AAIB
Air Accidents Investigation Branch

AAIB Bulletin 8/2020

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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:	DH-82A Tiger Moth, N54556
No & Type of Engines:	1 De Havilland Gipsy Major 1H piston engine
Year of Manufacture:	N/K (Serial no: T-6392RO)
Date & Time (UTC):	21 July 2019 at 1304 hrs
Location:	Private airstrip near Hythe, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Serious)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	51 years
Commander's Flying Experience:	523 hours (of which 77 were on type) Last 90 days - 10 hours Last 28 days - 3 hours
Information Source:	AAIB Field Investigation

Synopsis

The owner of the aircraft and his passenger, who was a professional pilot, were to carry out a flight to familiarise the passenger with the Tiger Moth. The owner occupied the front cockpit with the passenger in the rear cockpit, from which the aircraft is flown when solo. They completed a first sortie, which comprised general handling and circuits and was followed by a short break. They agreed to do some more circuits with the passenger flying the aircraft. After the first landing, the owner took control and performed a rolling takeoff and made an early right turn, estimated by the passenger to be at about 20-30 ft agl. The passenger noticed that the aircraft was becoming increasingly cross-controlled with full right rudder and left control stick, which resulted in the aircraft rolling into a steeply banked turn to the right and striking the surface of a crop field in a steep nose-down attitude. The pilot, in the front cockpit, was fatally injured and the passenger was seriously injured but able to release himself from the wreckage and drag himself clear.

The accident occurred because the increasing amount of right rudder was not reduced and left roll control stick reached the limit of its travel causing the aircraft to enter a descending, steepening turn to the right, and possibly to enter an incipient spin, before striking the ground. The reason for the loss of control was not determined, but the possibility that the pilot became incapacitated could not be excluded.

History of the flight

Background information

The passenger was an experienced commercial pilot who had decided to take up flying General Aviation (GA) aircraft again for recreational purposes. He did some revision with a training organisation and renewed his Single Engine Piston (SEP) rating on his Irish and UK ATPLs. About a month before the accident, he went to Pent Farm and met the owner of N54556 and it was agreed that they would go flying together at a later date. Subsequently, following an exchange of text messages, they agreed to meet at Pent Farm at 1000 hrs on 21 July 2019, the day of the accident.

The accident flight

The pilot and passenger pushed out N54556 from its hangar and discussed the aircraft. The passenger was not aware of the owner's qualifications but had no intention of flying the aircraft solo or logging the flight time.

The owner showed the passenger how to enter the rear cockpit and strap in. He was given a headset in a fabric helmet and was shown how to plug it into a battery powered intercom system but was told it would be difficult to communicate when flying. The owner hand swung the propeller to start the engine and removed the wheel chocks before climbing into the front cockpit, and they tested the intercom which was just acceptable.

The weather was good with no low cloud and with visibility in excess of 10 km. They taxied onto Runway 25, with the wind directly down the runway at about 10 kt, and the passenger carried out some taxiing before backtracking to the runway threshold. They lined up and the owner briefed the passenger on the takeoff technique before carrying out a power and magneto check. They commenced the takeoff run using full power, and the passenger felt the owner help him on the controls to lift the tail before the aircraft became airborne at about 55 kt. They climbed the aircraft at 70 kt, turning to the left before heading north.

The passenger carried out some turns before the owner, using hand signals because the poor intercom made communication difficult at higher power settings, directed him back towards Pent Farm. He also raised both hands to confirm to the passenger that he was not on the controls. They did the pre-landing checks, which included unlocking the slots and setting the trim lever just aft of the neutral position, before adopting the approach airspeed of 60-70 kt. The passenger felt the owner assisting on the controls, but without saying he was doing so, down to the landing. Following a backtrack, they carried out a further two circuits at 800 ft aal, before stopping for a break and returning to the parking area outside the hangar. The passenger had flown the last of the circuits unassisted by the pilot.

They discussed the flight and took some photographs before the passenger asked if they could do a couple more circuits. The owner happily agreed but mentioned he had to catch a train back to Belgium at 1600 hrs. The passenger had eaten a sandwich before the first flight but had not seen the owner eat anything, although he looked fit and well.

They went through the same start procedure and ensured the trim was set fully forward with the slots locked for takeoff. They did an engine power and magneto check and, when lined up, the owner warned the passenger about the proximity of a tree which was close to the right side of the runway. They made a normal right hand circuit with the passenger flying and he unlocked the slots and set the trim for landing. The passenger offset the approach slightly to the right to give him a better view of the runway. The landing appeared normal and he did not expect any intervention, but after touchdown the owner said "I have control" and applied full power. The passenger released the control stick but followed through lightly on the rudder pedals and, during the takeoff roll he locked the slots.

As soon as the aircraft became airborne, it started a right turn, much earlier than before, at about 20-30 ft agl. A few seconds later, with the aircraft in about a 20° bank to the right, the passenger noticed increasing application of right rudder, along with left control stick to counter the resulting tendency to roll to the right. The aircraft became severely cross-controlled, with the slip needle indicating fully left. The passenger asked the pilot what he was doing but received no audible reply, and he thought the pilot was demonstrating some manoeuvre without saying what he was doing.

The aircraft continued its roll to the right and the nose dropped with the roll and nose-down pitch increasing rapidly, although the passenger thought that the aircraft probably did not pass through the inverted, before it struck the ground in a nose-down but nearly wings level roll attitude. As the ground rushed up, the passenger shouted but there was no response from the owner. The engine stopped immediately on impact, and the passenger was aware of fuel leaking onto him and the pilot. He pushed the broken instrument panel and cockpit coaming clear and released the fire extinguisher and placed it outside. He released his harness and after several attempts was able to free his damaged legs and crawl away from the aircraft. A bystander, who had heard and seen the aircraft in difficulties, arrived at the site and assisted the passenger until the emergency services arrived and airlifted him to hospital.

The pilot received fatal injuries during the accident.

Accident site and wreckage examination

The aircraft struck the ground in an area of arable farmland containing a tall, dense and mature crop (Figure 1). At the time of the impact, the aircraft was complete. It was erect, in a steep nose-down attitude, with low forward speed and a significant descent rate, and was rotating to the right about a vertical axis. One blade of the wooden propeller was shattered with debris projected forwards. Fuel was recovered from the tank. Objects of only limited mass were present in the locker, which was not disrupted by the impact. After impact, the tail of the aircraft settled onto the ground, as shown in the image. The crop was flattened by first responders, not the aircraft.

Figure 1
The aircraft in the field

Examination of the flying controls revealed no evidence of pre-impact failure. In particular, the connecting rod between the front and rear cockpit rudder pedals was found attached at both ends; it was bent in two places but unbroken. A strip examination of the engine similarly revealed no evidence of pre-impact mechanical failure. The area containing the front seat was severely disrupted, whilst the area containing the rear seat was much less disrupted.

The features of the accident site and the degree and location of the aircraft damage were consistent with the aircraft being in an incipient or developed spin to the right at impact. The condition of the engine components, found on strip examination, coupled with the condition of the propeller, were consistent with the engine operating normally. Because the propeller was wooden, the amount of power being developed at impact could not be determined.

Aircraft information

The only documentation relating to maintenance that was recovered consisted of an airframe and an engine logbook. Entries in those logbooks stated that the earlier logbooks were lost or stolen, but at the time the replacement logbooks were raised, the estimated airframe and engine time in service was 3,500 hours and 1,500 hours respectively. The aircraft appeared to have been in the USA at that time.

Thereafter, the airframe logbook indicated that control surface and structural inspections commenced on 10 September 1979 and took place progressively until 30 August 1984, enabling each component to be covered in Ceconite 102. Because the original Tiger Moth aircraft utilised stitched and doped cotton fabric, fitment of the Ceconite covering was carried out in accordance with US Supplementary Type Certificate number SA2666WL.

The record stated that the aircraft was rigged in accordance with the De Havilland Maintenance Manual, inspected and found airworthy on 24 October 1984. A test flight was performed on 28 October 1984.

The logbooks did not record any flights after 6 July 2016 by which time the aircraft had completed a notional 3,753.8 hours and the engine 1,753.8 hours. It was presumed the aircraft was still in the USA on that date. Further logbook entries indicated that an annual inspection was completed on 5 January 2018. The location of the aircraft at that time was not determined and no records were found of the aircraft flying in the UK or Europe before the accident.

Maintenance providers reported that considerable detailed differences can be routinely found between examples of DH-82 Tiger Moth aircraft. A Test Pilot with considerable experience of the type reported that, notwithstanding such detailed differences, handling qualities did not significantly differ across a range of examples of DH-82 aircraft.

Weight and balance

The current weight and balance schedule for the aircraft was not located by the investigation. The passenger had noticed that the fuel tank contents indicator was showing between a half and two thirds full. As an indication only, the weight and moment arm for another Tiger Moth was used to estimate the weight and CG position for the accident aircraft. From a basic weight of 1,212 lbs and a moment arm of 8.9 inches aft of datum, a weight of 1,742 lbs and a CG position of 13.7 inches aft were calculated using the weights of the fuel on board, pilot, passenger and small items in the locker behind the rear seat occupant. The maximum permitted All Up Weight for the aircraft is 1,825 lbs with an aft CG limit with spin strakes fitted of 15.3 inches. It is probable that the accident aircraft was within its safe weight and CG operating envelope.

Airfield information

Pent Farm is a private airstrip 2.5 nm north-north-west of Hythe, Kent, with an elevation of 240 ft amsl. It has a single grass runway orientated 070°/250°, 1,000 m long and 25 m wide. There are high tension powerlines and 70 ft high pylons approximately 450 m to the north of and running parallel to the runway. There is high ground rising to 550 ft to the northeast and powerlines 25 ft high close to the Runway 25 threshold. Circuits are flown to the north, to the right from Runway 25, at 1,000 ft amsl. The village of Stanford on the extended centreline of Runway 25 is treated as an avoidance area. There is also a property to the north of Stanford to the west of the Runway 07 threshold which, although not part of the avoidance area, has horses and it would be normal to avoid overflying it, especially at a low height. The airfield and immediate surrounding area are shown at Figure 2.

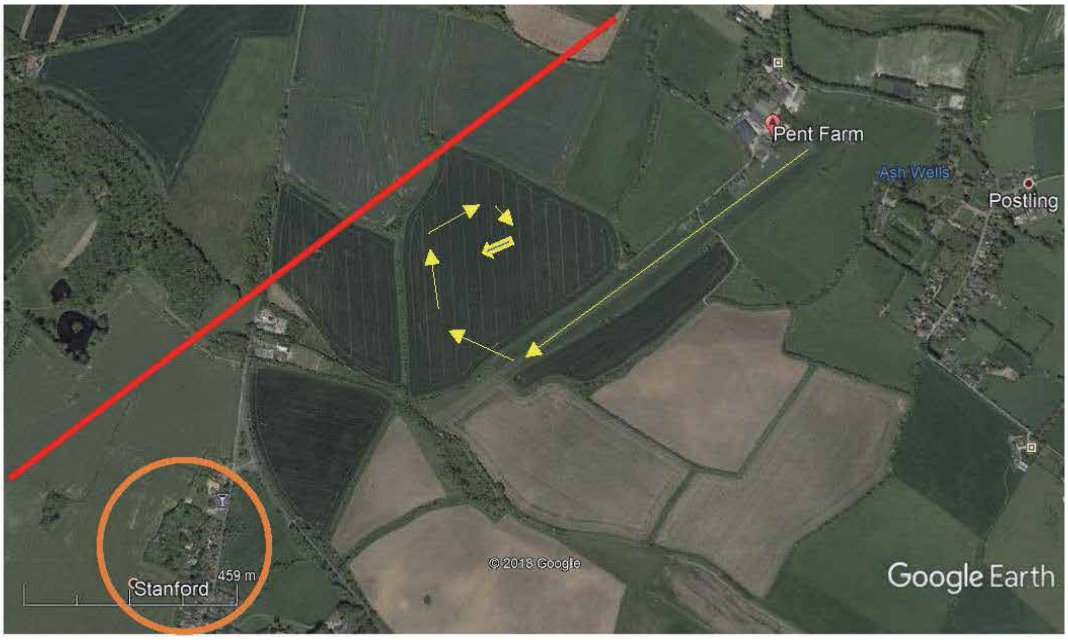

Figure 2

Pent Farm airfield showing the avoidance area of Stanford, estimated aircraft track and accident site in yellow, with pylon wires in red

Personnel

The owner and pilot of the Tiger Moth N54556

The pilot commenced flying whilst serving as an aircraft mechanic in his National Armed Forces between 1984 and 1995, during which time he obtained a National PPL and a civilian aircraft engineer's licence. After leaving the Armed Forces, he worked as an aircraft engineer and built up his own aircraft maintenance and restoration company whilst continuing his private flying. In 1999, the company expanded, and he added a flying school and larger hangar facilities. In 2017 he sold the company and focussed on purchasing and renovating Tiger Moths whilst working in the UK using his FAA Inspector's Licence, working for maintenance organisations on, and inspecting work carried out on FAA registered aircraft.

His FAA pilot's licence, which permitted him to fly N-registered aircraft, was based on him holding a current National PPL and Aircrew Medical Certificate, both of which were valid at the time of the accident flight.

His pilot's logbook was completed up to 30 June 2019, although he was believed to have flown since that date, but the investigation was unable to establish how many hours he had flown in that time.

The passenger

The passenger held an Airline Transport Pilot's Licence (ATPL) with a current SEP rating. He started flying in 1988 and during his career had been a Flying Instructor before gaining his ATPL. He had been employed flying a variety of commercial aircraft types including Boeing 737-800, BAe RJ100 and Embraer EMB 170/190 aircraft.

Medical and pathological information

At the time that this report was completed, no medical history or post-mortem report for the pilot had been seen by the investigation.

The pilot's medical history was requested from his National Aviation Authority but was not made available because of local confidentiality laws. A prescription medication and herbal supplement were found in his personal property and these were made known to the pathologist carrying out the post-mortem examination.

Tests and research

Two flight trials were carried out using a similar Tiger Moth to the accident aircraft, flown by a Test Pilot (TP) who was a graduate of the Empire Test Pilots' School (ETPS) and had a long history of experimental test flying.

The first flight was to assess the aircraft's handling qualities and performance, particularly with respect to rudder versus aileron authority, dihedral, and pressure errors and handling in steady heading sideslips (SHS). The testing was conducted using standard EASA Certification Specification (CS) 23 test techniques. The aircraft was instrumented with GPS-fed data loggers that recorded the flight path and altitude of the aircraft. Additionally, GoPro image recording cameras were worn by the pilot and fitted to the airframe to record the testing.

All testing was conducted with the wing slots locked closed as per the accident aircraft, the takeoff weight was 1,790 lbs (Maximum All Up Weight = 1,825 lbs), and the CG was 13.7 inches aft of the reference datum. Testing consisted of a series of right rudder inputs of increasing size opposed by up to full left aileron. Power was varied from idle power, through power for level flight to full climb power, and the airspeed indications were observed as sideslip was applied.

Initially, the aircraft was set up in level flight at 1,950 rpm and 60 KIAS. Right rudder was applied and then the subsequent roll (away from the generated sideslip) opposed with left aileron. The magnitude of the inputs was increased for subsequent test points. The force required to apply rudder was "very light" requiring minimal effort. When the applied force was released and the rudder was free, it very slowly returned to neutral. A right rudder input of approximately 50-60% required full left aileron to prevent the aircraft rolling to the right. Approximately 30° angle of bank to the left was achieved in this limiting sideslip, which provided very strong "seat-of-the-pants" cues. It was noticed that the aileron control response was most effective around neutral and decreased slightly towards full travel. The control inputs were of the same magnitude with both idle power and full power applied.

In the second sortie, additional rudder was applied having already applied full left aileron. On applying a step input of right rudder, the aircraft promptly rolled right and pitched gently nose-down. The roll rate achieved was in the order of 20° per second which was "uncomfortable". However, it was easy to recover the aircraft by centralising the rudder and rolling the wings level with aileron. It was evident that if full rudder was applied, the resulting sideslip and the aircraft's lateral stability would produce a powerful rolling moment to the right that could not be stopped even with the application of full opposite aileron.

Both rudder and ailerons tended to float towards neutral when released from modest inputs. However, beyond 70% right rudder travel, the rudder would remain applied with no tendency to centralise without the pilot's intervention. Additionally, with the rudder free to move and climb power applied, the rudder would gently migrate towards full right rudder deflection without any assistance from the pilot.

It was noted that with full power applied, at 60 KIAS the aircraft would normally achieve approximately 500 ft/min rate of climb. However, with full left aileron and 50-60% right rudder applied, the aircraft only achieved level flight in SHS. Evidently, the drag created by such aggressive sideslip manoeuvres was enough to reduce the aircraft's rate of climb to zero.

The airspeed indications were monitored as sideslip was applied and very little change in indicated airspeed was observed in level flight, less than 2 KIAS, even in extreme sideslips. The TP considered that: *'It was unlikely that pressure errors due to sideslip would have contributed to the accident'*. Additionally, the small windscreens in the open cockpits only provide protection from the slipstream with zero sideslip. As soon as 2-3° or more of sideslip was applied, there was considerable wind noise and buffet of the pilot's head. It would not have been possible to fly with large angles of sideslip without noticing it.

The owner of the accident aircraft normally flew it from the rear seat but on the accident flight he occupied the front seat. Although the field of view is similar, the view from the rear cockpit includes much more of the aircraft nose and structure making it easier to discern yaw and pitch attitudes. Additionally, the rear seat is further behind the main wheels, which makes the detection of swing (yaw) on the ground easier and allows better judgement of takeoff and landing attitudes.

The TP concluded that the Tiger Moth aircraft was easy to fly, with the open cockpit providing the pilot with good audio and buffet cues of airspeed and sideslip. Given these cues of extreme attitude and airflow, the TP found it hard to imagine how a pilot could put the aircraft into an extreme sideslip accidently. It was equally hard to understand in the circumstances surrounding the accident why applying any amount of sideslip during the climbing turn after takeoff would be helpful.

Analysis

The aircraft had flown immediately prior to the accident flight and had operated normally. No technical faults or pre-accident failures were identified that may have contributed to the accident (see *Loss of controllability*).

The pilot was properly licensed to operate the Tiger Moth and was experienced in flying it, but normally from the rear and not the front cockpit. Weight and Balance calculations for a similar aircraft showed that the accident aircraft was probably within its safe weight and balance envelope.

It was difficult to understand why the pilot would fly the aircraft in the extreme cross-controlled condition described by the passenger and not take corrective action when the limit of aileron control was approached. The following areas were considered:

- Incapacitation
- Loss of controllability
- Aircraft manoeuvring

Incapacitation

The pilot's medical history was not available to the investigation, but from those persons who knew him he appeared to be in good health and to be enjoying life. On the earlier flight and during the earlier conversations with the passenger, he had also appeared to be in good health.

The fact that the pilot did not respond to the questions from the passenger as the aircraft was developing the cross-controlled condition may have been due to some form of incapacitation.

The control stick was seen by the passenger to move to the extreme left position as the yaw developed but he was not touching or following through on that control. This movement was probably due to an input from the pilot, suggesting that he was not totally incapacitated at this time.

It was the continued forward movement of the right rudder pedal, beyond the point at which aileron control could prevent the secondary roll to the right, which led to the high angle of bank, nose-down pitch and rapidly increasing rate of turn to the right to the point of impact. By moving the left rudder pedal forward, the aircraft could easily have been brought back to normal controlled flight. This would have been a simple and natural action for the pilot to perform and not doing so supported the possibility that there was some lack of cognitive or physical ability on his part.

At the time of writing, the investigation had seen no medical evidence to support the possibility of incapacitation. Should the post-mortem report become available and provide relevant evidence, an addendum to this report will be issued.

Loss of controllability

It was possible that the pilot made a corrective rudder input but it had no effect. For this to have been the case, the rod linking the front rudder bar with the rear would have to have broken or become disconnected at one end before impact. The rod was found connected at both ends and, although it was bent during the impact sequence, it remained unbroken. It was concluded that there was effective control of the rudder from the front seat before impact.

Aircraft manoeuvring

Having taken control and commenced what the passenger described as a low and early turn, it is possible that the pilot had planned to fly an abbreviated low-level circuit or was simply avoiding the property with the horses. Whether an abbreviated or normal circuit was to be flown, the usual coordinated, balanced turn control inputs should have been made. With the pylon lines ahead and the aircraft in a nose-up climbing attitude, the pilot may have yawed the nose to the right to improve forward visibility, but this would not have required the extreme level of cross-controlled flight described by the passenger. It would also have significantly reduced the rate of climb at a time when gaining height was important.

The accident manoeuvre did not bear any relationship to conventional aerobatic manoeuvres and, given the height and airspeed of the aircraft, aerobatic manoeuvres would not have been possible.

Summary

At full power with the right rudder pedal above 70% of its travel, the pedal will migrate forward to full deflection, as reported by the passenger who was lightly "following through" on the rudder pedals. As the aircraft yawed and rolled to the right, the pilot may have made inputs on the control stick to limit the roll. In these circumstances, unless he was in some way partially incapacitated, it is probable that he would also have acted to prevent the very uncomfortable cross-controlled condition before, or as they reached, the point where the rapid roll to the right and, possibly, incipient spin resulted.

It was not possible to state conclusively why the cross-controlled flight condition was allowed to develop to the point where the rapid roll to the right occurred, although the possibility of incapacitation could not be excluded. If the pilot was not incapacitated, then he had the experience and ability to correct the situation by centralising the rudder and rolling wings level but did not do so. If he had not experienced this situation before, the rapid roll to the right may have surprised him, delaying corrective action.

Conclusion

The cause of the accident was the large amount of right rudder applied at high power beyond the limit of full left aileron control. This resulted in a steepening rolling turn to the right with the associated large nose-down pitch attitude and, possibly, an incipient spin.

No corrective action to address the situation appears to have been taken, and some of the evidence is consistent with the pilot becoming incapacitated. Without conclusive evidence of incapacitation, however, it was not possible to determine why the cross-controlled flight condition was allowed to develop to the point where it caused a rapid roll to the right.

Published: 16 July 2020.

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:	Saab 340B, ES-NSD
No & Type of Engines:	2 General Electric CT7-9B turboprop engines
Year of Manufacture:	1989
Date & Time (UTC):	30 August 2019 at 0645 hrs
Location:	Carlisle Airport, Cumbria
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 3 Passengers - 13
Injuries:	Crew - (None) Passengers - (None)
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	50 years
Commander's Flying Experience:	7,300 hours (of which 6,100 were on type) Last 90 days - 130 hours Last 28 days - 46 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further AAIB enquiries

Synopsis

During the climb the commander was unable to adjust the propeller rpm on the left engine. The engine was shut down and the aircraft landed without further incident. Inspection of the left engine revealed that the condition lever control cable was damaged, probably as a result of chafing against the accessory gearbox. A service bulletin published in 1988 provided instructions to fit chafing protection in this area. The aircraft maintenance records did not indicate that the service bulletin had been performed on ES-NSD, but photographs of the damaged cable showed that the chafing protection had been fitted. However, it was not in the correct location and would not have provided the intended protection. It was not established how this occurred.

Following the incident the operator introduced a periodic inspection of the engine control cables in its maintenance programme and the aircraft manufacturer took action to update the aircraft maintenance manual.

History of the flight

The aircraft was operating a scheduled passenger flight from Carlisle Airport to London Southend Airport. When the aircraft was at approximately 2,500 ft during the climb, the commander attempted to adjust the climb power having noted that the left engine propeller rpm was low. Attempts to adjust the rpm were not successful. The flight crew advised ATC of their intention to return to Carlisle as they had difficulty climbing. ATC declared a local standby.

The flight crew followed the checklist to shut down the left engine and the commander declared an emergency to ATC. ATC upgraded the incident and alerted external emergency services. The remainder of the flight was uneventful, and the aircraft landed at Carlisle twelve minutes after takeoff. The airport Rescue Firefighting Services (RFFS) were in attendance and advised ATC that no further assistance was required so the external emergency services were stood down.

Subsequent inspection of the left engine revealed that the section of the condition control cable which runs between the hydromechanical unit (HMU) and pitch control unit (PCU), was damaged.

Engine control system description

The aircraft was equipped with two General Electric (GE) CT7-9B turboprop engines, fitted with Dowty propellers. Engine control is provided by separate power and (propeller) condition levers, mounted on the control quadrant on the centre pedestal of the cockpit. Each power and condition lever are connected to the PCU and HMU fuel control gearbox on the respective engine, by a mechanical push-pull cable and a series of bellcranks and pulleys. The cables provide an adjustable, mechanical connection between the HMU and PCU units (Figure 1).

The condition lever, through the push-pull cable and PCU, adjusts the pitch of the propeller blades and sets the propeller speed. It also provides inputs to the HMU, which delivers high pressure metered fuel to the engine.

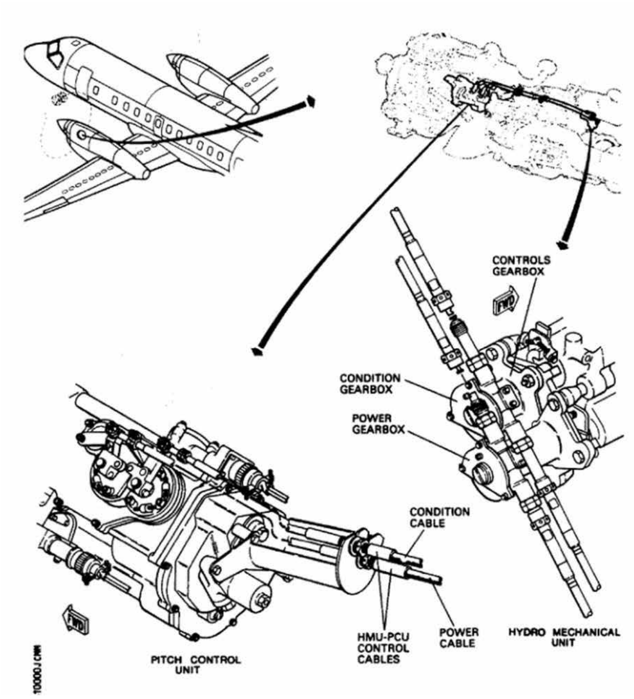

Figure 1

Figure from Saab 340 aircraft maintenance manual showing engine control cable routing between HMU and PCU

The construction of the power and condition control cables consists of three stainless steel races separated by two rows of free-floating stainless steel ball bearings. The balls are held in position by stainless steel or Teflon ball guides. This stack of races, balls and ball guides are enclosed in a flexible stainless steel casing and protective vinyl cover.

Aircraft examination

There were no photographs of the damaged condition control cable prior to it being removed from the engine but Figure 2 shows the cable after it was removed from the engine. The operator noted that a short section of plastic tubing secured by cable-ties, had been fitted adjacent to the area of visible damage.

The operator initially indicated that the cable appeared to have failed due to chafing against the accessory gearbox and attributed this to the large radius bend at the opposite end of the cable, near the HMU (Figure 3). It subsequently suggested that the cable had broken in the bend near the HMU.

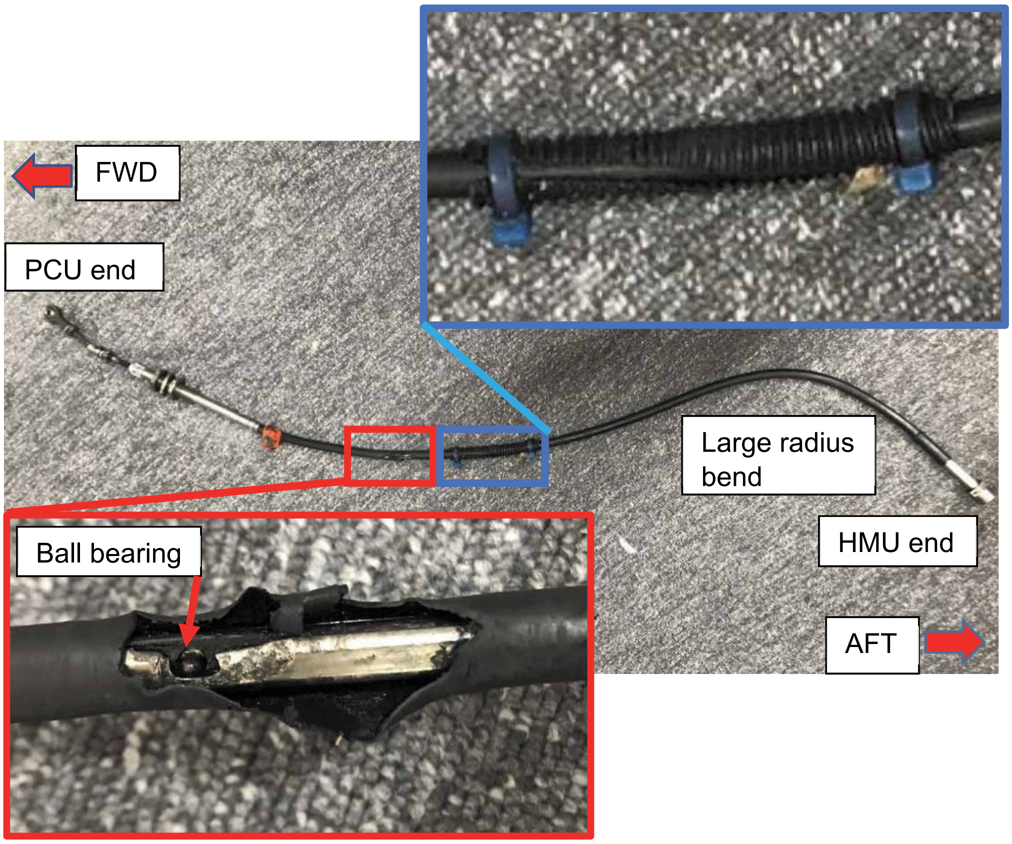

Figure 2

ES-NSD left engine condition control cable, insets show damage and chafing protection

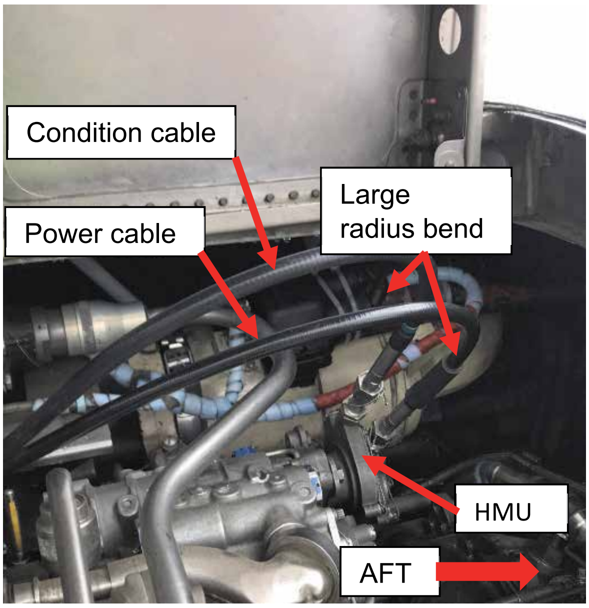

Figure 3

Bend in engine control cables near HMU
(taken after replacement of condition control cable)

Information from the manufacturer

Background information

The aircraft manufacturer advised that during 35 years of operation of the Saab 340, there had been several reported failures of engine power or condition control cables, especially in the early years of operation. Typical failures included a broken inner (centre) race or loose rivets on the inner race attachment joints. Some failures were related to incorrect installation of the cables, but others were related to the original routing of the cables. As a result, several modifications were introduced via service bulletin (SB) to prevent further failures.

The manufacturer is aware of ten engine control cables failures since 2001, excluding ES-NSD; in six of those occurrences the cables had not been modified and in four occurrences, the modification status was unknown.

SB 340-76-027

SB 340-76-027 Revision 01 *'Engine controls – powerplant – chafing protection of engine control cables'* was issued on 12 November 1988. It described attaching silicon tape and a 4-inch long section of plastic convolex tubing at a specified location on the HMU-PCU section of the condition control cable, to prevent chafing of the cable on the accessory gearbox. Compliance with the SB was described as 'recommended'. Figure 4, taken from SB 340-76-027 shows the location in which the convolex tube should be installed.

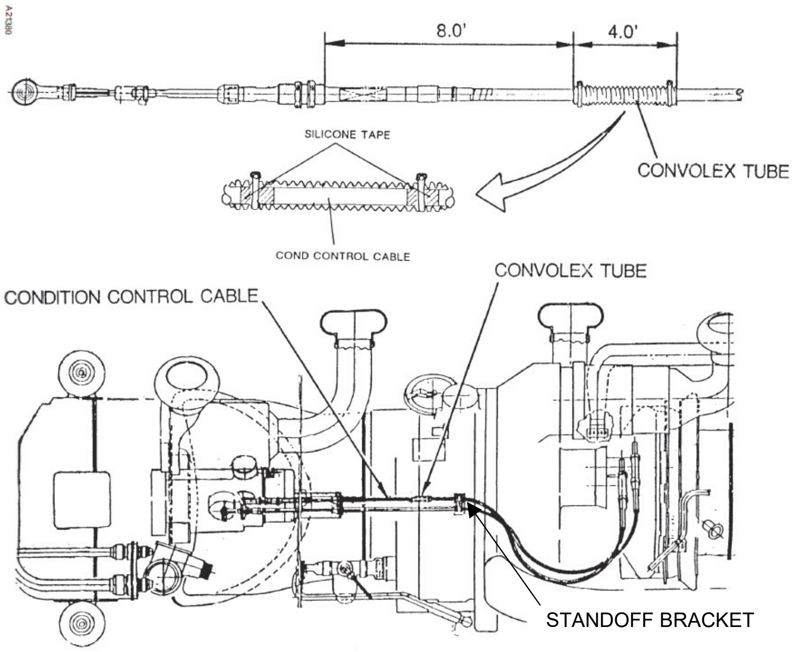

Figure 4

Location of anti-chafing protection on condition control cable from SB 340-76-027

SB 340-76-044

SB 340-76-044 Revision 01 *'Engine controls – engine control cables – relocation of condition and power lever cable standoff bracket'* was issued on 19 April 2016. It stated that chafing between the condition lever cable and the engine accessory gearbox had been found on some aircraft due to inadequate clearance between the cable and the accessory gearbox. The SB provided instructions to relocate the existing cable standoff bracket from the aft side of the engine case flange to the forward side of the flange, to provide addition clearance between the cable and the accessory gearbox. The location of the standoff bracket is identified in Figure 4. Compliance with the SB was described as 'recommended'.

Assessment of cable damage

The cable from ES-NSD was not examined, but the aircraft manufacturer reviewed the photographs of the damaged condition control cable provided by the operator. It assessed that the large holes in the outer flexible stainless steel casing and vinyl covering were consistent with chafing damage. The ball guide and outer race on the affected side appeared to be damaged, such that the ball bearings were exposed. As far as could be determined from the photographs, the centre race appeared undamaged. The manufacturer noted that chafing protection, although fitted, was not in the correct position and would not have protected the cable from chafing against the accessory gearbox. The correct location is approximately coincident with the area of damage shown in Figure 2. Figure 5 also shows the correct location of chafing protection on a condition cable installed on the engine of another aircraft.

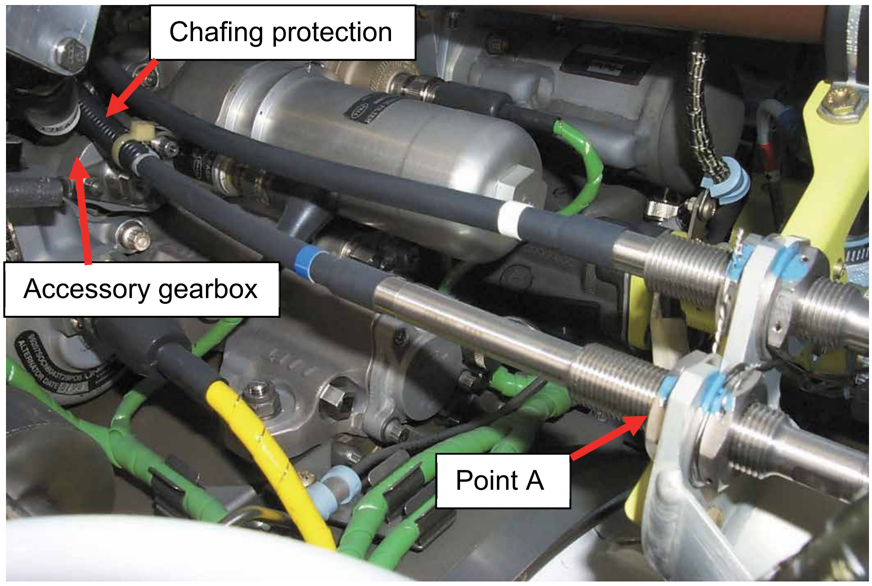

Figure 5

Correct location of chafing protection on condition control cable (view looking aft)

Point A in Figure 5 corresponds approximately to the datum shown in SB 340-76-027 (Figure 4); the chafing protection should be installed 8 inches from this point.

Cable installation

The manufacturer stated that an important consideration when installing the HMU-PCU engine control cables is how the cables are bent. Due to the internal construction of the control cables they should only be bent in one direction when installed. Otherwise, the resulting unfavourable bend shape will cause increased friction and wear which will reduce the life of the cable. The specific cable installation requirements are described in the Powerplant Build-up Manual (PBM). When comparing the PBM with the Aircraft Maintenance Manual (AMM) the manufacturer noted that the procedure which provides detailed guidance on how the cables should be bent, was not included in the AMM. As control cables sometimes need to be replaced in-service, the manufacturer will update the AMM to include the detailed cable installation guidance.

Aircraft information

The aircraft had been in the operator's fleet since June 2019 and underwent its last maintenance, which was a line check, on 29 August 2019.

A review of the maintenance records indicated that the left engine had been changed in January 2016 and the propeller gearbox in March 2018. There were no other documented inspections or maintenance actions during which the condition control cable would have been disturbed and no record that it had ever been replaced. There was no record that SB 340-76-027 had been embodied on ES-NSD, or on the other Saab 340s in the operator's fleet. It subsequently requested instructions from the aircraft manufacturer to complete the SB.

It could not be established, from inspection or from the aircraft's maintenance records, if SB-340-76-044 had been embodied on ES-NSD.

The operator conducted a fleet inspection of the condition lever cables for signs of chafing; no anomalies were noted. It also created a periodic inspection of the cables in its maintenance programme.

Analysis

Chafing of the condition control cable where it passes over the accessory gearbox is a known condition and the aircraft manufacturer published non-mandatory SB 340-76-027 in 1988 to mitigate this problem with the addition of chafing protection. It also published optional SB 340-76-044 in 2016 to increase clearance between the condition lever and the accessory gearbox.

Despite the presence of convolex tubing on ES-NSD's left engine condition control cable, the aircraft's maintenance records did not contain any reference that SB 340-76-027 had previously been embodied. Possible explanations could include that the cable, or entire left engine assembly, had previously been installed on another aircraft having SB 340-76-027 embodied; or, that at some point in the past, maintenance personnel had added chafing protection without formal embodiment of the SB.

SB 340-76-027 described the precise location in which the chafing protection should be added to condition control cable to prevent chafing against the accessory gearbox. The chafing protection on the condition control cable from ES-NSD was installed at an incorrect location, and was adjacent to, rather than coincident with, the area where chafing damage was most likely to occur. It was not established why the chafing protection was installed in this location but there are several possible explanations: the position of the chafing protection may have been measured from an incorrect datum, for example the end of the rigid metal cable sleeve shown in Figure 5; if the cable-ties were not sufficiently tight, the chafing protection may have slipped from its original position; or, it may have been installed without reference to SB 340-76-027. Following this incident, the operator requested instructions from the manufacturer to perform SB 340-76-027 on all of its Saab 340s and introduced inspections of the cable in its maintenance programme.

In addition to the visible damage, the operator suggested that the cable had broken in the large bend near the HMU gearbox. The cable was not physically examined but it was considered possible that the cable had also suffered an internal failure at this point, which was not externally visible in the photographs provided. But the manufacturer considered that the substantial chafing damage evident in the photographs would have been sufficient to cause problems with cable operation and could have accounted for the lack of response from the condition lever during the incident.

It was not established if SB-340-76-044 had been embodied on ES-NSD but it is likely that if the standoff bracket had been in its original (pre-SB) position, it would have been visible on the left edge of Figure 3. Therefore, it was considered likely that SB-340-76-044 had been embodied.

The aircraft manufacturer noted a discrepancy in the instructions for cable installation between the PBM and AMM and will update the AMM to ensure the same information is included in both manuals.

Conclusion

During the climb after takeoff, the left engine condition lever did not respond to the commander's inputs and he was unable to adjust the propeller rpm on the left engine.

The condition control cable had suffered damage due to chafing against the accessory gearbox, which most likely affected the correct operation of the cable. Although chafing protection was fitted to the cable, it was not in the correct location and would not have provided the intended protection.

ACCIDENT

Aircraft Type and Registration:	Piper PA-28RT-201 Arrow IV, N2943D
No & Type of Engines:	1 Lycoming IO-360-C1C6 piston engine
Year of Manufacture:	1979 (Serial no: 28R7918231)
Date & Time (UTC):	25 May 2020 at 1216 hrs
Location:	Enstone Aerodrome, Oxfordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to propeller, right step, left flap and underside of fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	578 hours (of which 101 were on type) Last 90 days - 3 hours Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Whilst on the downwind leg the pilot became distracted by a lower-level helicopter that appeared to be joining the circuit directly on the base leg. This led to an interruption in his pre-landing checks, before the landing gear would have been lowered. The landing gear remained retracted and the aircraft landed gear-up.

History of the flight

The pilot joined the downwind leg for Runway 26 North at Enstone Airfield, following a standard overhead join. No radio operator was on duty and blind calls were being made by circuit traffic on the Air/Ground frequency. A helicopter was flying circuits in the Runway 26 microlight circuit, which is lower and closer to the runway than the main circuit, and another aircraft had reported joining from the south. Whilst on the downwind leg, the pilot became distracted by a second, lower-level, helicopter that appeared to be joining the circuit directly on the base leg for Runway 26. The pilot of the second helicopter did not make any radio calls on the Air/Ground frequency and the pilot of N2943D was uncertain of its intentions. He stated that he thought it was during this period of distraction that he missed the check to lower the landing gear.

The second helicopter continued to fly to the south, away from the airfield, and descend. The remainder of the circuit and final approach were uneventful. As the pilot flared the aircraft for landing, it continued to settle, and he realised that he had not lowered the landing gear. The aircraft came to rest on the grass surface of Runway 26 North. The pilot completed his shutdown checks and was able to make an unobstructed exit from the aircraft.

The pilot stated that he had not flown for some time due to poor weather and the Covid-19 restrictions, and was aware of his lack of recency. He had reviewed the aircraft checklists prior to the flight, which he had postponed once due to adverse weather.

Conclusion

The pilot considered that the cause of the accident was his distraction on the downwind leg, due to the helicopter traffic that appeared to be ahead of him in the circuit. This led to an interruption in his pre-landing checks, which were being conducted from memory and not from the written check-list. When the pre-landing checks were recommenced, he continued from the point that he thought he had reached, rather than starting again. He also stated that he had not carried out his usual 'Mixture/Prop/Wheels - Red/Blue/Green' memory check whilst on final approach.

The pilot had no recollection of the 'wheels up/low revs' warning buzzer during the base leg or final approach, but he did recall hearing it during the dead side descent, prior to joining the circuit.

ACCIDENT

Aircraft Type and Registration:	Rockwell Commander 114, G-BFXS
No & Type of Engines:	1 Lycoming IO-540-T4B5D piston engine
Year of Manufacture:	1977 (Serial no: 14271)
Date & Time (UTC):	20 May 2020 at 1015 hrs
Location:	Little Snoring Airfield, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Abrasions to the underside of the fuselage and left wing and damage to the propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	545 hours (of which 88 were on type) Last 90 days - 1 hour Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was planning to complete two landings at Little Snoring Airfield before flying to Old Buckenham Airfield in order to complete the required three landings in 90 days prior to flying with passengers. He took off from Runway 07 and completed the first circuit without incident. As he was flying downwind in the second circuit another pilot asked him to extend his circuit to allow them to takeoff. He extended downwind then made his approach to land. He thought he had completed his normal downwind checks, which would normally include extending the landing gear, and on final approach he made his normal "red, blue, greens"[1] landing checks. However, on landing the propeller and fuselage struck the runway and he realised the landing gear was not selected down. The landing gear warning horn did not sound. The pilot was uninjured and was able to exit the aircraft unaided.

The pilot had not flown for several months and he thinks that the lack of recency combined with the distraction of extending the circuit caused him to forget to extend the landing gear. He believes that on final approach he glanced inside and saw the GPS green light[2] and mistook it for the landing gear green lights.

Footnote

1 "Red, Blue, Greens" means mixture fully rich (red lever), propeller fully forward (blue lever) and landing gear down and locked with three green lights illuminated.

2 G-BFXS has green lights indicating the navigation source selected for the Horizontal Situation Indicator.

The landing gear warning horn did not sound because the pilot had selected only partial flap, intending to complete a touch-and-go. The landing gear warning horn sounds when the landing gear is not down and either the flaps are extended beyond 25° or when the throttle is retarded below a position corresponding to a manifold pressure of approximately 14 inches of mercury.

Figure 1

G-BFXS instrument panel showing the landing gear indicator lights and GPS light

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK MTOsport, G-TYRO
No & Type of Engines:	1 Rotax 914-UL piston engine
Year of Manufacture:	2014 (Serial no: RSUK/MTOS/056)
Date & Time (UTC):	27 May 2020 at 1715 hrs
Location:	Rufforth Airfield, near York, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the rotor blades, propeller, nose leg and fuselage
Commander's Licence:	Private Pilot's Licence
Commander's Age:	67 years
Commander's Flying Experience:	111 hours (of which 111 were on type) Last 90 days - 4 hours Last 28 days - 3 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had completed two circuits of the airfield, each to a full stop landing, without incident and had then departed for a short local flight. On returning to the airfield he joined the circuit and made a powered approach to land on Runway 05. The weather was good with a light crosswind from the left.

The pilot reported that, in the flare, as the gyroplane was about to touchdown, he felt a strong gust from the left which caused it to yaw into wind and he was unable to straighten it before it touched down. The gyroplane had very little airspeed but as it touched down it rolled over to the right.

The pilot was uninjured and was able to exit without assistance. The gyroplane sustained damage to its rotor blades, propeller, nose leg and to the right side of the fuselage.

Figure 1
Gyrocopter after the accident

AAIB Record-Only Investigations

This section provides details of accidents and incidents which were not subject to a Field or full Correspondence Investigation.

They are wholly, or largely, based on information provided by the aircraft commander at the time of reporting and in some cases additional information from other sources.

The accuracy of the information provided cannot be assured.

Record-only investigations reviewed May - June 2020

24-Mar-20 **Cessna 182H** **G-ATCX** Stoodleigh Farmstrip, nr Exeter, Devon

The pilot reported that sloping ground caused him to lose depth perception as he approached the ground and he flared too high. This resulted in a high sink rate and a heavy landing. The nosewheel detached and the propeller struck the ground. The pilot exited the aircraft without injury.

27-Apr-20 **Eurofox 912(S)** **G-DSUE** Northrepps Airfield, Norfolk

The pilot applied heavy braking having landed long, this caused the tail wheel aircraft to tip forward and it came to rest inverted near the end of the grass runway. The aircraft was severely damaged, but the pilot and passenger were uninjured. The pilot considered that a lack of recency had contributed to the accident.

25-May-20 **Cessna R182** **G-WIFE** RAF Kirknewton, West Lothian

The aircraft landed with the landing gear inadvertently retracted. The underside of the aircraft and the propeller were damaged.

23-Jun-20 **Dragon Chaser** **G-CIFM** Sutton Meadows Airfield, Cambridgeshire

During the crosswind leg of a circuit the engine stopped, possibly as a result of carburettor icing, which led to the pilot carrying out a forced landing across one of the runways. However, the aircraft was not able to stop within the runway's width and, as the pilot attempted to steer the aircraft away from the runway's edge, the aircraft tipped on to a wingtip and sustained damage.

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

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.

1/2018 Sikorsky S-92A, G-WNSR
West Franklin wellhead platform,
North Sea
on 28 December 2016.

Published March 2018.

2/2018 Boeing 737-86J, C-FWGH
Belfast International Airport
on 21 July 2017.

Published November 2018.

1/2020 Piper PA-46-310P Malibu, N264DB
22 nm north-north-west of Guernsey
on 21 January 2019.

Published March 2020.

Unabridged versions of all AAIB Formal Reports, published back to and including 1971, are available in full on the AAIB Website

http://www.aaib.gov.uk

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 Service
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
DFDR	Digital Flight Data 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)
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
PM	Pilot Monitoring
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
TODA	Takeoff Distance Available
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System
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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