIB enquiries in response to a report from Rochester Airport

Synopsis

Following a medical procedure, the pilot asked a qualified flight instructor (FI) to act as his "safety pilot". The FI agreed and occupied the right seat of the pilot's dual-controlled aircraft. The pilot had not sought advice from an Aero-Medical Examiner (AME) prior to the flight.

The left of two parallel runways (Runway 20L) at Rochester Airport was being used for takeoff but the pilot was unaware that Runway 20R was being used for landings when he carried out some forced landing practice orientated towards Runway 20L. During the second approach, when the aircraft was close to the ground, the FI in the right seat overrode the pilot's control inputs and turned the aircraft right, towards the parallel Runway 20R. The right mainwheel hit and destroyed an airfield lighting unit before the pilot regained control and landed the aircraft on Runway 20R.

The pilot assessed the accident to be a breakdown in communication and inappropriate aircraft handling by the FI during the approach. A contributory factor was a misunderstanding of the regulations concerning a '*Safety Pilot*'.

History of the flight

Six days after a minor eye operation, the pilot asked an FI, whom he had previously flown with, to act as his "safety pilot" and occupy the right seat of the pilot's dual-controlled, EASA aircraft for a local flight. The pilot believed his eyesight had fully recovered after the operation[1] but, as it was also six weeks since his previous flight, he thought having a 'safety pilot' was a sensible precaution. However, the role of 'safety pilot' was not discussed before the flight and the FI did not regard himself as the Pilot-in-Command (PIC)[2].

Two parallel runways positioned close together, Runway 20 Left (20L), the '*relief*' runway, and Runway 20 Right (20R), the '*main*' runway, were in use. Runway 20L has a takeoff and landing distance of 684 m and the threshold is displaced more than 100 m upwind from the threshold of Runway 20R (830 m). Before departure, the FI met the airfield's duty Flight Information Service Officer (FISO) and was told Runway 20L would be used for takeoff but Runway 20R would be used for landing. Circuits were not permitted because the condition of the grass was not suitable but practice forced landing (PFL) was allowed. According to the pilot, he was not informed that Runway 20R was to be used for landing.

After takeoff, the aircraft departed the circuit area and recorded radiotelephony indicates both the pilot and the FI spoke on the radio. Returning to the airfield, the pilot asked to fly to the overhead to carry out a PFL and go-around. The FISO asked him to report overhead, ready to commence, stating the circuit was right-hand but without mentioning which of the parallel runways was in use. The pilot's reply indicates he planned to use "THE RESERVE" (referring to the relief Runway 20L), but the FISO did not appreciate this.

The first PFL approach was towards Runway 20L but the aircraft was too high so the pilot went around before attempting a second PFL, also towards Runway 20L. In the latter stages of this approach, at the suggestion of the FI, the pilot "warmed the engine" by advancing the throttle for a short time. He did not recall being advised to go-around during this approach.

The surface wind was from 210º at 15 kt and the pilot believed that, by the time he was approximately 15 ft above the ground, he was in a position from which he could have landed on Runway 20L, albeit the aircraft was pointing left of the runway, because he "overcompensated for the drift". He later stated that he was about to apply power and right rudder when, without warning, his inputs on the control column were overridden and the aircraft turned approximately 60º right. He initially thought there was a malfunction of the flying controls but then the FI declared "20 MAIN" and the pilot realised the FI was manipulating the control column and had rolled the aircraft to the right towards Runway 20R.

The pilot believed the aircraft was now close to stalling, because the power had not been increased, but he managed to regain control and land on Runway 20R. After taxiing to the apron he was made aware that the right mainwheel had struck an abbreviated precision approach path indicator (APAPI) unit positioned in the Runway 20L undershoot (Figure 1).

Footnote

1 See *Medical*.
2 See *EASA regulations*.

Figure 1

APAPI units showing damage to the left unit, in a view looking along Runway 20L from the undershoot. The units are installed for Runway 20R which is on the right of the photograph

Following the accident, the pilot realised he and the FI should have briefed carefully before the flight and discussed what they understood the term 'safety pilot' to mean and who was to be PIC. Although after the flight the pilot signed in the aircraft technical log (which was also the journey log) captain column, he thought he was flying as Pilot-in-Command Under Supervision (PICUS) and expected the 'safety pilot' to offer verbal input during the flight. He also thought the FI, acting as 'safety pilot', could take control if safety was compromised and assumed the FI would announce such action in the conventional way, stating 'I have control'.

Instructor's report

The FI had logged 10,309 hours total flying experience (mostly instructional), with 5,010 hours on type and 16 hours total time within the preceding 28 days. When he agreed to act as 'safety pilot' he considered it a 'check flight' rather than an instructional flight, because he knew the pilot was licensed and his currency permitted him to fly with passengers.

During the first PFL, the FI observed the aircraft was positioned too high and that the pilot sensibly executed a go-around. On the second approach the FI saw the aircraft deviate below the optimum glidepath so, at approximately 400 ft, his recollection was that he suggested the pilot apply a "clearing burst of power for five seconds". By doing this the FI thought the engine would be warmed and the additional power would allow the aircraft to regain the glidepath but the pilot did not apply power for as long as suggested. The FI's recollection was that because the aircraft was still low, he directed the pilot to go-around but the pilot did not react.

At a late stage in the approach the FI recognised the aircraft was "in a stalling configuration, low and slow" and was tracking towards a rough area to the left of Runway 20L. He regarded the situation as dangerous and tried to take control by turning the aircraft right towards Runway 20R. However, he was prevented from taking full control because the pilot did not relinquish control. Nevertheless, he believed his unannounced intervention was necessary because the pilot had not, in his opinion, been flying in a "satisfactory manner". He could not explain why he did not announce taking or handing back control, nor why he did not initiate a go-around.

In retrospect, the FI realised a thorough pre-flight brief ought to have been held and that he should have enquired carefully about the pilot's medical situation. When he checked the relevant regulations he (like the pilot) was not aware that 'safety pilot' is not a recognised role in normal operations. Although he felt his intervention prevented a more serious accident from occurring, to refresh his skills and to learn from the event, the flight instructor carried out subsequent training with a flight examiner.

Airfield report

The airfield duty manager was positioned to the east of the Runway 20R threshold when he observed the aircraft approaching left of the Runway 20L approach path. He described the aircraft as appearing to be "very low" and "very slow". He estimated it was two feet above the ground, flying relatively slowly and still downwind and to the left of the Runway 20L threshold when it abruptly veered right towards Runway 20R. He had the impression the aircraft was close to stalling when the right mainwheel struck the left APAPI unit, which detached from its mountings.

EASA regulations

Medical

The pilot possessed an EU Class 2 Medical Certificate valid until 8 November 2017 with one limitation, that he have available corrective spectacles and carry a spare set of spectacles (VNL). On 1 December 2016 he underwent a minor operation to remove a cataract from his right eye and was told he could drive a motor vehicle two days later. He did not seek advice from his AME but was apparently informed during a hospital check on 4 December that the sight in his right eye was "good, 20/20"[3].

A day after the accident, an ophthalmologist stated the pilot's uncorrected vision was 20/20 or better in each eye. The pilot was unable to explain why he did not speak to his AME before flying, except that he believed his eyesight had been adequately checked and that he had thought he was doing the safest thing by flying with an FI, who could take control if necessary.

Footnote

[3] Visual acuity of 20/20 is a US measurement for which the UK equivalent is 6/6. This is better than a score of 6/12 which is the visual acuity a pilot should demonstrate in each eye, with or without corrective lenses, when tested for an EASA Class 2 Medical Certificate.

Annexe IV to Commission Regulation (EU) No 1178/2011 states at PART MED.A.020,

> *'Decrease in medical fitness*
>
> *a) Licence holders shall not exercise the privileges of their licence and related ratings or certificates at any time when they:*
>
> *(1) are aware of any decrease in their medical fitness which might render them unable to safely exercise those privileges;*
>
> *(2) take or use any prescribed or non-prescribed medication which is likely to interfere with the safe exercise of the privileges of the applicable licence;*
>
> *(3) receive any medical, surgical or other treatment that is likely to interfere with flight safety.*
>
> *b) In addition, licence holders shall, without undue delay, seek aero-medical advice when they:*
>
> *(1) have undergone a surgical operation or invasive procedure;*
>
> *(2) have commenced the regular use of any medication;*
>
> *(3) have suffered any significant personal injury involving incapacity to function as a member of the flight crew;'*

The PART MED regulations also state (paragraph MED.B.001) that a pilot, who does not fully comply with the requirements for a Class 2 medical certificate, can have a certificate issued with a limitation code if it is assessed they can perform their duties safely by complying with that limitation. If an:

> *'Operational Safety Pilot Limitation (OSL)' is placed on a pilot's medical certificate then he or she 'shall only operate an aircraft if another pilot fully qualified to act as pilot-in-command on the relevant class or type of aircraft is carried on board, the aircraft is fitted with dual controls and the other pilot occupies a seat at the controls.'*

The related Guidance Material states that this '*Safety Pilot* 'is to be aware of the incapacity which the pilot might suffer from and be prepared to take over the controls during flight.

The term '*Safety Pilot*' only applies to pilots with the limitation '*OSL*' on their Class 2 medical certificate and this pilot had no such limitation. Where an '*OSL*' limitation does apply, the '*Safety Pilot*' has to be the PIC.

Pilot-in-command

Regulation (EC) No 216/2008 of the European Parliament is EASA's '*Basic Regulation*' and Annex IV, paragraph 1.c. states:

> *'Before every flight, the roles and duties of each crew member must be defined. The pilot in command must be responsible for the operation and safety of the aircraft and for the safety of all crew members, passengers and cargo on board.'*

The 'Basic Regulation' also states, at Article 7, that:

> *'Except when under training, a person may only act as a pilot if he or she holds a licence and a medical certificate appropriate to the operation to be performed.'*

Further guidance on a PIC's responsibilities during non-commercial operations are given in Commission Regulation (EU) No 1178/2011. PART-NCO.GEN.105 states at paragraph (f):

> *'During flight, the pilot-in-command shall…remain at the controls of the aircraft at all times except if another pilot is taking the controls.'*

Also, in accordance with PART-NCO.OP.130 the PIC is to:

> *'ensure that before or, where appropriate, during the flight, passengers are given a briefing on emergency equipment and procedures.'*

Flight instructors

Subpart J to Annexe I to Commission Regulation (EU) No 1178/2011 states that the privileges of a FI certificate are to conduct flight instruction for the issue, revalidation or renewal of a licence or rating. For an FI to perform such duties, on an aircraft for which he or she is suitably qualified, he or she will be the PIC for the flight and will sign the journey log as the person in charge. There is no EASA or CAA definition for the term '*check flight*', as used by the FI.

The pilot in command of a single pilot aircraft who flies alone or with passengers is responsible for the safe conduct of the flight and logs the time as PIC. However, when accompanied by an FI, exercising the privileges of an FI certificate, the pilot should log the flights as *'pilot under training'* or '*dual instruction time'*. There are exceptions to this, such as when a student pilot on an integrated course receives instrument training and the FI does not control the aircraft for any part of the flight; they may then certify the pilot's log book to state they acted as *'student pilot-in-command (SPIC)'*. Also when a pilot successfully undertakes a flight test in a single pilot aircraft with an EASA or CAA Authorised Examiner they are entitled to log the time as '*pilot-in-command under supervision (PICUS)'*.

AAIB Comment

Prior to the flight the pilot and FI had not appropriately briefed and agreed their roles and procedures. Both the pilot and the FI thought the FI could act as 'safety pilot', providing verbal advice from the right seat, while being available to take control if the pilot became incapacitated. However, the role of '*Safety Pilot'* was not applicable because the pilot's medical certificate was not endorsed '*OSL*' and, because the FI did not sign for the aircraft as PIC, his role being that of a passenger and he should not have tried to perform instructional duties.

Although not causal to the accident, the pilot had an operation to remove a cataract from his right eye. Following the procedure he should have consulted with his AME as it was a surgical operation and also to ensure that the treatment he had received did not '*interfere with flight safety*'.

Safety actions

Following an investigation, a safety action was taken at the airfield to ensure pilots are told the runway in use when they call on the radio prior to arrival.

In May 2017 the CAA published CAP 1535, '*The Skyway Code*'[4] which is intended to provide General Aviation pilots involved in non-commercial and flight training operations with practical guidance on the operational, safety and regulatory issues relevant to their flying. '*The Skyway Code*' includes a section on the responsibilities of the Pilot in Command in a format which is intended to be more accessible than from regulatory documents.

To further clarify the term '*Safety Pilot*' when used with an '*Operational Safety Pilot Limitation (OSL)'* placed on a Medical Certificate, the CAA will produce an article for '*Clued Up'*, its magazine for the general aviation community. Additionally, the CAA will also ask the General Aviation Safety Council (GASCO) to publish the same article in its Flight Safety Bulletin.

BULLETIN CORRECTION

Following publication of the report, further clarification was received from the Civil Aviation Authority relating to the recording of the flight in the pilot's log book. The final paragraph of the section headed '*Flight Instructors*' was amended online on 2 October 2017.

Footnote

4 See http://www.caa.co.uk/General-aviation/Safety-information/The-Skyway-Code/

ACCIDENT

Aircraft Type and Registration:	Aerotechnik EV-97 Eurostar, G-TIVV
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2005 (Serial no: PFA 315-14435)
Date & Time (UTC):	17 May 2017 at 1125 hrs
Location:	Yarrow Valley, Scottish Borders
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Damage to nose landing gear, propeller and lower fuselage panels
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	444 hours (of which 112 were on type) Last 90 days - 6 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was taking off for a local flight, with a friend as his passenger. After reaching flying speed, with the wheels just off the ground, he realised that he could not move the control stick back, as usual. As a result, the aircraft was not climbing away from the surface and the pilot aborted the takeoff. The aircraft landed back on the airstrip but bounced and pitched up, before appearing to stall and impact the ground in a nose-down attitude. It came to rest with its nose landing gear collapsed and damage to the propeller and lower fuselage panels. Neither occupant was injured.

The pilot examined the aircraft afterwards and all the controls worked normally. He concluded that there may have been a restriction in the cockpit, which prevented the control stick from moving rearwards normally. He noted that the passenger had been carrying a bulky camera or could have been obstructing the controls in some other way.

General Aviation Safety Sense Leaflet 02 – *'Care of Passengers'*, published by the CAA, gives details of information that passengers should be given before they fly. This includes the need to keep items secure and away from the controls, to prevent restrictions.

ACCIDENT

Aircraft Type and Registration:	Ikarus C22, D-MNBU
No & Type of Engines:	1 C22 Rotax 912 UL piston engine
Year of Manufacture:	1994 (Serial no: 9409-3597)
Date & Time (UTC):	25 August 2016 at 0800 hrs
Location:	Popham Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Nosewheel and left mainwheel
Commander's Licence:	Other
Commander's Age:	62 years
Commander's Flying Experience:	40 hours (of which 40 were on type) Last 90 days - 25 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

D-MNBU was landing on Runway 08 at Popham Airfield during a competition. It was performing what the pilot described as a "spot turn" manouevre, in which the pilot shuts down the aircraft's engine at height and then glides the aircraft to land. The pilot reported Popham's weather to be clear, with 5 kt wind and a temperature of 18°C. The runway, which has a grass surface, was reported as being soft.

Shortly before landing, the aircraft's speed became too slow, causing it to stall on to the runway. The nosewheel and left main landing gear were damaged, and the pilot sustained minor injuries.

The pilot believed that the accident was caused by paying insufficient attention to the aircraft's speed during a challenging manoeuvre.

Miscellaneous

This section contains Addenda, Corrections and a list of the ten most recent Aircraft Accident ('Formal') Reports published by the AAIB.

The complete reports can be downloaded from the AAIB website (www.aaib.gov.uk).

TEN MOST RECENTLY PUBLISHED FORMAL REPORTS ISSUED BY THE AIR ACCIDENTS INVESTIGATION BRANCH

2/2011 Aerospatiale (Eurocopter) AS332 L2 Super Puma, G-REDL
11 nm NE of Peterhead, Scotland
on 1 April 2009.

Published November 2011.

1/2014 Airbus A330-343, G-VSXY
at London Gatwick Airport
on 16 April 2012.

Published February 2014.

2/2014 Eurocopter EC225 LP Super Puma
G-REDW, 34 nm east of Aberdeen, Scotland on 10 May 2012
and
G-CHCN, 32 nm south-west of Sumburgh, Shetland Islands
on 22 October 2012.

Published June 2014.

3/2014 Agusta A109E, G-CRST
Near Vauxhall Bridge,
Central London
on 16 January 2013.

Published September 2014.

1/2015 Airbus A319-131, G-EUOE
London Heathrow Airport
on 24 May 2013.

Published July 2015.

2/2015 Boeing B787-8, ET-AOP
London Heathrow Airport
on 12 July 2013.

Published August 2015.

3/2015 Eurocopter (Deutschland)
EC135 T2+, G-SPAO
Glasgow City Centre, Scotland
on 29 November 2013.

Published October 2015.

1/2016 AS332 L2 Super Puma, G-WNSB
on approach to Sumburgh Airport
on 23 August 2013.

Published March 2016.

2/2016 Saab 2000, G-LGNO
approximately 7 nm east of
Sumburgh Airport, Shetland
on 15 December 2014.

Published September 2016.

1/2017 Hawker Hunter T7, G-BXFI
near Shoreham Airport
on 22 August 2015.

Published March 2017.

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GLOSSARY OF ABBREVIATIONS

aal	above airfield level
ACAS	Airborne Collision Avoidance System
ACARS	Automatic Communications And Reporting System
ADF	Automatic Direction Finding equipment
AFIS(O)	Aerodrome Flight Information Service (Officer)
agl	above ground level
AIC	Aeronautical Information Circular
amsl	above mean sea level
AOM	Aerodrome Operating Minima
APU	Auxiliary Power Unit
ASI	airspeed indicator
ATC(C)(O)	Air Traffic Control (Centre)(Officer)
ATIS	Automatic Terminal Information System
ATPL	Airline Transport Pilot's Licence
BMAA	British Microlight Aircraft Association
BGA	British Gliding Association
BBAC	British Balloon and Airship Club
BHPA	British Hang Gliding & Paragliding Association
CAA	Civil Aviation Authority
CAVOK	Ceiling And Visibility OK (for VFR flight)
CAS	calibrated airspeed
cc	cubic centimetres
CG	Centre of Gravity
cm	centimetre(s)
CPL	Commercial Pilot's Licence
°C,F,M,T	Celsius, Fahrenheit, magnetic, true
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
EAS	equivalent airspeed
EASA	European Aviation Safety Agency
ECAM	Electronic Centralised Aircraft Monitoring
EGPWS	Enhanced GPWS
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
EPR	Engine Pressure Ratio
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
FAA	Federal Aviation Administration (USA)
FDR	Flight Data Recorder
FIR	Flight Information Region
FL	Flight Level
ft	feet
ft/min	feet per minute
g	acceleration due to Earth's gravity
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
hrs	hours (clock time as in 1200 hrs)
HP	high pressure
hPa	hectopascal (equivalent unit to mb)
IAS	indicated airspeed
IFR	Instrument Flight Rules
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
IP	Intermediate Pressure
IR	Instrument Rating
ISA	International Standard Atmosphere
kg	kilogram(s)
KCAS	knots calibrated airspeed
KIAS	knots indicated airspeed
KTAS	knots true airspeed
km	kilometre(s)
kt	knot(s)
lb	pound(s)
LP	low pressure
LAA	Light Aircraft Association
LDA	Landing Distance Available
LPC	Licence Proficiency Check
m	metre(s)
mb	millibar(s)
MDA	Minimum Descent Altitude
METAR	a timed aerodrome meteorological report
min	minutes
mm	millimetre(s)
mph	miles per hour
MTWA	Maximum Total Weight Authorised
N	Newtons
N_R	Main rotor rotation speed (rotorcraft)
N_g	Gas generator rotation speed (rotorcraft)
N_1	engine fan or LP compressor speed
NDB	Non-Directional radio Beacon
nm	nautical mile(s)
NOTAM	Notice to Airmen
OAT	Outside Air Temperature
OPC	Operator Proficiency Check
PAPI	Precision Approach Path Indicator
PF	Pilot Flying
PIC	Pilot in Command
PNF	Pilot Not Flying
POH	Pilot's Operating Handbook
PPL	Private Pilot's Licence
psi	pounds per square inch
QFE	altimeter pressure setting to indicate height above aerodrome
QNH	altimeter pressure setting to indicate elevation amsl
RA	Resolution Advisory
RFFS	Rescue and Fire Fighting Service
rpm	revolutions per minute
RTF	radiotelephony
RVR	Runway Visual Range
SAR	Search and Rescue
SB	Service Bulletin
SSR	Secondary Surveillance Radar
TA	Traffic Advisory
TAF	Terminal Aerodrome Forecast
TAS	true airspeed
TAWS	Terrain Awareness and Warning System
TCAS	Traffic Collision Avoidance System
TGT	Turbine Gas Temperature
TODA	Takeoff Distance Available
UHF	Ultra High Frequency
USG	US gallons
UTC	Co-ordinated Universal Time (GMT)
V	Volt(s)
V_1	Takeoff decision speed
V_2	Takeoff safety speed
V_R	Rotation speed
V_{REF}	Reference airspeed (approach)
V_{NE}	Never Exceed airspeed
VASI	Visual Approach Slope Indicator
VFR	Visual Flight Rules
VHF	Very High Frequency
VMC	Visual Meteorological Conditions
VOR	VHF Omnidirectional radio Range

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