Air Accidents Investigation Branch

AAIB Bulletin 2/2017

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AAIB Special Bulletins and Interim Reports

This section contains Special Bulletins and Interim Reports that have been published since the last AAIB monthly bulletin.

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AAIB Air Accidents Investigation Branch

AAIB Bulletin S1/2017 *SPECIAL*

ACCIDENT

Aircraft Type and Registration:	Sikorsky S-92A, G-WNSR
No & Type of Engines:	2 General Electric Co CT7-8A turboshaft engines
Year of Manufacture:	2014 (Serial no: 920250)
Location:	West Franklin wellhead platform, North Sea
Date & Time (UTC):	28 December 2016 at 0844 hrs
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 2 Passengers - 9
Injuries:	Crew - None Passengers - None
Nature of Damage:	Left outer mainwheel rim distortion, seized tail rotor pitch change shaft bearing, servo piston fracture and minor damage to helideck
Commander's Licence:	Airline Transport Pilot's Licence (H)
Commander's Flying Experience:	To be confirmed
Information Source:	AAIB Field Investigation

The investigation

The accident occurred on 28 December 2016; the operator raised a Mandatory Occurrence Report and transmitted it to the UK Civil Aviation Authority (CAA) the same day.

The AAIB became aware of the accident[1] during the morning of 5 January 2017 and initiated a Field Investigation. This Special Bulletin is published to provide preliminary information gathered from an initial ground inspection, recorded data, and other sources.

In accordance with established international arrangements, the National Transportation Safety Board (NTSB) of the USA, representing the State of Design and Manufacture of the helicopter, appointed an Accredited Representative to participate in the investigation. He is supported by advisers from the helicopter manufacturer and the Federal Aviation Administration (FAA). The European Aviation Safety Agency (EASA), the UK CAA and the helicopter operator also assisted the AAIB.

History of the flight

The flight was the second sector of a four-sector rotation from Aberdeen to the Elgin-Franklin Offshore Field in the North Sea.

The helicopter commander was the handling pilot for both sectors. The first sector from Aberdeen to Elgin Process Utilities Quarters (PUQ) was uneventful. As the helicopter, on a heading of 270°, with nine passengers on board, lifted from the Elgin PUQ helideck it yawed unexpectedly to the right through 45°. The commander applied full left yaw pedal, checked the rotation and landed back onto the deck. The flight crew discussed the likely cause, which they thought to have been the result of local turbulence or wind effects created by the platform structures which, anecdotally, is not uncommon for this helideck. They decided to continue and during the subsequent lift off into the hover the commander applied left yaw pedal, the helicopter responded and turned to the left; all control responses appeared normal. The commander then climbed to 500 ft for the brief transit to the West Franklin wellhead platform, 3.3 nm to the south.

The helicopter made a normal approach and deceleration to the West Franklin and crossed over the helideck. During the descent to land, at approximately 4 ft above the helideck, it yawed rapidly to the right, reaching a maximum rate of 30 degrees per second. At the same time it rolled 20° to the left, at which point the left main landing gear contacted the helideck. It continued to yaw to the right on its left mainwheels and nosewheels before the right mainwheels contacted the surface. The helicopter came to rest on a heading of 041° having rotated through 187°.

The helicopter was shut down and the crew and passengers disembarked; there were no injuries. The helicopter was subsequently craned from the helideck onto a ship and recovered to Aberdeen.

Footnote

[1] The AAIB have classified this event as an accident; this is consistent with the International Civil Aviation Organisation definition as this helicopter sustained damage which adversely affected its performance and flight characteristics, and required replacement of the affected components.

Weather

The meteorological observation from the Elgin PUQ at 0608 hrs was: surface wind from 220° at 17 kt, visibility 10 km or greater, overcast cloud at 2,000 ft and temperature 8°C, dewpoint 3°C and pressure 1038 hPa. No lightning activity was recorded in the area.

Initial investigation

The technical investigation focussed on the tail rotor and associated components. Once the panels were removed it was immediately apparent that the tail rotor servo piston was damaged. The servo was removed and revealed that the tail rotor pitch change shaft (TRPCS) double row angular contact bearing was in a severely distressed condition (Figure 1).

Figure 1

TRPCS double row angular contact bearing from G-WNSR

Further disassembly and examination of the components found signs of severe overheating with extreme wear on the inner and outer thrust races and barrel shaped rollers of the bearing. It was found that the roller bearings seized to the inner member. The outer race roller had excessive axial play (0.5 in), such that the tail rotor driveshaft imparted a torsional load to the tail rotor servo. This torsional load caused the primary piston rod to fracture inside the servo. Due to the failure of the primary piston, the secondary piston sleeve separated axially from the primary piston adjacent to the link fitting, with the consequential total loss of control of the tail rotor.

The components were shipped to the helicopter manufacturer for forensic analysis. Initial findings indicate that the failure of this specific bearing was rapid; a period of 4.5 hours had elapsed from the first exceedance of the relevant bearing condition indicator recorded on the operator's Health and Usage Monitoring System (HUMS) to the point of failure.

Health and Usage Monitoring System

The HUMS used by the operator for this helicopter was the Integrated Mechanical Diagnostic HUMS (IMD-HUMS)[1]. A routine download of the HUMS was performed on the evening of 27 December 2016 and the helicopter was released to service. A detailed analysis of the data, conducted after the accident, showed that the Tail Gearbox Bearing Energy Analysis limit had been exceeded on 27 December 2016.

Previous events relating to the TRPCS bearing

There have been two previous events, the first being in 2007, where a degradation of the TRPCS bearing has occurred, leading to reduced tail rotor control in flight. These events were identified by the flight crews and resulted in immediate landings. The underlying causes were identified and a number of safety measures were introduced. At this early stage of the investigation the helicopter manufacturer is not clear whether this bearing degradation is the result of a new root cause, or a previously unidentified failure mode.

Safety actions

The initial findings suggest that the damage to the servo in this case is such that it could have imparted extreme or erratic inputs to the tail rotor at any time after the failure of the primary piston. Evidence suggests that the yaw which occurred on departure from the Elgin PUQ was uncommanded and may be related to the condition of the TRPCS bearing. The AAIB considers that this failure mode would seriously affect the ability of flight crews to maintain control of the helicopter.

The operator

> The operator has subsequently introduced a number of measures to further strengthen the ability to detect impending bearing degradation. These include: a review of all HUMS data to ensure no anomalies, fleet-wide borescope inspections, a requirement for HUMS to be serviceable before flight and the time between HUMS download/analysis reduced to a maximum of 5 hours. The operator has also reviewed their HUMS processes and analytical procedures and introduced a requirement to carry out an additional assurance check.

The helicopter manufacturer

> On 31 December 2016 the helicopter manufacturer issued to all operators an 'All Operators Letter' (AOL), CCS-92-AOL-16-0019, which described the event. It emphasises the use of the HUMS Tail Gearbox Bearing Energy Tool, provided on the ground station, which will detect a TRPCS bearing that is experiencing degradation, and recommends that this Tool should be utilised as often as reasonably possible.

Footnote

[1] The IMD-HUMS includes the use of additional stand-alone mechanical diagnostic software tools for the HUMS Ground Station (GS) that help assess the condition of a number of specific components, one of which is the Tail Gearbox Bearing Energy Analysis software tool; however, these require the user to visually inspect the data and search for exceedances. The helicopter manufacturer now offers an alternative GS analysis system which offers a number of enhancements to IMD-HUMS, including more advanced algorithms and the automatic alerting of all exceedances on receipt of new HUMS data.

This was followed by an Alert Service Bulletin (ASB) issued by the manufacturer on 10 January 2017. ASB 92-64-011 introduces a one-time inspection of the TRPCS and bearing assembly for ratcheting, binding, or rough turning. The manufacturer has recommended that compliance is essential and is to be accomplished prior to the next flight from a maintenance facility; three flight hours are allowed in order to return directly to a maintenance facility. Concurrent with the release of ASB 92-64-011, the manufacturer published Temporary Revision 45-03 to require operators to use S-92 HUMS ground station software to review Tail Rotor Gearbox energy analysis Condition Indicators for alert conditions on a reduced flight hour interval. Records in excess of published alert levels require inspection of the pitch change shaft and bearing.

Ongoing investigation

The AAIB investigation will continue to examine all the operational aspects of this accident and conduct a detailed engineering investigation of the relevant helicopter components. The AAIB will report any significant developments as the investigation progresses.

Published 11 January 2017

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.

SERIOUS INCIDENT

Aircraft Type and Registration:	ATR 72-212 A, G-COBO	
No & Type of Engines:	2 Pratt & Whitney Canada PW127M turboprop engines	
Year of Manufacture:	2009 (Serial no: 852)	
Date & Time (UTC):	4 March 2016 at 09:15 hrs	
Location:	On departure from Manchester Airport	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 4	Passengers - 27
Injuries:	Crew - None	Passengers - None
Nature of Damage:	None	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	58 years	
Commander's Flying Experience:	8,276 hours (of which 928 were on type) Last 90 days - 113 hours Last 28 days - 49 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The aircraft arrived at Manchester Airport from Guernsey and remained on the ground for more than an hour, while it was snowing and the temperature was 0ºC. The flight crew decided no de-icing or anti-icing treatment was needed, as they did not consider the snow was settling on the aircraft, and the aircraft subsequently departed to return to Guernsey.

During the takeoff, the commander exerted less aft pressure on the control column, to rotate the aircraft, than he expected and maximum nose-down pitch trim was then needed to maintain the appropriate climb attitude. The autopilot was engaged four times but on each occasion it disengaged, as designed, and the commander had to apply continuous forward pressure on the control column to retain the desired pitch attitude, as the climb proceeded.

Once at the cruising level, the commander decided he was having to exert excessive forward pressure on the control column and he elected to divert to East Midlands Airport (EMA). While descending, the aircraft flew out of icing conditions and the control difficulties dissipated. The crew assessed that ice contamination had caused the problem and they made a normal landing.

No ice was found on the aircraft during a post-flight inspection but analysis by the manufacturer concluded that, from the start of the flight until the latter stages of the descent, the airflow over the horizontal tailplane and elevator was disrupted by ice contamination.

Several safety actions have been taken to improve awareness of the hazards of not de-icing or anti-icing aircraft before flight.

Background

The crew reported for duty at Guernsey Airport at 0550 hrs and operated a passenger flight to Manchester. The co-pilot was Pilot Flying (PF) and he reported that the takeoff and climb were normal, with no unusual pitch trim indications. The aircraft cruised clear of cloud at FL170 and, before descending, the crew noted Manchester's Automatic Terminal Information System (ATIS) broadcast from 0720 hrs[1]. The reported air temperature was 1ºC and snow was falling. Consequently, because the aircraft was likely to encounter in-flight icing conditions, the crew increased the approach and landing speeds[2].

Early in the descent, the aircraft entered an extensive area of cloud. It then remained in cloud during the approach but only a thin layer of ice was seen to accumulate on the wing leading edges. This was less than the crew anticipated in the prevailing conditions. The ICING light on the ice detection panel illuminated when the aircraft was at a range of 3.5 nm on final approach. So, in accordance with Standard Operating Procedures (SOPs), the crew switched on the pneumatic anti-icing systems, before landing uneventfully at 0810 hrs.

While taxiing in, the crew's perception was that light, wet snow was falling and melting on the taxiways, although some was lying on adjacent grass areas. In addition, the co-pilot could see no ice on the airframe or on the Ice Evidence Probe (IEP) when he actioned the after-landing checklist. At 0814 hrs, the commander looked at the static air temperature gauge and observed that it was indicating between 1ºC and 2ºC. He then commented "IT DOESNT APPEAR TO BE STICKING…SO I THINK WE CAN GET AWAY WITHOUT DE-ICING", adding that he would "HAVE A GOOD LOOK". There was then a protracted delay before the aircraft could park, because another aircraft was being de-iced on their allocated parking stand. During this delay, the commander said he did not see any snow settling on the aircraft and suggested snow visible on other aircraft had probably accumulated overnight. The aircraft shut down at 0837 hrs, 23 min before it was scheduled to depart on a return flight to Guernsey.

The co-pilot later stated that he had no previous experience of ground operations in snow. He had been trained that an aircraft was clear of ice if none was visible on the IEP or on the leading edge de-icing boots or the propeller spinner and he saw no ice in these locations while taxing-in.

History of the flight

After shutdown, the pilots agreed that the commander would carry out an external inspection and then decide if de-icing was needed. They later stated they would have

Footnote

1 See *Meteorological information.*

2 Ice accretion can reduce the angle of attack at which an aircraft stalls and this increases the stall speed. For an approach in icing conditions or with ice accreted to the airframe, the standard operating procedure is to add an increment to the approach and landing speeds. Similar increments are required when taking off in icing conditions.

been prepared to delay the departure if they believed there was a need to de-ice (or anti-ice), despite commercial pressures to keep to the schedule. While parked, the aircraft was refuelled and the fuel quantity in the wing tanks was increased from 900 kg to 2,800 kg.

It was the commander's belief that the air temperature was just above freezing (approximately 1ºC) and he thought the falling snow was melting on the aircraft. He could not see the top of the horizontal tailplane[3] but, from the rear access step, he thought he saw most of the top of the wings and believed there was no frozen contamination. After completing his inspection he told the co-pilot, who had remained in the flight deck, that they could continue without de-icing. The co-pilot judged the commander's inspection to be thorough because it took a long time and he accepted this decision.

The two cabin crew members seldom saw snow in Guernsey, which has a relatively mild climate, and they took photographs while the aircraft was parked. These showed snow lying on the fuselage and on the Senior Cabin Crew Member's (SCCM) coat. She later recalled brushing snow from her coat when passengers began boarding.

Before departure, the crew noted the 0850 hrs ATIS which reported snow falling and a temperature of 0ºC. The commander, who was PF for this flight, informed a member of ground staff that no de-icing procedures were required and the aircraft was pushed back at 0910 hrs, 10 minutes later than scheduled. When the engines were started, the crew switched on the electric anti-icing systems, having already added the appropriate icing increments to the takeoff and climb speeds.

At 0919 hrs, the aircraft commenced takeoff. When rotation speed (V_R) was achieved, the commander found he needed to apply less aft pressure on the control column than he anticipated and, once airborne, had to push forward on the column to achieve the climb attitude. He used the electric pitch trim switch several times to trim in a nose-down direction, which caused an aural warning to be generated. This warning is triggered when the pitch trimmer is activated for more than one second.

The crew engaged the autopilot one minute after takeoff but it disengaged approximately two minutes later. In response, the crew re-engaged it but it disengaged again after one more minute and the co-pilot noticed the pitch trim indicator showed full nose-down deflection. A PITCH MISTRIM message was displayed on the Automatic Flight Control System (AFCS) display unit, so the crew actioned the '*Pitch Mistrim*' drill from the Quick Reference Handbook (QRH) which only stipulated that the autopilot be disengaged. The co-pilot suggested the problem might have been caused by contamination and the commander replied by saying the reason he had been happy to depart was that the snow was not sticking to the aircraft and, because it was wet, he expected it to have "blown off".

Footnote

[3] An access platform or ladder would have been required to inspect the aircraft's upper aerodynamic surfaces.

While still climbing, the crew again re-engaged the autopilot and this time it operated for approximately three minutes before disengaging once more. One further attempt was made to use the autopilot but, after less than two minutes, it disengaged again. By this time the commander had asked the co-pilot to check the load sheet and announced his intention to divert if he was still having control difficulties once they levelled-off.

The aircraft was levelled at FL170 and the co-pilot stated the load sheet looked very similar to the one from the previous flight. Shortly after this, the commander announced, "RIGHT I WANT TO DIVERT TO EAST MIDLANDS, BECAUSE I AM HAVING TO PUT FORWARD PRESSURE ON…" The co-pilot then asked ATC for a diversion to EMA due to a pitch trim problem. He later stated he did not query the commander's decision because it appeared the commander was having to exert a lot of forward force to maintain the required attitude. He agreed with the decision to go to EMA because he knew it was close by, he had seen it was clear of weather during the flight to Manchester and it was an airport they both visited regularly. The aircraft flew clear of cloud soon after the descent began.

This was the co-pilot's first diversion during commercial operations and he later said he experienced a very high workload while preparing for the landing and supporting the commander, who was flying the aircraft manually. Once the commander had told the SCCM they were diverting to EMA, the co-pilot informed the passengers. He then listened to the 0920 hrs ATIS broadcast for EMA, which reported Runway 27 was in use, the wind was from 260º at 14 kt, visibility 10 km or more, temperature 3ºC and dew point 0ºC.

While preparing to land, the commander said he was worried what would happen when FLAP 15 was selected. He suggested this might cause further control difficulty and warned the co-pilot to be prepared to re-select FLAP 0 if so instructed. A few seconds later, the commander announced the aircraft was becoming easier to fly and then stated, "I RECKON IT WAS ICE I'VE GOT THE PITCH TRIM BACK".

At 0954 hrs, the aircraft made a normal landing at EMA and, after shutdown, the horizontal tailplane was inspected. No ice was found, so the commander decided the problem might have been mechanical and placed the aircraft unserviceable.

Later that day an engineer inspected the aircraft and found no faults. The operator downloaded flight data from the Flight Data Recorder (FDR) and from the Cockpit Voice Recorder (CVR) before the aircraft was returned to service.

Neither the commander nor the operator immediately considered that a serious incident had occurred and there was a three day delay before the AAIB was notified. The AAIB then assessed the occurrence as one '*which could have caused difficulties controlling the aircraft*' so, in accordance with Regulation (EU) No 996/2010, it was classified as a serious incident.

Meteorological information

At 0900 hrs on the day of the flight, a slow-moving, occluded weather front affected the north of England, and radar imagery from the Met Office showed the associated cloud stretching east-west and extending approximately 30 nm south of Manchester. The Met Office reported thick cloud layers to a height of 15,000 ft amsl, or higher, near Manchester. EMA was south of the area of cloud, and little or no cloud returns were evident further south across England.

Manchester Airport experienced persistent snow or sleet through the morning and the air temperature was at or below freezing from the surface upwards. Further south and east the freezing level rose towards 2,000 ft amsl. Atmospheric data indicated to the Met Office that at 0800 hrs the air temperature at FL170 would have been approximately -33ºC.

The ATIS broadcast by Manchester at 0720 hrs gave the visibility as 800 m in snow, with few cloud at 400 ft agl, broken cloud at 1,000 ft, temperature 1ºC and dew point -1ºC. At 0740 hrs, the reported visibility had reduced to 600 m in heavy snow, with scattered cloud at 400 ft, broken cloud at 800 ft and temperature and dew point both 0ºC. The 0750 hrs ATIS was similar but with few cloud at 200 ft, broken cloud at 800 ft, temperature 0ºC and dew point -2ºC. For the aircraft's departure from Manchester, the 0850 hrs ATIS was current. It reported a surface wind of 230º at 4 kt, visibility 1,200 m in snow, with few cloud at 200 ft, broken cloud at 800 ft, the temperature and dew point both 0ºC and the QNH 988 hPa.

Recorded information

The downloaded FDR and CVR data was obtained from the operator. The FDR data for the flight was analysed by the aircraft manufacturer, along with comparative data from the previous flight, from Guernsey.

Previous flight

The aircraft took off at Guernsey at 0651:30 hrs with a recorded elevator trim of -0.82º nose-up, which is consistent with the manufacturer's recommended pitch trim for the weight and Centre of Gravity (CG), as shown on the load sheet. No significant pitch trim command was apparent after takeoff and, during the flight, the recorded pitch trim varied between -0.88º nose-up and +0.61º nose-down. The aircraft landed at 0809:40 hrs, two minutes after ice accretion was detected.

Incident flight

According to the data, the takeoff at Manchester commenced at 0918:50 hrs, with the elevator pitch trim set at –1.27º nose-up. This is also consistent with the manufacturer's recommended pitch trim for the figures from the load sheet. Rotation began at 0919:14 hrs and 14 seconds later a nose-down force of more than 10 decanewtons (daN)[4] was sensed on the commander's control column. (Discrete data inputs register when either a nose-down or a nose-up force greater than 10 daN is exerted by either pilot to move his control column.) After a further 3 seconds, nose-down pitch trim was manually applied.

Footnote

[4] 10.2 daN equates to approximately 10.2 kilogramme-force (kgf).

At 0920:05 hrs the autopilot was engaged and approximately 2 seconds later the pitch trim increased and moved to the nose-down stop. The position recorded was +1.76º-nose-down, which is beyond the normal stop of +1.5º in autopilot control (see *Pitch trim*).

The autopilot disengaged briefly at 0922:40 hrs and was then re-engaged for varying periods of time before finally disengaging approximately two minutes prior to the top of climb. A speed of 180 KIAS was maintained for the latter part of the climb and the aircraft reached FL170 at 0932:40 hrs, before commencing descent at 0934 hrs.

When the autopilot was disengaged, a nose-down force of more than 10 daN was frequently exerted on the commander's control column. However, as the aircraft descended this event was recorded less often and the final time such force was exerted was at 0950 hrs, prior to landing gear extension. Five minutes previously, at an altitude of approximately 5,000 ft amsl, in the descent, the pitch trim had started to decrease from its +1.76º nose-down position.

The aircraft landed at 0952:30 hrs with the pitch trim showing -0.1º nose-up, which was similar to the landing position for the previous flight.

Elevator hinge moment analysis

The aircraft manufacturer computed the elevator hinge moment for two different times during steady phases of each of the two flights. The recorded pitch trim at these times was compared against the pitch trim which the manufacturer calculated should be needed for trimmed flight, without any input on the control column. For the first flight, there was only a negligible difference (averaging 0.065º) between the recorded and the computed figures. For the incident flight, the computed pitch trim was -0.17º and -0.19º for the respective points but in each case the recorded trim was +1.76º, meaning the average difference was 1.94º. This would have been greater had the pitch trim not reached its stop, because an additional nose-down force was required on the control column to maintain the desired elevator position.

It was evident that for much of the flight the elevator had a tendency to deflect upwards and that the aircraft would have adopted an undesired nose-up attitude but for the maximum nose-down pitch trim which had been applied and the pilot's control input.

Aircraft information

The ATR-72-212A is a twin-engined, high-wing turboprop aircraft, with a horizontal tailplane mounted near the top of the tail fin (Figure 1).

Pitch control

Two elevators provide pitch control and both have associated trim tabs. The left horizontal tailplane assembly is shown at Figure 2 with the trim tab visible towards the rear of the elevator.

Figure 1
ATR 72-212A (photos courtesy of ATR Aircraft)

Figure 2
Left side of tailplane assembly showing trim tab (circled) on left elevator

Each control column mechanically drives the elevator on the associated side. The elevators are linked by an uncoupling mechanism, so that movement of one elevator moves the other and this causes the control column on the other side to move. In the event of a control jam, applying a force of approximately 50 daN[5] on the free control column will trigger the uncoupling mechanism, leaving each column only linked to its associated elevator (Figure 3).

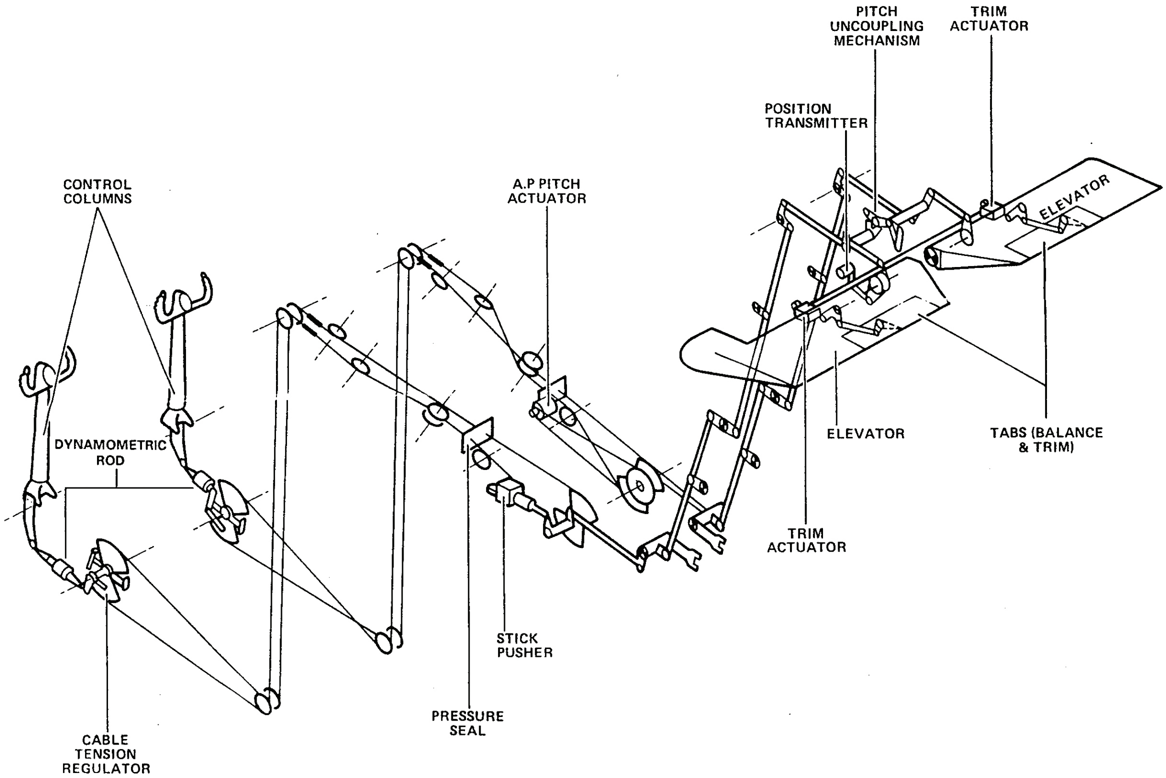

Figure 3

Schematic diagram of elevator control system

Pitch trim

The elevator trim tabs are linked mechanically to their associated elevator. When the elevator moves, they move in the opposite direction. For every 1º of elevator movement, its tab is adjusted 0.5º from its null, or neutral, position.

The null position of the pitch trim tabs can be further adjusted through actuation of the electrical pitch trim system, to offset any residual control force and reduce the elevator hinge moment. The tabs can be driven automatically by the autopilot system or manually by either pilot over a normal range of -5º (nose-up) to +1.5º (nose-down). A microswitch should prevent the tabs moving beyond +1.5º (+/-0.1º) under normal control.

Footnote

5 52 daN equates to approximately 53 kgf.

Each control wheel has a pair of pitch trim rocker switches to allow either pilot to electrically command the trim tabs up or down, under normal control. A further switch on the central console commands the tabs to move using standby control, which increases the range of movement of the trim tabs null position to +1.75º (+/-0 1º) (nose-down).

Actuation of the pitch trim for more than one second, manually or via the autopilot, generates an aural warning. This has a '*whooler*' sound intended to alert the pilots to prolonged movement of the pitch trim system. The achieved trim tab (null) position is shown on a pitch trim position indicator on the main instrument panel, with markings between -5º (nose-up) and +1.5º (nose-down).

Higher up the main instrument panel there is a display for AFCS messages. A PITCH MISTRIM message will illuminate if the autopilot operates the pitch trim and a pre-determined torque level is detected by the autopilot pitch servomotor. This can occur if the trim tabs reach the extent of travel or if an actuator jams, indicating the aircraft will be out of trim when the autopilot is disengaged.

Autopilot disengagement

Either pilot can manually disengage the autopilot via a button on their control yoke or via an AP pushbutton on the flight guidance control panel. It will also disengage if a manual pitch trim input is made (using the normal or standby control switches), if the stall warning activates or if either pilot exerts a pitch control input in excess of 10 daN (nose-up or nose-down).

A PITCH MISTRIM message is not directly associated with autopilot disengagement but it does indicate the autopilot pitch servomotor is experiencing a certain load. If the load increases further, it could lead to elevator movement which is inconsistent with the command from the autopilot. In this case, the autopilot will be disengaged by its internal monitoring circuitry.

Icing protection

The ATR-72-212A is certified for flight in icing conditions and is equipped with an illuminated Ice Evidence Probe (IEP), an ice detector, and electric and pneumatic systems to anti-ice and/or de-ice windshields, probes, engine intakes, propellers and the leading edges of the wing and horizontal stabiliser. When ice is detected by the detector, an ICING light illuminates on the main instrument panel to alert the crew.

For flight in icing conditions, but with no ice detected, the manufacturer's Flight Crew Operating Manual (FCOM) states the electrical anti-icing systems are to be switched on. This action also illuminates an ICING AOA pushbutton, positioned close to the ICING light, indicating that the angle of attack for stall warning and the angle of attack for stick pusher activation have been reduced. The FCOM then states the minimum manoeuvre / operating speeds defined for '*normal (no icing) conditions MUST BE INCREASED'.* The increased speeds are referred to as '*MINIMUM ICING SPEEDS'* and specific speeds for given aircraft weights are provided.

When the amber ICING light illuminates, or if ice is seen to accrete on the IEP, the FCOM states that the pneumatic de-icing systems are also to be switched on. Once clear of icing conditions and after the electrical anti-icing systems are switched off, the ICING AOA push button can be pressed to extinguish the light, provided the crew first make a visual check that the aircraft is free of ice. The safety speeds can then be reduced to '*normal*'.

Engineering actions

No faults were found during post-flight engineering checks of the aircraft's elevators and pitch trim tabs and no evidence of de-icing fluid residue was seen. After the aircraft had returned to service for 13 days, another commander, flying with the same co-pilot, thought he needed to apply less aft pressure to the control column during takeoff than he expected. The elevator control and pitch trim systems were checked but no discrepancies were evident, so a flight test was performed to check the pitch trim tab null, or neutral, position. It was found to be set within the manufacturer's required tolerances and the aircraft was assessed serviceable.

During the investigation it was evident the elevator trim tab was recorded as having run to +1.76º in normal control, whereas a microswitch should have limited it to +1.5º. Tests indicated that this was likely to have been caused by failure of the microswitch within the left trim tab actuator. Thus, during the incident, the pitch trim system assisted the pilot to a greater extent than would be expected under normal control; ie to the extent that could have been achieved if the pilot had used the standby trim switch on the central console.

Weight and balance

The aircraft operator is aware that small changes in CG can affect the pitch trim setting and that it is important to ensure aircraft loading for each flight accords with the prepared load sheet. For this reason, the crew checked the correct number of passengers were seated in each of three designated blocks of seat-rows. However, this check does not break down the number of females, males and children in each block. Different nominal weights are assigned to each of these groups and this can lead to slight differences between the calculated CG and the actual CG if the groups are not distributed uniformly within a block. To allow for this, the CG limits on the operator's load sheets are more limiting than the regulated limits. Consequently the operator accepts that in some cases pilots may detect a slight variation in the amount of effort required for aircraft rotation while taking off. Tables are used by crew to assess which pitch trim setting to use for takeoff at a specific mass and CG index.

For the departure from Guernsey the aircraft had a calculated takeoff mass of 18,393 kg and for the departure from Manchester it was 19,024 kg, with a regulated takeoff mass of 22,800 kg for both flights. The CG index on the incident flight was calculated at 26% of the Mean Aerodynamic Chord (MAC), almost midway between the forward and aft limits, while on the previous flight it was at 29.5%, approximately two-thirds of the way towards the aft limit. Before departure from Manchester, the crew confirmed the load sheet accurately recorded the baggage, cargo and fuel onboard, and cross-checked passenger seating in the manner previously mentioned.

Other aircraft

Aircraft handling companies at Manchester stated that all other commercial aircraft which departed on the morning of 4 March 2016 sought de-icing/anti-icing before start-up. The de-icing providers had difficulty coping with the demand for their services and some flights were delayed while others were subsequently cancelled.

Guidance material

De-icing/anti-icing requirements

The FCOM states:

> *'Atmospheric icing conditions exist when OAT on ground and for take-off is at or below 5°C or when TAT in flight is at or below 7°C and visible moisture in the air in any form is present (such as clouds, fog with visibility of one mile or less, rain, snow sleet and ice crystals).'*

and:

> *'Ground icing conditions exist when the OAT is at or below 5°C when operating on ramps, taxiways and runways where surface snow, standing water or slush is present.'*

It also states that even small quantities of ice accretion '*which may be difficult to detect visually*' can detrimentally affect aerodynamic efficiency of an '*airfoil*'. A cautionary note adds, '*Wing, tailplane, vertical and horizontal stabilizers, all control surfaces and flaps should be clear of snow, frost and ice before take off.*' Additionally there is a statement that '*elevator hinge moment may be affected by external conditions*' and that '*from experience, the most likely cause appears to be take off with ice remaining on the tail plane*'.

The manufacturer and the operator further define freezing conditions as existing when the air temperature is less than 3ºC and visible moisture in any form is present. In Part A of the Operator's Manual (OM), it states;

> *'Aeroplane commanders are to ensure that anti and de-icing operations appropriate to the conditions are carried out on the ground before departure, and that pre-flight inspection indicates that all remaining deposits and hoar frost, ice and snow have been removed before any attempt is made to take off.'*

and it includes the following definitions:

> '***Contamination*** *in this context, is understood as being all forms of frozen or semi-frozen moisture, such as frost, snow, slush or ice.*
>
> ***Contamination check*** *a check of aircraft for contamination to establish the need for de-icing.*

> ***Anti-Icing*** *Precautionary procedure which provides protection against the formation of frost or ice and accumulation of snow or slush on treated surfaces of the aeroplane for a limited period of time (holdover time).*
>
> ***De-Icing*** *Procedure by which frost, ice, slush or snow is removed from an aeroplane in order to provide clear surfaces.*
>
> ***De-Icing/Anti-Icing*** *Combination of the procedures 'de-icing' and 'anti-icing'. It may be performed in either one or two steps.'*

Part A in the OM also mentions that, in rain or high humidity conditions, water may form into ice or frost on the surface of an aircraft wing that has been cold soaked below 0ºC.

Thickened fluids

Part A in the OM states that, following application of thickened anti-icing fluid[6] to an aircraft, '*maintenance action stipulated by the manufacturer should be conducted to detect and remove residues within three days*.' This is because some fluid can dry-out in aerodynamically quiet areas and later re-hydrate when the humidity increases. The resultant gel can reduce lift and increase drag or cause flight control restriction if it freezes. Regular inspections and cleaning are recommended[7] and the manufacturer had issued Service Letter No. ATR72-30-6006 which advises when and how this should be done. The Service Letter recommends, when thickened fluids are used, there should be a weekly inspection programme. This aircraft had been treated with thickened fluid once in that winter period, four days before the flight, but no residue inspection was carried out. However, the engineer who inspected the aircraft after the flight saw no evidence of residue on the tailplane.

For several years, the engineering requirement had been to check for residues after an airframe had received 10 applications of thickened fluid. This inspection regime was regarded as appropriate by the operator, because it seldom needed to use thickened fluids, but was at odds with the requirement in Part A of the OM for an inspection within three days of thickened fluid application.

Training

Licensing training

European flight crew licensing regulations require an understanding of the meteorological conditions affecting ice formation to be demonstrated, before pilots gain a commercial flight crew licence. The training syllabus for such licences also encompasses ground de-icing procedures. This includes types of de-icing fluid and how they should be used to ensure an aircraft's aerodynamic surfaces are clear of contamination for takeoff.

Footnote

6 Type II and Type IV fluids are referred to as thickened fluids and are in common use. They have a higher viscosity than Type I fluid, due to the addition of a pseudo-plastic thickening agent.

7 See UK Aeronautical Information Circular 88/2014, '*Recommendations for De-icing/Anti-icing of Aircraft on the Ground'* and Transport Canada publication TP 14052 'Guidelines *for Aircraft Ground – Icing Operations'*.

The ATR 42 and ATR 72 are aircraft variants. Thus, pilots' licences are endorsed with an ATR42/72 type rating on completion of type rating training, and differences courses must be completed when transitioning between the two variants. Each Approved Training Organisation (ATO) must prepare a syllabus for type rating training, in accordance with EASA's flight crew licensing requirements, and include any Training Areas of Special Emphasis (TASE) from the EASA Operational Suitability Data (OSD) report for the type. The TASE for ATR42/72 initial and differences training includes:

> *'Ice detection and management systems and displays*
>
> - *Knowledge of all ice detection including APM*[8] *systems and management of ice protection and prevention, procedural skills managing the consequences of icing;*
> - *Ground icing and effect of improper de-icing on different structural components and flight controls (eleva*tor) '

The pilots had completed type rating training for the ATR 42/72 at the same ATO. The ATO's training manual makes no specific mention of ground icing and the effect of improper de-icing but trainees were referred to a publication produced by the manufacturer, entitled '*Cold Weather Operations'*. This illustrated booklet includes meteorological notes about ice formation and recognition, as well as detailed procedures for ATR ground de-icing and anti-icing, aimed at ensuring clean aerodynamic surfaces for takeoff. The type's de-icing and anti-icing systems are also described in the booklet, along with the associated procedures and appropriate performance considerations for operation in snow and ice.

Operator's training

The operator is required to specify in its OM details of crew conversion training and recurrent training needed to comply with procedures for despatch and flight in icing conditions[9]. Pilot conversion training includes Line Flying Under Supervision (LIFUS), for which Part D in the OM includes a syllabus of topics that must be covered. Ground de-icing procedures are covered in this manner, by way of discussion if necessary.

Part D in the OM also states pilots should receive annual recurrent ground training and that this should include aircraft de-icing/anti-icing procedures and requirements. Consequently, the syllabus for recurrent proficiency checks and associated simulator training incorporates '*Winter Operations*' once per year.

Additionally, the operator distributes a '*Flying Staff Memo*' (FSM) to crews before each winter season, and both pilots had signed to acknowledge having read the FSM '*Winter Awareness 2015'*. This began by recommending that crew read the manufacturer's '*Cold Weather Operations'* booklet, with copies to be requested by any pilot who had not previously received one. The FSM re-iterated pertinent guidance from the OM concerning operation

Footnote

[8] APM stands for Aircraft Performance Monitoring.
[9] Refer to the Associated Means of Compliance for CAT.OP.MPA.255.

in icing conditions and referred pilots to some UK Aeronautical Information Circulars (AICs), including 88/2014 (‘*Recommendations for De-icing/Anti-icing of Aircraft on the Ground’*) and 98/1999 (‘*Turbo-Prop and Other Propeller Driven Aeroplanes: Icing-Induced Stalls*’). The operator stated that it had, in the past, circulated NASA-produced training material[10].

The operator’s expectation was that pilots would spend time on personal study of the recommended material to enhance their knowledge of winter operations. No classroom or computer-based training was provided and individuals’ knowledge levels were only tested within the scope of recurrent simulator/aircraft proficiency checks. When asked, neither pilot recalled having received or being referred to the manufacturer’s booklet.

Human factors

Crew Resource Management (CRM) training

The operator provides initial and recurrent CRM training to all crews and reinforces this during simulator exercises. The aim is to ensure good communication between crew members and to ensure all crew members work towards a common goal with an understanding of what their colleagues are doing. The Part B in the OM guides pilots to use a decision making process to manage abnormal occurrences. This is designed to ensure the crew work closely together to diagnose what has happened, then to generate options that suit the circumstances before deciding what to do. It is stressed that the decisions reached and action taken should constantly be reviewed so as to try and ensure that the best course of action has been taken or to modify it accordingly.

Crew experience

The commander joined this operator in January 2016. He was already in current flying practice on the ATR 42/72 and completed the operator’s conversion training before assuming command duties. This involved classroom, simulator and aircraft training and encompassed the operator’s CRM syllabus, as well as 20 sectors of LIFUS. Winter operations were discussed with a training captain who said the commander demonstrated good knowledge of de-icing/anti-icing procedures and was aware that the operator’s policy was to seek such treatment if there was any uncertainty.

The commander had gained most of his flying experience while based in Guernsey where, due to a mild climate, de-icing/anti-icing is seldom necessary and then usually only after overnight frost. Thus, although he had logged over 8,000 hrs, his experience of operating in freezing precipitation was not extensive.

This was the 30 year old co-pilot’s first airline position and his total flying experience was 920 hours, of which 620 had been flown on the ATR 72 with this operator. He had completed the operator’s CRM and winter operations training but he had no previous experience of flight in snow or of de-icing/anti-icing between flights.

Footnote

10 NASA has an *Icing Branch* and the associated website includes material to help pilots train for flight in icing conditions, http://aircrafticing.grc.nasa.gov/

Cognitive biases

A pilot's decision making can be affected by various cognitive or heuristic biases[11] which can prevent their balanced consideration of all available evidence. Once an initial mental model of a situation is formed, a pilot can be prone to 'confirmation bias'. This can prevent him or her from accepting clear evidence that contradicts their initial understanding. Pilots are equally susceptible to 'optimism bias' which means they only envisage a positive outcome to a problem. It can be the subconscious result of overcoming previous difficulties and means that they tend to believe they are less prone to risk than others.

Previous similar events

Previous events, which shared some similarities with this incident, were reviewed during the investigation.

2003, ATR 72-212, France

In January 2004, France's Bureau d'Enquêtes et d'Analyses (BEA) published a bulletin of air transport incidents, including analysis of a serious incident involving an ATR 72-212 at Paris the previous year[12]. The aircraft was taxiing for departure without having de-iced/anti-iced when it was affected by a snow shower for approximately five minutes. It stopped snowing approximately four minutes before takeoff and the pilots decided the snow was melting and had not settled on the aircraft.

After taking off into icing conditions, a PITCH MISTRIM message was presented at FL 100. A large amount of pilot effort was needed in the nose-down sense to level the aircraft and the pitch trim indicator ran to the fully nose-down position. The aircraft returned to the airfield of departure, with the pilot having to exert excessive nose-down effort on the control column until the airspeed reduced below 130 kt on final approach. An immediate inspection found approximately 0.5 cm of rime ice on the upper surface of the horizontal tailplane and the elevator. It was calculated that this could have added 120 kg to the tailplane and, assuming no ice had formed elsewhere on the airframe, this could potentially have moved the CG aft by 5%[13].

The BEA reported that the pitch trim began to move nose-down as the aircraft started to rotate and was fully nose-down before the flaps were retracted. It stayed in this position until speed was reduced on final approach. The ice on the upper surface of the horizontal tailplane and elevator modified the airflow boundary layer causing the elevator's nose-down pitching force to reduce. The trim tab compensated until it reached full-travel and the pilot then had to exert continuous effort in the nose-down sense to maintain the desired attitude.

Footnote

[11] Academics and psychologists have identified numerous biases which affect human behaviour and actions. Captain Shem Malmquist FRAeS, summarised several biases which may have contributed to aircraft accidents in an internet article written in April 2014 https://airlinesafety.wordpress.com/2014/04/21/the-role-of-cognitive-bias-in-aircraft-accidents/

[12] The BEA bulletin provided anonymity to reporters and consequently the registration and date off the incident are not available but the report can be studied at https://www.bea.aero/fileadmin/documents/ita/pdf/ita.special.givrage.en.pdf

[13] If the CG of G-COBO had moved 5% aft it would have remained within the CG envelope.

VP-BYZ, 2 April 2012, ATR 72-201, Russia[14]

The aircraft was not de-iced/anti-iced and the upper wing and stabiliser surfaces were not inspected. There were sleet showers at the airfield, the air temperature was +2ºC and other departing aircraft did seek de-ice/anti-ice treatment. After takeoff, the pilot used extensive nose-down trim and then, after flap retraction, the aircraft stalled and crashed. An investigation into this fatal crash by the State accident investigation authority concluded the stall was caused by frozen contaminant on the aerodynamic surfaces, due to lack of de-ice/anti-ice treatment.

OY-JRY, 9 November 2007, Norway[15]

This ATR 42 became airborne, without pilot input, before reaching rotation speed. The pilots were unable to prevent the aircraft from pitching-up and the airspeed reducing, with the result that the stick shaker operated. Eventually, control was regained before the aircraft stalled. Prior to takeoff the aircraft had been de-iced and anti-iced but the manufacturer assessed that less fluid was used for anti-icing than usual and that the aircraft's behaviour indicated that the horizontal stabiliser had been '*improperly*' treated with fluid.

Manufacturer's analysis

The manufacturer analysed the FDR data and concluded that the aircraft's abnormal nose-up pitching tendency was consistent with the aerodynamic effects of upper surface icing on the horizontal tailplane. The manufacturer's explanation is summarised as:

Any aerodynamic load on the elevators will induce an elevator hinge moment which has to be balanced by applying an effort on the elevator through the control column or through the autopilot pitch actuator. In normal flight conditions, with a nominal aircraft and no ice contamination, the elevators will be deflected to a certain position to balance the aircraft.

If a downward aerodynamic force is applied to the elevator, the elevator deflection can be maintained by applying effort through the control column or through the autopilot pitch actuator. This effort can be cancelled through a pitch trim input which deflects the elevator trim tab downwards and creates an upward aerodynamic moment of equal magnitude to the downward moment on the elevator. In this condition, the elevator hinge moment resulting from elevator and tab aerodynamic forces is null and there is no residual effort on the control column or on the autopilot actuator (Figure 4).

Footnote

[14] A copy of the Russian State accident report in English is available at https://www.bea.aero/docspa/2012/vp-z120402/pdf/vp-z120402.pdf

[15] See Accident Investigation Board Norway Report SL 2013/03 at https://www.aibn.no/Luftfart/Rapporter/2013-03-eng

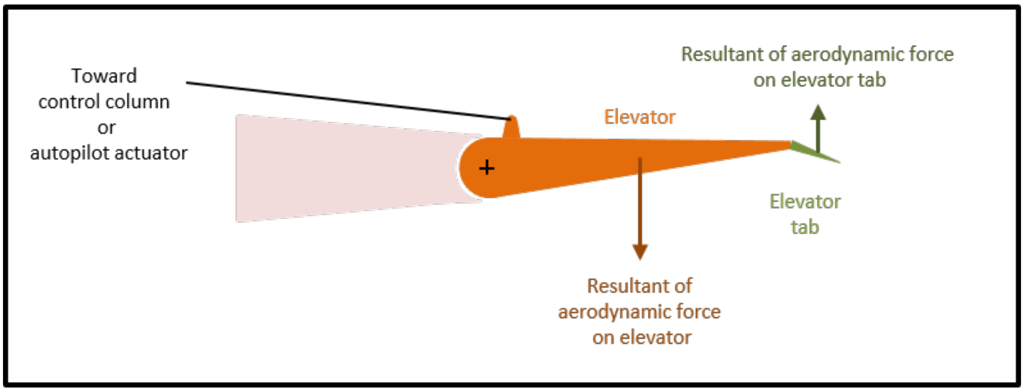

Figure 4

Manufacturer's diagram to illustrate aerodynamic forces in normal flight with pitch trim set

Comparison was made with a similar flight condition, with the elevator deflected the same way, but with ice contamination to the upper surface of the horizontal tailplane, which may also extend over the upper surface of the elevator (and possibly over the elevator tab as well). Numerical aerodynamic simulation, using a two-dimensional cross-section of the horizontal tailplane and elevator assembly, showed that a 5 mm layer of ice on the upper surface thickens the airflow boundary layer. The pressure distribution on the lower surface is virtually unaffected by this but the pressure on the upper surface is reduced. Thus, for a given deflection of the elevator, less downward aerodynamic force will result (Figure 5).

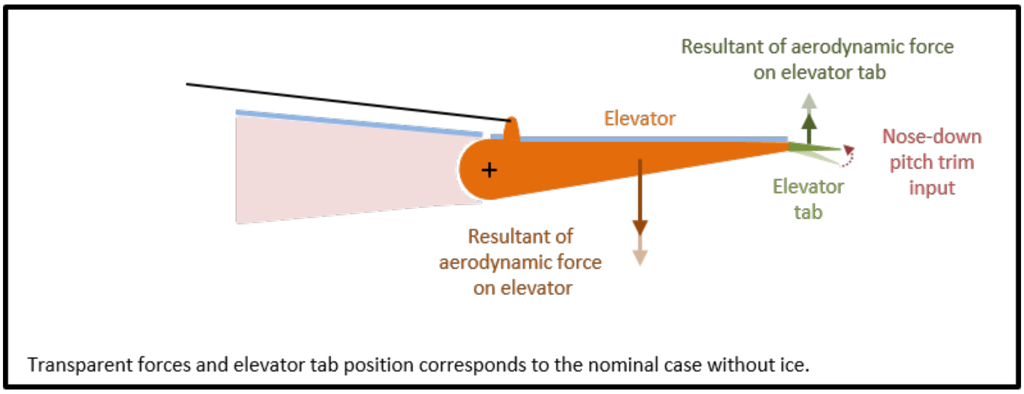

Figure 5

Manufacturer's diagram to illustrate aerodynamic forces with an ice-contaminated upper surface and the pitch trim set to compensate

To compensate, nose-down effort has to be applied through the control column or through the autopilot pitch actuator. This effort can be alleviated with a nose-down pitch trim input, which moves the elevator tab upwards, until autopilot pitch actuator or pitch control column efforts are cancelled, or until the elevator trim reaches its stop.

Simulated icing profile

The manufacturer indicated this event had similarities to the 2003 event at Paris. Following that event, a simulator profile was developed so pilots can experience the effect which ice contamination may cause after takeoff, if the horizontal tailplane has been '*badly de-iced*'. This simulation induces the pitch trim to run to the fully nose-down stop (elevator tab up) before the PITCH MISTRIM message appears on the ADU. As speed increases further, the pilot has to exert progressively more effort in the nose-down sense to maintain the desired attitude.

This profile is incorporated in the ATR 42/72 simulators used by the manufacturer's own ATO and forms part of the manufacturer's approved conversion course. It illustrates one potential repercussion of improper ground de-icing, in accordance with the TASE in the OSD. Pilots are taught to respond by slowing the aircraft to a safe speed, which reduces the nose-down effort needed, and then to descend and land. The profile is not incorporated in all ATR 42/72 simulators worldwide.

Analysis

De-icing/anti-icing

When flying the approach into Manchester in icing conditions, the crew saw little ice accreting on the aircraft. This may have led them to assume ice accretion was unlikely while on the ground. Also, the commander's declaration of the temperature being a little above 0ºC may have reinforced this belief. He told the co-pilot the snow did not appear to be "STICKING" and, before parking, he considered they could probably "GET AWAY WITHOUT DE-ICING".

The commander advised the co-pilot he would "HAVE A GOOD LOOK" during his external inspection but his early pronouncement may have made both pilots susceptible to 'confirmation bias'. From then on, they may have subconsciously tried to make the evidence available to them accord to the commander's original assessment. This was apparent when the commander saw snow on other aircraft and declared it must have accumulated overnight.

Neither pilot seemed to consider the possibility there might be unseen ice on the upper surfaces after landing, nor that the skin temperature would probably have been colder than 0ºC. The large quantity of fuel that was added might have caused the skin temperature of the wings to warm above 0ºC but the tailplane temperature would have remained at or below 0ºC.

Photographs taken on the ground at Manchester showed snow lying on the aircraft but the commander assessed it was not "sticking" and considered that any which remained would "blow off" during takeoff. He could not see all the upper surfaces and did not arrange a '*contamination check*'. However, even without such a check, it was apparent both '*atmospheric icing conditions*' and '*freezing conditions*' existed because the temperature was less than 3ºC, with visible moisture present. These were conditions in which the guidance is to de-ice/anti-ice an aircraft completely and check it afterwards. If the co-pilot had had previous experience of winter operations, he might have questioned the commander's decision not to de-ice/anti-ice.

The decision to depart without being certain the aircraft was free of ice, suggests the crew were affected by 'optimism bias' and only foresaw a positive outcome ie any snow 'blowing off'.

Nose-up pitch

The calculated CG on this flight was further forward than on the previous flight, on which the trim system had operated within the normal range. Therefore, the aircraft's nose-up pitching moment was not due to inappropriate loading. Also, no faults were found after the flight, indicating that there was no control malfunction or technical problem.

Thickened de-icing fluid had been applied to the aircraft four days before the flight. This fluid can dry out in aerodynamically quiet areas and subsequently re-hydrate and cause control restrictions. However, no evidence of fluid residue was found on the external surfaces of the tailplane after the incident and the problem experienced was that increasing effort was needed to push the nose down as the speed increased, rather than there being a control restriction. So the previous application of thickened fluid was not a factor in this serious incident.

The manufacturer's analysis was that the aircraft behaved in a manner consistent with the presence of ice contamination on the upper surface of the horizontal tailplane and the trim tab ran to the end of its nose-down travel while compensating.

It was concluded that the autopilot was disengaged by its internal monitoring circuitry, as a result of the load experienced by the autopilot pitch servomotor, or a manual pitch input.

Once the trim tab reached the stop, the commander had to apply an additional nose-down input on the control column to maintain the desired aircraft attitude. After levelling, he decided he would not be able to maintain the effort needed on the controls for the duration of the cruise, and made a decision to divert to EMA. The co-pilot accepted this because he believed the weather was good at EMA and both of them were familiar with this airport. As the flight progressed the crew realised that icing was the likely cause of their problems.

In the previous incident at Paris in 2003, when the tailplane had not been de-iced, it was possible to estimate the weight of ice that formed and the effect that weight would have had to the CG. It was not possible to estimate the weight of ice that formed on this flight but had it been similar to that in the 2003 incident, the aircraft's CG would have stayed within the CG envelope.

The control problem subsequently dissipated as the aircraft descended into warmer air, suggesting that ice on the tail detached or melted. Hence, no ice was found on the aircraft following its normal landing.

The evidence indicated the horizontal tailplane was affected by ice which formed while the aircraft was on the ground in freezing conditions and was not de-iced/anti-iced. The outcome was uneventful but there is evidence that failure to de-ice/anti-ice adequately could lead to a more serious outcome in certain conditions.

Training

The crew was based in Guernsey, where snow seldom falls and de-icing is seldom necessary. However, the pilots had been trained for conditions like those at Manchester, so a contributory factor in deciding not to de-ice may have been that their training was less effective than it might have been.

Their conversion course syllabus specifically covered ground de-icing and the effect of improper aircraft treatment but this may not have been emphasised sufficiently during the training. Neither pilot had read the manufacturer's '*Cold Weather Operations*' booklet, even though this was referred to during the conversion course and circulated by the operator.

Ground de-icing procedures had been discussed with the commander as part of his recent conversion training and both pilots had acknowledged the operator's extant FSM '*Winter Awareness* 2015'. The operator's recurrent winter training for its pilots relied on their self-study of this FSM and the reference material mentioned, in order to update their understanding of guidance in the OM and elsewhere. No recurrent classroom-based training was provided and the knowledge amassed from this self-study was not tested, other than through participation in recurrent simulator checks, which included a winter operations element.

The manufacturer's ATO includes a scenario for poor de-icing of the tailplane in its conversion course but not all ATR simulators incorporate this profile, which only represents one potential consequence of inadequate ground de-icing.

CRM issues

The co-pilot appears to have been excluded from some of the commander's decision making process. After the loadsheet had been checked for any CG issues, there was no further discussion of possible alternative reasons for the problem. No options were generated before actions were taken and there was no ongoing review of what had happened and what could be done. This was the co-pilot's first diversion during commercial operations and his workload in support of the commander felt very high.

Safety actions

> The ATO responsible for the pilot's type conversion training is adjusting its conversion course to align with the EASA Operational Suitability Data report. This is being achieved by incorporating the manufacturer's simulator profile for a badly de-iced tailplane.

The operator has enhanced its winter awareness training for pilots by purchasing a computer-based training module. All pilots will complete this before each winter season and their knowledge will be tested as part of the process.

The operator's conversion courses are being extended through the inclusion of a ground training day, with a training captain, prior to the start of Line Flying Under Supervision. This is to ensure time is spent discussing, in detail, technical issues relating to line operations. Winter operations and de-icing/anti-icing will be among the topics covered.

The operator provided the co-pilot with additional training before he was allowed to resume line flying duties.

The operator is reviewing its requirements for aircraft inspections following use of thickened de-icing fluids.

The operator intends to provide better guidance for the aftermath of a serious incident by making changes to its Operations Manual (Part A). This is likely to include a recommendation for a group debrief to take place as a matter of course, so the crew can discuss what happened and what they have learnt.

The manufacturer has stated it will contact all operators prior to the start of the next European winter, to promote awareness of the circumstances which led to this serious incident.

Conclusion

The investigation concluded that ice contamination affected the tailplane and caused pitch control difficulty after the aircraft rotated, on departure. The evidence indicated that this would have been avoided if the aircraft had been de-iced/anti-iced and then inspected carefully before flight.

The crew considered, before parking, that de-icing was probably going to be unnecessary. It may then have become difficult for them to change their assessment because of 'confirmation bias', even though they were in freezing conditions and snow was falling. A contributory factor may have been the crew's lack of experience operating aircraft in such conditions.

The commander optimistically thought that lying snow would blow off the aircraft before rotation; an assessment that was flawed and a possible reflection on the training the pilots had received for such winter conditions. The operator has recognised that recurrent winter training for pilots may have been over-reliant on self-study and has taken remedial action.

ACCIDENT

Aircraft Type and Registration:	Westland Scout AH1, G-BYRX
No & Type of Engines:	1 Rolls-Royce Nimbus MK 10501 turboshaft engine
Year of Manufacture:	1966 (Serial no: F9640)
Date & Time (UTC):	29 December 2015 at 1430 hrs
Location:	Near Barn Farm, Ruddington, Nottinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - 1 (Minor)
Nature of Damage:	Helicopter damaged beyond economic repair
Commander's Licence:	Private Pilot's Licence
Commander's Age:	76 years
Commander's Flying Experience:	1,444 hours (of which 380 were on type) Last 90 days - 44 hours Last 28 days - 1 hour
Information Source:	AAIB Field investigation

Synopsis

While hover taxiing for takeoff, the pilot reported that the helicopter suddenly pitched nose-up and as he was unable to regain control he lowered the collective allowing the aircraft to descend to the ground where it rolled onto its side. The investigation was unable to establish the reason for the loss of control, but it is possible that there was a restriction in one of the flying control servo-jack control valves leading to higher control forces required to control the helicopter in the hover.

History of the flight

The pilot reported that the wind was approximately 11 kt and the helicopter lifted into the hover as normal. After hover taxiing for approximately 150 m, with the wind from the right, the pilot started to experience difficulty in controlling the helicopter and attempted to yaw to the left in order to position into wind. However, the helicopter did not appear to respond to the control inputs and instead the nose rose to 45-60º above the horizon and the cyclic stick became "solid" in the aft position. The pilot instinctively lowered the collective, which resulted in the aircraft descending until the tail struck the ground and the helicopter rolled onto its right side (Figure 1). The pilot reported that the engine remained running and the centralised warning system gave no indication that a hydraulic failure had occurred. He also stated that he felt no unusual vibrations through the airframe or controls either before or during the event.

Figure 1
Position of helicopter after the accident

Helicopter description

General

G-BYRX is an ex-military helicopter that is fitted with a gas turbine engine, a four-bladed main rotor and two-bladed tail rotor. Flying controls were provided at both front seat positions.

Flying controls

The helicopter is equipped with a collective lever and cyclic stick which control the main rotor, and two sets of yaw pedals which control the tail rotor. The main rotor controls are servo-assisted by hydraulic power and the cyclic stick is provided with electrically-operated trimmers. Movement of the collective lever and cyclic stick is transmitted through a series of pitch rods and bellcrank assemblies to the control spider, which controls the pitch angle of each main rotor blade (Figure 2).

Servo-jacks

Three hydraulic servo-jacks, one for the collective and two for the cyclic control, are mounted at the base of the main rotor gear box. Each of the servo-jacks incorporate a control valve which is connected to the relevant control rod.

With hydraulic pressure available, initial movement of the control rod opens the control valve allowing hydraulic fluid to enter and exit the appropriate sides of the jack piston. This causes the jack body to move until the valve reaches an equilibrium position and closes.

If there is no hydraulic pressure available at the servo-jack, initial movement of the control rod still opens the control valve but the jack body does not move. Instead, further movement of the control rod will move the spider assembly, with the jack body following the movement of the control rod.

A POWER CONTROL - MANUAL/POWER guarded switch mounted on the collective lever controls a hydraulic selector valve that enables hydraulic fluid to be shut off from the servo-jacks.

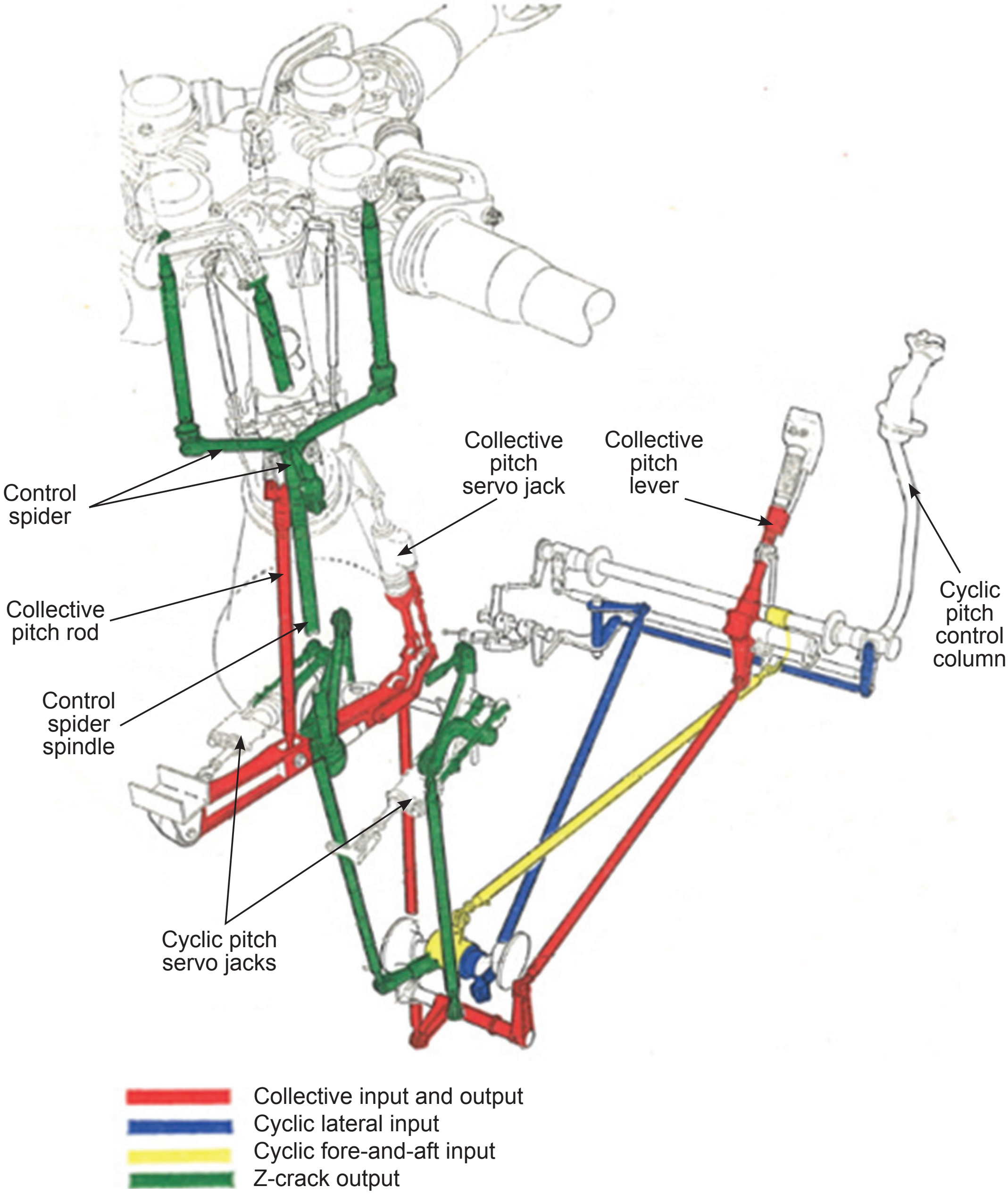

Figure 2

Scout main rotor control system

Hydraulic system

The hydraulic system uses mineral oil and operates at a pressure of 775 to 1050 (±25) psi. The system comprises a power pack, a hydraulic pump mounted on, and driven by, the main rotor gearbox, and three servo-jacks that are coupled to the main rotor control rods (Figure 3).

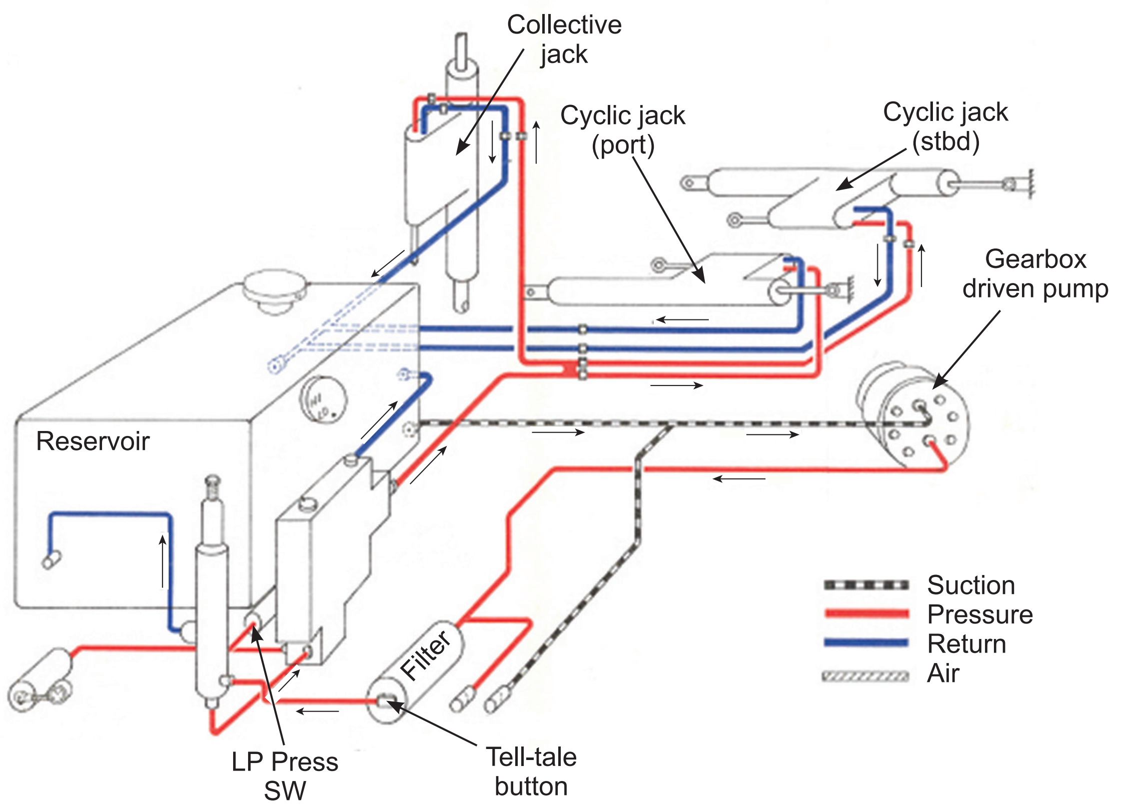

Figure 3
Hydraulic system

The power pack includes a reservoir with a capacity of 5.2 pints of oil; a high-pressure filter fitted with a tell-tale button, which protrudes when the filter begins to clog; an accumulator that is charged with air or nitrogen to 400 psi; and a power / manual selector valve which enables hydraulic fluid to be diverted from the servo-jacks and returned to the reservoir, thereby allowing full manual control.

In comparison to flying the helicopter with power control, manual control requires the pilot to apply significantly more force to move the flying controls.

Centralised warning system

G-BYRX is equipped with a centralised warning system consisting of two attention lamps and an indicator unit containing eight warning captions. A pressure switch in the hydraulic pack operates when the hydraulic pressure falls below 660 ± 60 psi, causing the HYD caption to illuminate.

Helicopter handling characteristics

The aircrew manual[1] for the Scout makes the following statements about flying in manual control:

> *'The cyclic stick forces are light with powered controls selected…on reversion to manual control the collective lever is difficult to move in either direction; yaw control is unaffected. At low forward speeds the aircraft tends to pitch nose up; at speed above 60 knots the aircraft may pitch nose up or nose down but the force required to overcome either condition should not exceed 10 lb.'*

Examination by the AAIB

The AAIB undertook a brief visual examination of the helicopter at the pilot's farm complex after it had been recovered it from the accident site.

The damage to the helicopter was consistent with the pilot's account of it having landed heavily on its tail before coming to rest on its right side. The tail boom and skids had broken away, and the main and tail rotor blades had been destroyed. The damage to the tail rotor assembly and main rotor system dynamic components was consistent with the rotor being driven under power when the main rotor blades struck the ground.

The main rotor control system was examined as far as possible. The control rods were correctly connected and there was no evidence of a control restriction having occurred. The collective control was free to move through its full range. The cyclic control was in the fully aft position and with some force could be moved left and right; however, due to distortion of the airframe, it could not be moved forward from the fully aft position. The control rods to the main rotor were disconnected at the servo-jacks and it was possible to move the cyclic control throughout its full range of travel. The control rods at the servo jacks were manually operated and the servo jacks and the spider operated through their full range of travel,

The hydraulic pack was intact, the accumulator pressure, with the hydraulic pressure dissipated read just over 400 psi and the tell-tale button on the filter had not operated. There was heavy staining on the hydraulic reservoir contents sight glass up to the 'HI' mark; however the level of the fluid was at the bottom of the sight glass. There was no evidence of a hydraulic leak from any of the components. The pilot advised that the fluid was at the correct level prior to the flight and that fluid had leaked out when the helicopter rolled onto its side.

Detailed examination of the helicopter

The helicopter was recovered to the AAIB where a detailed examination of the main rotor control system was carried out. The controls all moved through their full range of travel and there was no evidence of a control restriction having occurred.

Footnote

[1] Scout AH Mk1 Aircrew Manual AP 101C-0701-15 (2nd edition),Part 3, Chapter 2 – Handling in flight.

A hydraulic fluid sample (220 ml) was taken from the pressure pipe at the collective servo-jack. The sample was a dull red colour and there was no visible sign of suspended material.

The hydraulic pump was rotated using an electric drill and the pressure on the gauge read 900 psi. The control input linkages were manually operated and all three servo-jacks operated normally. The hydraulic reservoir was replenished with fresh hydraulic fluid and the tests were repeated. Apart from an occasional drip from the right cyclic servo valve, there was no evidence of a hydraulic leak from any part of the hydraulic system. The pressure in the accumulator was reduced and the pressure switch operated at approximately 650 psi.

The hydraulic system was removed from the helicopter intact and along with the hydraulic fluid sample was sent to 1710 Naval Air Squadron, Material Investigation Group for further analysis.

Detailed examination of servo jacks

A detailed examination of the servo-jacks carried out by 1710 Naval Air Squadron established that there was:

- Evidence of a build-up of fine black coloured deposits within all three servo jacks
- Longitudinal wear marks on the large pistons in two of the jacks, possibly caused as a result of wear and a slight misalignment between the piston and cylinder
- Light oxidisation (surface corrosion) on the servo valve control valves; however the location and extent of the oxidisation would not have affected the operation of the servo control valves
- No evidence of a blockage of the servo control valves

Analysis of hydraulic fluid

Analysis of the hydraulic fluid determined that it was of the correct grade and the physical properties such as density and total water content were within the expected parameters. Elemental analysis did not indicate any anomalous wear conditions or elevated levels of barium[2]. Gas chromatography highlighted degradation of the hydraulic fluid, but in the opinion of the laboratory it was not sufficient to degrade the oil to a level where it was not capable of operating.

Debris was found in the hydraulic filter; however it was considered to be normal for the age of the filter.

Footnote

2 In 1710 NAS experience, elevated levels of barium can cause formation of aggregates within the hydraulic fluid which form 'sticky' residues. The fluid itself is not specifically degraded, but the residues can result in problems within the system.

Approval basis

G-BYRX was granted approval[3] on 11 February 2000 by the Civil Aviation Authority (CAA) for G-BYRX to operate on a National Permit to Fly based on the provisions of BCAR Chapter A3-7, paragraph 3.1(d)[4]. In the Airworthiness Approval Note (AAN), the CAA agreed a maintenance policy based on the existing military maintenance schedule[5] with the addition of calendar limitations to the servicing check intervals.

Paragraph 4.8 of the AAN states:

> *'Flying Controls*
> *In the event of a hydraulic system failure full manual mechanical control is available.'*

The validity for the Permit to Fly was last issued by the CAA on 5 November 2015 and was valid until 6 November 2016.

Maintenance

Hours flown on civil register

The maintenance records show that since January 2001 the helicopter had flown approximately 310 hours and since 24 October 2004 had flown 210 hours, flying between 11 and 26 hours per year.

Check flight

The last check flight was carried out on 24 October 2015 using the CAA check flight schedule 'CFS 289, Issue 3.' The pilot reported that the performance was *'SATIS'* and commented *'a smooth and well looked after aircraft.'*

Scheduled maintenance

The helicopter was maintained on its previous military Basic Servicing Schedule, which consisted of five servicing periods identified as B1 to B5. The servicing intervals were

B1 inspection: 25 flying hours.
B2 inspection: 75 flying hours.
B3 inspection: 150 flying hours, with a 24 month calendar backstop.
B4 inspection: 300 flying hours, with a 48 month calendar backstop.
B5 inspection: 600 flying hours, with a 48 months calendar backstop.

The last scheduled maintenance, a B2 inspection, was completed on 2 October 2015 at 5,676.50 flying hours. No significant faults were identified during the maintenance.

Footnote

[3] Airworthiness Approval Note No 27163 Addendum 1.
[4] Applicable to ex-military origin helicopters.
[5] AP101C-0701-5A1 (Master Servicing Schedule).

Maintenance of hydraulic components

The component log cards and aircraft records show that the hydraulic filter has a life of 900 flying hours and the servo-jacks have a life of 3,600 flying hours. The dates that these components were fitted to the helicopter and the life used at the time of the accident are shown in Table 1. There was no requirement in the maintenance documents for the hydraulic fluid to be regularly tested and there was no calendar life for the overhaul or testing of the servo-jacks.

Component	Life of component	Date repaired / tested	Date installed	Life used at installation	Total Life used
Hydraulic filter	900 hours	N/A	14/10/03	0 hours	228 hours
Servo Jack (Port)	3,600 hours	8/8/83	12/10/90	544.7 hours	1,655 hours
Servo Jack (Starboard)	3,600 hours	15/1/86	12/10/86	1,497.6 hours	3,278 hours
Servo Jack (Collective)	3,600 hours	7/6/86	7/11/86	0 hours	1,745 hours

Table 1

Life and usage data for the hydraulic filter and servo jacks

Analysis

The damage to the helicopter was consistent with the pilot's account that the helicopter descended tail first to the ground while the engine was running. The investigation could not identify any evidence that a mechanical restriction of the flying controls had occurred and the hydraulic and warning system all operated normally after the accident.

Immediately after the accident, the fluid level in the hydraulic reservoir was found to be below the minimum mark, which the pilot explained was a result of the fluid leaking out of the reservoir when the helicopter rolled onto its side. The pilot also reported that the Power Control Switch was in the POWER position and the HYD caption had not illuminated during the flight. Therefore, there should have been sufficient pressure to operate the flying control servo-jacks.

It is possible that there was a temporary restriction of a servo-jack because of debris blocking a servo control valve. Such a restriction could have led to the loss of control as it would have been disorienting and challenging for the pilot with the increased control forces required while operating at low level in the hover.

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.

SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A319-111, G-EZFX
No & Type of Engines:	2 CFM CFM56-5B5/3 turbofan engines
Year of Manufacture:	2010 (Serial no: 4385)
Date & Time (UTC):	1 October 2016 at 1415 hrs
Location:	On approach to London Gatwick Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 6 Passengers - 105
Injuries:	Crew - None Passengers - None
Nature of Damage:	None reported
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	36 years
Commander's Flying Experience:	5,312 hours (of which 5,011 were on type) Last 90 days - 217 hours Last 28 days - 49 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

G-EZFX was operating a flight from La Rochelle Airport in France to London Gatwick Airport with 105 passengers and six crew on board. During the climb after takeoff the crew noticed some vibration which ceased after a few minutes. The vibration returned intermittently during the flight until, while the aircraft was holding at FL120 before making an approach to Gatwick Airport, it occurred accompanied by a strong burning smell (which went away quickly). The vibration and smell occurred again a few minutes later, so the crew donned their oxygen masks, declared a PAN and asked for an immediate landing. The smell ceased during the approach.

The operator reported that the vibration and smell were caused by a bearing failure in the avionics bay extractor fan. A program to overhaul the fans was already in place for units with more than 20,000 flying hours but the unit in this incident failed after 19,363 hours.

The operator also reported that the manufacturers of the fan and the aircraft were developing a new fan design which would include a vibration monitoring unit to shut down the fan prior to bearing failure.

INCIDENT

Aircraft Type and Registration:	Reims Cessna F406 Caravan II, G-FIND
No & Type of Engines:	2 Pratt & Whitney Canada PT6A-112 turboprop engines
Year of Manufacture:	1989 (Serial no: 0045)
Date & Time (UTC):	25 September 2016 at 1540 hrs
Location:	En route cruise
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	None notified
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	15,000 hours (of which 389 were on type) Last 90 days - 87 hours Last 28 days - 13 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and information supplied by the aircraft operator

Synopsis

While in cruising flight with the autopilot engaged, the aircraft suddenly pitched nose down. The handling pilot had difficulty controlling the aircraft until the autopilot was disengaged and the pitch trim, which had run significantly nose down, was returned to a normal setting. The autopilot was not re-engaged and the aircraft landed without further incident.

History of the flight

On the day of the incident, the aircraft was flying a series of four training flights for the purpose of conducting Proficiency Checks on two company pilots. On board were the aircraft commander, who was the examining pilot, and the two pilots undergoing check. Between flights, the occupants changed seats as necessary to meet the check requirements.

While carrying out control checks before takeoff on the second of the series of flights, the crew noticed that the pitch trim wheel operated and the pitch trim ran forward (nose down sense). The crew were unsure if the movement, which appeared to be in three separate bursts, had been the result of inadvertent operation of the electric trim switch during the control checks. They therefore repeated the control checks three times before takeoff while monitoring the pitch trim, with no movement or other unusual indications evident. The aircraft then completed the second and third flights without incident.

The fourth flight originated at Coventry Airport and was to include a visual circuit at Coventry with one engine simulated inoperative. This was to be followed by restoration of normal engine power and a transit to East Midlands Airport (where the aircraft was based), where the proficiency check profile would be completed. The pilot under check occupied the right hand seat for the flight.

Following the circuit at Coventry, the aircraft started a climb to 3,000 ft for the transit. The autopilot was engaged at 1,500 ft but, on passing 2,500 ft, it disconnected, accompanied by associated audio and visual warnings. The climb to 3,000 ft was completed manually and the autopilot re-engaged once in stable, cruise flight. It was engaged in 'HEADING' and 'ALTITUDE HOLD' modes.

As the aircraft neared East Midlands, the aircraft suddenly pitched nose-down. The handling pilot reported that he immediately tried to correct the nose down pitch by pulling back on his control wheel and pressing the autopilot disconnect button mounted on it. Neither pilot heard an aural warning that would have indicated that the autopilot had disengaged, and increasing back pressure was required on the control wheel as the aircraft continued to pitch nose down. The handling pilot therefore reached across and operated the disconnect button on the left control wheel and also set the autopilot master switch on the main instrument panel to OFF. Again, neither pilot recalled hearing the autopilot disconnect aural warning.

The aircraft was by this stage in a 10º nose-down pitch attitude with increasing airspeed. The handling pilot placed both hands on the control wheel and commented that he was having difficulty flying the aircraft. The commander noticed an abnormally forward pitch trim indication, so manually reset the trim to the takeoff setting (between one and a half and two revolutions of the pitch trim wheel were required). This allowed the handling pilot to fly the aircraft normally while making his own manual pitch trim inputs. Neither pilot had noticed the pitch trim in motion before or during the incident. The remainder of the flight was flown manually without further incident.

Previous occurrences

G-FIND, 6 September 2007 (AAIB Bulletin 6/2008)

G-FIND was involved in an earlier incident which bore some similarities with this incident and which was the subject of an AAIB field investigation. In that incident, which also occurred during a crew training flight, control restrictions were encountered. Although the technical investigation was inconclusive, it was considered likely that an accidental and undiagnosed autopilot engagement had occurred during what was intended to be manual flight.

G-TWIG, 22 October 2004 (AAIB Bulletin 7/2006)

In this fatal accident, G-TWIG deviated suddenly from controlled flight and struck the ground in a steep dive and at high speed. There was extreme fragmentation of the wreckage and, although major airframe and power plant failures were discounted, there was insufficient evidence to draw firm conclusions about the reasons for the accident.

The investigation included a detailed examination of pitch trim system components, and concluded that the trim setting at the time of the accident equated to an almost fully nose down trim condition. The investigation could not discount the possibility of an electric trim malfunction, although flight tests carried out as part of the investigation indicated that the control forces associated with such a nose-down trim condition *'could be overcome with little difficulty'*.

The investigation also considered the possibility of an autopilot malfunction. Specifically, a spurious nose down input followed by failure of a safety system which was intended to disengage the autopilot if the nose-down pitch angle exceeded 21°. It was determined that the control forces to counter to failure may have been significant, but that the expected response would have been to switch off the autopilot and manually re-trim the aircraft.

Action by the aircraft operator

The Air Data Computer and Autoflight Computer were removed from G-FIND and replacement units installed. The operator did not intend to refit the original units, but they were returned to the manufacturer for strip down and fault diagnosis. At the time of writing, the operator was awaiting reports on this work.

As a result of the G-FIND incident of September 2007, the aircraft operator contracted an approved design organisation to develop an autopilot system modification. The modification introduced a prominent autopilot disconnect switch and warning light, allowing a pilot to isolate the autopilot servos and trim actuator to quickly establish manual flight if necessary.

The switch introduced by the modification had been used successfully in the incident of 25 September 2016. As a result, three newly acquired F406 aircraft were being similarly equipped at the time of writing.

ACCIDENT

Aircraft Type and Registration:	Cessna F177RG Cardinal RG, G-TOTO
No & Type of Engines:	1 Lycoming IO-360-A1B6 piston engine
Year of Manufacture:	1972 (Serial no: 0049)
Date & Time (UTC):	14 December 2016 at 1535 hrs
Location:	Denham Aerodrome, Buckinghamshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to propeller, engine and fuselage
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	8,850 hours (of which 17 were on type) Last 90 days - 120 hours Last 28 days - 33 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The commander was conducting a revalidation of the handling pilot's SEP class rating. As part of this training flight, a flapless circuit to Runway 24 was flown and the handling pilot raised the landing gear on the crosswind leg, just prior to turning downwind. The commander reported that raising the landing gear was not standard procedure in the aircraft when flying circuits, and that she intended to tell the handing pilot to lower it once the gear had finished travelling.

A protracted period of radio communication from two aircraft ahead of G-TOTO in the circuit distracted the handling pilot from lowering the landing gear, and the commander from noticing that it had not been lowered. Further distraction was caused by an aircraft joining the circuit overhead, and consequently the landing gear was not lowered as part of the downwind checks. The commander reported that the low sun angle and attention to trees on the flapless approach demanded greater attention than normal, and the landing was completed without selecting the landing gear DOWN.

After the aircraft was recovered, a maintenance inspection revealed that the landing gear warning horn was not working.

ACCIDENT

Aircraft Type and Registration:	Colomban MC-15 Cri-Cri, G-CRIK
No & Type of Engines:	2 Solo Kleinmotoren Gmbh 210D piston engines
Year of Manufacture:	2014 (Serial no: PFA 133-13289)
Date & Time (UTC):	13 September 2016 at 15:40 hrs
Location:	Popham Airfield, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Starboard aileron buckled and canopy damaged
Commander's Licence:	Private Pilot's Licence
Commander's Age:	32 years
Commander's Flying Experience:	284 hours (of which 3 were on type) Last 90 days - 1 hour Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot had altered the mixture setting on each engine's carburettor and decided to carry out a short flight to check the adjustments. The weather was good, with a light wind, CAVOK, OAT 29°C, dew point 16°C and a QNH of 1008 hPa. He flew a circuit from Runway 03 during which both engines seemed to run normally. He then turned the aircraft onto final approach and lowered landing flap, whilst still retaining a moderate power setting. At a speed of approximately 60 KIAS and at a height of 400 to 500 ft agl, he closed one throttle followed by the second. As he closed the second throttle, the first engine stopped. He started to advance the throttle of the live engine but this also stopped. The nose pitched down and he established a glide approach. During the flare, at about two feet, the right wing dropped and the aircraft sank onto the grass surface, landing heavily. During the touchdown, the pilot's head struck the canopy but he was uninjured.

The pilot considered that the engines had stopped due to the adjustment of the mixture controls on both carburettors, giving excessively lean conditions at low rpm whilst in flight.

ACCIDENT

Aircraft Type and Registration:	Eurocopter AS350B2 Ecureuil, G-VGMG
No & Type of Engines:	1 Turbomeca Arriel 1D1 turboshaft engine
Year of Manufacture:	1992 (Serial no: 2668)
Date & Time (UTC):	11 July 2016 at 1642 hrs
Location:	Lake Farm, Old Race Course, Bideford, Devon
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Tail boom failed and damage to skids and vertical tail
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	6,461 hours (of which 2,189 were on type) Last 90 days - 49 hours Last 28 days - 21 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

During a practice hydraulics-off landing the handling pilot inadvertently tried to land downwind and then pitched up and slowed excessively when he realised this. The helicopter started to yaw so the commander, who was the examiner, took control but experienced a brief freezing of the cyclic, collective and pedals. The helicopter hit the ground heavily, nose down, on the front part of the skids, the tailboom failed and the main rotor struck the vertical fin. The cause of the control freeze could not be identified.

History of the flight

The commander of the flight was an examiner in the left seat and was carrying out an operational proficiency check of a pilot in the right seat (P2 pilot). After a normal departure a practice hydraulic failure was carried out. The examiner initiated this by pressing the 'HYD TEST' pushbutton on the centre console. This causes hydraulic pressure from the pump to be re-circulated to the reservoir and the 'HYD' warning caption to illuminate with associated warning horn. The cyclic and collective controls remain powered via hydraulic accumulators for a sufficient time to allow the helicopter to be decelerated to a safe speed, while pressure to the accumulator of the tail rotor control load compensator is relieved. The P2 pilot carried out the appropriate procedure and reduced the airspeed to below 60 kt. The examiner then deselected 'HYD TEST' to re-pressurise the hydraulic system. The P2 pilot then performed the second part of the test and pressed the 'HYD CUT-OFF' switch on the collective. This removes hydraulic pressure and accumulator pressure to the cyclic and collective controls, resulting in higher control forces on both the cyclic and collective. The accumulator of the tail rotor control load compensator remains pressurised and will provide continuing pilot load assistance as a function of pedal position.

The examiner confirmed verbally with the P2 pilot that the increased forces were higher than normal and the flight was continued for a 'hydraulics off' landing. As the approach was initiated to the field the examiner was aware that they were approaching to land downwind. The wind was about 10 kt from the west. He prompted the P2 pilot about this and was expecting him to perform a go-around as they were at about 20 to 30 ft agl. However, the P2 pilot responded by pulling back rapidly on the cyclic, causing a pitch-up and for the airspeed to drop below about 20 kt. This induced a yaw to the left so the examiner immediately took control, applied right pedal to counteract the turn and pushed the cyclic forward to correct the excessive nose-up attitude. He recalled that he struggled with the controls and later estimated that the cyclic, collective and pedals had frozen for about 1 to 1.5 seconds. The helicopter continued to yaw left and descended, causing the left skid to lightly touch the ground. According to the examiner the "rotors became extremely violent and almost uncontrollable". Then the right skid lightly touched the ground and the helicopter lurched to the left. The examiner applied right pedal and right cyclic, causing the helicopter to "lurch" 90° to the right and "plunge" to the ground in a slightly nose-down attitude. The helicopter came to a stop with its nose resting on the ground. A rapid shut-down and disembarkation were carried out.

The tailboom had failed below the engine exhaust pipe and was hanging downwards. Only two hydraulic pipes were keeping the tailboom attached to the helicopter. The main rotor blades had struck the top of the vertical fin, although there was no apparent damage to the tail skid at the base of the vertical fin. The skids had fractured at the front cross tube attachment. The ELT had activated automatically and the emergency services made contact but were stood down.

Additional information

No fault investigation was carried out on G-VGMG because the damage to the helicopter was assessed to be beyond economic repair.

The commander had not been expecting the P2 pilot to pitch the helicopter up so suddenly when the P2 pilot realised that they were landing downwind. The commander took control immediately, but the brief apparent freezing of the controls (cyclic, collective and pedals) reduced his ability to bring the helicopter back under control. The commander did not think that the helicopter had suffered any technical fault, and he had experienced a brief freezing of the controls before, but at a greater height so it was not an issue. He did not think that the P2 pilot was resisting him on the controls.

The cyclic/collective control system and the pedal control system are independent, and according to the helicopter manufacturer the probability of having simultaneous freezing of both is "extremely improbable".

The AS350B2 flight manual highlights the following with a caution:

> *'Do not attempt to carry out hydraulic failure hover flight or any low speed maneuver without hydraulic pressure assistance. The intensity and direction of the control feedback forces will change rapidly. This will result in excessive pilot workload, poor aircraft control, and possible loss of control.'*

The accident investigation bureau of France (BEA) and the helicopter manufacturer commented that they were investigating a separate occurrence involving an AS350B3e helicopter. There were two instructor pilots on board and they were carrying out a training flight including practice hydraulic failures. The pilots reported stiff controls (cyclic, collective and pedals) during the hydraulic failure training and even after hydraulic assistance was reapplied. The pilots stated that they had not been on the controls at the same time when the event started. However, this helicopter was fitted with a camera which revealed that both pilots were on the controls at the beginning of the event and their inputs were probably counteracting each other.

It cannot be ascertained whether or not a similar interaction to that in the BEA's investigation took place in G-VGMG.

ACCIDENT

Aircraft Type and Registration:	Piper PA-22-150 Tri-Pacer, N6830B	
No & Type of Engines:	1 Lycoming O-320 piston engine	
Year of Manufacture:	1956 (s/n 22-4128)	
Date & Time (UTC):	5 August 2016 at 1131 hrs	
Location:	Wyke Oliver Farm, Weymouth, Dorset	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 2
Injuries:	Crew - 1 (Minor)	Passengers - 2 (Minor)
Nature of Damage:	Extensive	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	51 years	
Commander's Flying Experience:	288 hours (of which 59 were on type) Last 90 days - 7 hours Last 28 days - 2 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot reported that while in the cruise at approximately 1,700 ft amsl he selected the carburettor heat ON and the engine lost power (decreasing from 2,300 to 1,500 rpm). Selecting the carburettor heat OFF had no effect so he reselected it ON. He moved the throttle lever backwards and forwards and selected a different fuel tank but neither action restored power. He transmitted a distress call to Yeovilton Radar and then concentrated on landing in a suitable field.

The aircraft touched down in the pilot's chosen field at 60 mph but bounced back into the air when it ran over a bump. It touched down again and the pilot began to brake but he was unable to bring the aircraft to a halt before it struck an obstacle and turned onto its back. The three occupants vacated the aircraft through the normal exits.

It was not determined why the engine lost power.

ACCIDENT

Aircraft Type and Registration:	Piper PA-32R-300 Cherokee Lance, G-BDWP	
No & Type of Engines:	1 Lycoming IO-540-K1G5D piston engine	
Year of Manufacture:	1976 (Serial no: 32R-7680176)	
Date & Time (UTC):	11 September 2016 at 2020 hrs	
Location:	Bagby (Thirsk) Airfield, Yorkshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Propeller, engine, cowl, left wing, left landing gear and nose landing gear	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	60 years	
Commander's Flying Experience:	2,299 hours (of which 1,901 were on type) Last 90 days - 29 hours Last 28 days - 11 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot was on the approach, with a slight tailwind, to Runway 06 when he realised he was too low. He applied power but touched down in the field short of the threshold. The field and transition to the runway were not smooth, resulting in significant aircraft damage. The pilot was uninjured.

He stated that he was distracted trying to make contact with another aircraft which he believed was intending to taxi across the runway. He later found that the other pilot was aware of him and had stopped clear of the runway, but was temporarily out of radio contact.

Runway 06 has a 2.6% upslope which can create the visual illusion of being higher on the approach than is actually the case and lead to a low approach. The airfield information notes that, in light winds, pilots tend to use the upslope for landing and the downslope of the reciprocal, Runway 24, for takeoff.

The landing was at night and the pilot observed that the runway edge lighting was good but lacked threshold lighting which might have been helpful. However, the airfield is unlicensed and CAA Publication CAP 793 - *'Safe Operating Practices at Unlicensed Aerodromes'* recommends the use of threshold lighting but there is no requirement to do so.

ACCIDENT

Aircraft Type and Registration:	Robinson R66, N166MG	
No & Type of Engines:	1 Rolls-Royce 250-C300/A1 turboshaft engine	
Year of Manufacture:	2016 (s/n 0694)	
Date & Time (UTC):	15 August 2016 at 1215 hrs	
Location:	Private site, Stowe, Buckinghamshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 2
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Collapsed skids and minor distortion to several body panels	
Commander's Licence:	Commercial Pilot's Licence	
Commander's Age:	47 years	
Commander's Flying Experience:	2,437 hours (of which 54 were on type) Last 90 days - 47 hours Last 28 days - 17 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot reported that he was landing at a private site that he had visited previously. The weather was CAVOK with wind from 090° at 5 kt.

Having approached the site from the south-south-west the pilot landed the helicopter on a relatively flat area above a slope, with the rear of the helicopter's skids over the edge of the slope. As the helicopter settled it pitched nose-up. The pilot responded by simultaneously raising the collective and pushed forward on the cyclic. This caused the helicopter to lift and roll left. The pilot lowered the collective to avoid colliding with trees surrounding the site. The helicopter subsequently landed firmly, resulting in the front of the skids collapsing and minor distortion to several fuselage panels.

The pilot stated that he had misjudged the position of the slope and may have over-reacted to the initial pitch-up.

ACCIDENT

Aircraft Type and Registration:	Denney Kitfox Mk 2, G-BSUZ
No & Type of Engines:	1 Rotax 582 piston engine
Year of Manufacture:	1990 (Serial no: PFA 172-11875)
Date & Time (UTC):	12 September 2016 at 1500 hrs
Location:	Brimpton Airfield, Berkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Substantial
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	68 years
Commander's Flying Experience:	123 hours (of which 13 were on type) Last 90 days - 14 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that, after a normal approach to Runway 25 at Brimpton Airfield, the aircraft bounced on landing, porpoised and overturned. Both occupants were able to leave the aircraft via its doors. Having recently purchased the aircraft, the pilot was undertaking conversion training with an instructor.

ACCIDENT

Aircraft Type and Registration:	Flight Design CTSW, G-OMSA	
No & Type of Engines:	1 Rotax 912ULS piston engine	
Year of Manufacture:	2009 (Serial no: 8501)	
Date & Time (UTC):	1 September 2016 at 1400 hrs	
Location:	Damyns Hall Aerodrome, Essex	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Damage to landing gear, tail, propeller, fuselage, and right wing; windscreens broken	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	70 years	
Commander's Flying Experience:	134 hours (of which 134 were on type) Last 90 days - 5 hours Last 28 days - 2 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The weather was CAVOK with 5 kt of wind along Runway 21, which has a grass surface. The pilot had 134 hours flying time, all on the accident type, of which 33 hours were in command. The pilot's report stated that he crossed the threshold at 60 KIAS and that at the flare the aircraft struck the runway hard and the nose dug in, causing it to pitch over onto its back. He exited the aircraft unaided and uninjured, and there was no fire. The pilot commented that he later noticed a deep rut in the runway, but did not know whether it had been made during the accident or was there previously. He was unsure of the cause of the crash.

ACCIDENT

Aircraft Type and Registration:	Mainair Blade, G-MYVY
No & Type of Engines:	1 Rotax 582-2V piston engine
Year of Manufacture:	1995 (Serial no: 1033-0495-7-W831)
Date & Time (UTC):	18 September 2016 at 1330 hrs
Location:	Hawksview Airfield, Warrington
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	54 years
Commander's Flying Experience:	121 hours (all on type) Last 90 days - 16 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot reported that he was approaching Runway 08 at the airfield with a wind from 090° at 7-8 kt, 10 km visibility, a temperature of 15°C and FEW clouds at approximately 1,500 ft agl. After the aircraft passed over buildings which lie immediately to the west of the runway, the pilot reduced power for landing. At the same time, he noticed that the windsock was showing the wind backing to blow across the runway from the north. He did not remember what happened next except that the aircraft crashed onto the runway. Later, he assessed that the aircraft stalled on the final approach.

ACCIDENT

Aircraft Type and Registration:	P & M Aviation QuikR, G-CHUX
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2012 (Serial no: 8643)
Date & Time (UTC):	1 September 2016 at 1815 hrs
Location:	Hawksview Airfield, Stretton, Cheshire
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Minor) Passengers - N/A
Nature of Damage:	Extensive damage to the glassfibre pod, wing spar buckled
Commander's Licence:	Student pilot
Commander's Age:	61 years
Commander's Flying Experience:	45 hours (all on type) Last 90 days - 19 hours Last 28 days - 10 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After arriving overhead the airfield the pilot checked the windsock but misread the wind direction. As a result he planned to land on Runway 08, instead of 26. He conducted a go-around off the first approach and, on the second attempt, landed a long way into the runway, bounced and then veered to the right before colliding with a fence to the right of the runway.

History of the flight

The aircraft departed Arclid airfield near Sandbach, Cheshire, after the pilot had been authorised by his instructor for a solo cross-country training flight. He arrived overhead Hawksview Airfield, near Warrington, approximately 20 minutes later. The pilot expected the wind to be from the west but, after checking the windsock, he mistakenly concluded that it was from the east; he therefore planned to land on Runway 08.

The first attempt resulted in the aircraft being too high on approach so the pilot conducted a go-around. On the second attempt the aircraft touched down a long way along the runway, bounced and then veered towards the right hand boundary of the strip. The pilot attempted to regain control but was unable to prevent the aircraft colliding with a fence, coming to rest on its side.

The pilot freed himself from the aircraft, by which time several bystanders had arrived on the scene. He was taken to hospital by the airfield owner after it became apparent that several fingers of his right hand were broken.

Conclusion

The pilot attributed the accident to his wrong interpretation of the wind direction, leading to him conducting a downwind landing.

ACCIDENT

Aircraft Type and Registration:	Quik GTR, G-CIDG
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2014 (Serial no: 8665)
Date & Time (UTC):	11 November 2016 at 1600 hrs
Location:	Headcorn Aerodrome, Kent
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Extensive
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	52 years
Commander's Flying Experience:	110 hours (of which 46 were on type) Last 90 days - 18 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The pilot was about to turn the microlight onto finals just as a Cessna 208 (single-engined turbine aircraft) descended ahead onto finals. The pilot made a turn away from the airfield to allow some separation then turned onto and called finals for a nil-wind landing. When the microlight was about 30 feet above the runway it rolled "violently" to the right in the wake of the twin that had just landed, and hit the ground in a nose-down attitude. There was severe structural damage to the microlight, including to the wings, fuselage and cockpit area. The pilot, who was wearing a helmet and lap harness, was assisted from the wreckage by airfield staff and taken to hospital by ambulance with a fractured vertebra.

Bulletin Correction

When first published the first sentence of this report incorrectly referred to a 'twin-engine aircraft used by the airfield's skydiving centre'. The full text of the first sentence should read:

> The pilot was about to turn the microlight onto finals just as a Cessna 208 (single-engined turbine aircraft) descended ahead onto finals.

The online version of this report was corrected on 23 March 2017.

ACCIDENT

Aircraft Type and Registration:	Quik GT450 Quik, G-CFKJ
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2008 (Serial no: 8405)
Date & Time (UTC):	31 August 2016 at 1000 hrs
Location:	Caernarfon Airport, Gwynedd
Type of Flight:	Training
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Nose landing gear
Commander's Licence:	Student
Commander's Age:	71 years
Commander's Flying Experience:	28 hours (of which 18 were on type) Last 90 days - 15 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The student pilot stated that he was practising solo visual circuits using Runway 25 at Caernarfon Airport. Having flown one go-around on the previous circuit, and not being lined up with the runway, he became pre-occupied with positioning the aircraft and flared late for landing. The aircraft touched down firmly and bounced before landing on its nosewheel, causing it to collapse. As a result of the damage the foot throttle jammed open at full power. The pilot was unable to free the throttle and the aircraft continued to travel about 20 m before coming to rest on grass at the side of the runway.

The pilot believed the accident was caused by a combination of his inexperience, a late flare, and that after the bounce the correct response would have been to arrest the aircraft's subsequent rate of decent.

ACCIDENT

Aircraft Type and Registration:	Rotorsport UK MTO Sport gyroplane, G-CFVG
No & Type of Engines:	1 Rotax 912ULS piston engine
Year of Manufacture:	2009 (Serial no: RSUK/MTOS/007)
Date & Time (UTC):	28 September 2016 at 0947 hrs
Location:	Northrepps (Cromer) Aerodrome, Norfolk
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Extensive damage to cockpit pod, rotor blades and propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	77 years
Commander's Flying Experience:	16,000 + hours fixed wing, incl ATPL flying (160 hours on gyroplanes, all on type) Last 90 days - 37 hours Last 28 days - 8 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During what initially appeared to be a normal takeoff, the gyroplane rolled to the left and crashed onto its left side, with the pilot becoming trapped in the cockpit.

History of the flight

Following a pre-flight inspection the pilot started the engine and taxied to the runway, back-tracked along Runway 22 and turned through 180° in preparation for takeoff. The wind was reportedly 8-10 kt, straight down the runway. After conducting the magneto checks, the pilot, in accordance with standard operating procedure, pre-rotated the rotor to 200 rpm[1], trimmed fully forward and, with the control stick fully aft, opened the throttle to achieve 5,000 rpm released the brakes and commenced the takeoff. Initially everything appeared normal although the pilot reported that he experienced an increasing realisation that 'something was not right'. The next thing he remembered was being trapped inside the cockpit with the aircraft lying on its left side. He was able to release his harness and turn off the ignition switch with his right foot but could not move further. The airfield owner, who

Footnote

[1] Pre-rotation involves operating a clutch mechanism that takes drive from a pulley attached to the propeller shaft and powers the rotor via a Bendix gear mounted immediately below the rotor. After the appropriate rotor pm has been achieved, the pilot disengages the clutch and commences the takeoff run by opening the throttle, thus allowing all the engine power to be directed to the propeller.

was in his vehicle nearby, called the emergency services. An ambulance arrived promptly and the crew were able to free the pilot after cutting his clothes. The fire crews then righted the aircraft in order to prevent fuel and oil leaking onto the engine and exhaust.

Additional information

The pilot commented that he had flown a friend's MTO3 gyrocopter (which has essentially the same control and trim system) following his accident and on one occasion encountered what he felt may have been similar symptoms, when he needed to exert considerable forward force on the control stick in order to prevent the nose lifting excessively after takeoff.

Description of trim system

The pilot was at a loss to explain why the accident had occurred other than to suggest a possible intermittent fault in the pitch trim system.

The gyrocopter is equipped with an electrically-operated pneumatic control system that is used to operate the rotor brake and pitch (longitudinal) trim. An electric pump generates compressed air that, after being passed through a filter (in order to dry the air), is fed, via a series of solenoid valves to three cylinders: a double-acting cylinder operating the rotor brake and trim, a single-acting cylinder operating the pre-rotator engagement and an additional cylinder that engages the Bendix gear. The pump has a maximum capability of 10 bar but is limited to 8 bar by means of a pressure relief valve. A rotary knob on the instrument panel changes the system between BRAKE and FLIGHT and a pressure gauge is also provided on the panel that allows the pilot to see the trim position in flight (the higher the pressure, the more nose-up trim). During the takeoff procedure, when the pre-rotator is released, air at a pressure of around 2 bar is ported into the nose-up side of the trim actuating cylinder, causing the stick to move aft slightly. The current training standard (which applied during the period the pilot of G-CFVG was learning) teaches pilots to release the trim pressure by trimming forward after pre-rotator release, although this is not in the flight manual.

The Calidus and Cavalon gyrocopters, which are successor models to the MTO Sport, have modified trim systems that do not apply pneumatic pressure to the trim actuator following pre-rotator release.

Discussion

The gyroplane manufacturer commented that they thought that any pneumatic trim system fault was unlikely to have generated sufficient control forces to cause a problem. However they emphasised the importance of maintaining accurate pitch control during takeoff; aft stick is applied during the takeoff roll in order to maintain the airflow through the rotor disc such that it continues to be driven. After the nose lifts off the ground, it is necessary to check forwards in order to maintain the airspeed and allow the rotor rpm to continue to increase. There is a risk that, if the pitch angle is allowed to increase unchecked, the rotor blades could strike the ground behind the aircraft, slowing or damaging the rotor and causing a loss of lift. This would be predominant on the left side (retreating blade) and result in a roll to the left. Retreating blade stall was considered unlikely in this case, as such occurrences invariably result in the rotor blades striking the tops of one or more of the three vertical stabilizers; these were found to be intact after the accident.

Other possibilities worthy of consideration is an intermittent fault, such as moisture in one of the solenoid valves, caused the trim actuating cylinder to be subjected to a pressure in excess of 2 bar, or that the pilot omitted to release trim pressure after pre-rotator release.

ACCIDENT

Aircraft Type and Registration:	Skyranger 912(2) Skyranger, G-INCE
No & Type of Engines:	1 Rotax 912-UL piston engine
Year of Manufacture:	2003 (Serial no: BMAA/HB/270)
Date & Time (UTC):	26 August 2016 at 1630 hrs
Location:	Hackford, Wymondham
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Fuselage, landing gear and right wing damage, engine shock-loaded
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	44 years
Commander's Flying Experience:	126 hours (of which 70 were on type) Last 90 days - 10 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

The aircraft approached the airfield to land in a southerly direction in weather reported as fine with wind from 220° at 3.5 kt. As the aircraft approached the runway, the pilot reported that a gust of wind from the right pushed him towards a tree on the left side of the runway. The aircraft clipped this tree with its left wingtip.

Despite applying full power and commanding right roll and rudder, the aircraft continued to bank left. As the aircraft was then approaching power lines, the pilot elected to reduce power and land the aircraft in a field of maize. The pilot, who was wearing a full harness, escaped with minor injuries.

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).

BULLETIN CORRECTION

Aircraft Type and Registration:	Embraer EMB-505 Phenom 300, HZ-IBN
Date & Time (UTC):	31 July 2015 at 1408 hrs
Location:	Blackbushe Airport, Surrey
Information Source:	AAIB Field Investigation

AAIB Bulletin No 12/2016, page 34 refers

The above Field Investigation Report contained an error in the 'Survival aspects' section. The original text stated '*right side of the fuselage'* but should have stated '*left*'. The first sentence of this section should now read:

> Due to the resting attitude of the fuselage, in which the cabin entry door was on the upper **left** side of the fuselage, the aircraft manufacturer was requested to calculate the cabin door opening forces for this condition.

The online version of the report was amended on 12 January 2017.

BULLETIN CORRECTION

Aircraft Type and Registration:	Pegasus Quantum 15, G-MZCR
Date & Time (UTC):	16 July 2016 at 1430 hrs
Location:	East Haxted Farm Airstrip, near Edenbridge, Kent
Information Source:	AAIB Field Investigation

AAIB Bulletin No 1/2017, page 39 refers

The description of the accident site and wreckage examination referred to "*lift control wires*" and "*flying control wires*", terms which may cause confusion as the cables in question are structural and not specifically for control. These terms have now been replaced by '*lower side rigging cables'* and '*rigging cables'*.

The relevant paragraph should read as follows:

> One of the left *lower side rigging cables* had failed in tensile overload and the second had been cut by the emergency services. The luff control wire, which controls the shape of the wing trailing edge for trimming purposes, had also failed in tensile overload. All other *rigging cables* were intact and were in good condition. The flying control bar had been bent, probably by contact with the pilot's body during the accident impact. The trim control was set to the takeoff position which is also appropriate for landing. The pilot's lap and shoulder straps were intact and had not failed at their attachments, although the shoulder strap had been cut by the emergency services.

The online version of this report was corrected on 12 January 2017

BULLETIN CORRECTION

Aircraft Type and Registration:	Piper PA-28-161 Cherokee Warrior II, G-CDER
Date & Time (UTC):	6 August 2016 at 1600 hrs
Location:	English Channel, 1.2 nm from Winchelsea Beach, East Sussex
Information Source:	AAIB Field Investigation

AAIB Bulletin No 1/2017, page 25 refers

There was a typographical error in the opening sentence of the last paragraph on page 25 of the Bulletin. The text should read:

> 'The aircraft then flew 1.2 nm off-shore before turning onto a *south-westerly* heading, to fly approximately parallel to the shore line.'

The online version of this report was corrected on 12 January 2017.

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

1/2011 Eurocopter EC225 LP Super Puma, G-REDU near the Eastern Trough Area Project Central Production Facility Platform in the North Sea on 18 February 2009.

Published September 2011.

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.

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 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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