AAIB
Air Accidents Investigation Branch

AAIB Bulletin 8/2019

TO REPORT AN ACCIDENT OR INCIDENT
PLEASE CALL OUR 24 HOUR REPORTING LINE

01252 512299

Air Accidents Investigation Branch
Farnborough House
Berkshire Copse Road
Aldershot
Hants GU11 2HH

Tel: 01252 510300
Fax: 01252 376999
Press enquiries: 0207 944 3118/4292
http://www.aaib.gov.uk

AAIB investigations are conducted in accordance with Annex 13 to the ICAO Convention on International Civil Aviation, EU Regulation No 996/2010 and The Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 2018.

The sole objective of the investigation of an accident or incident under these Regulations is the prevention of future accidents and incidents. It is not the purpose of such an investigation to apportion blame or liability.

Accordingly, it is inappropriate that AAIB reports should be used to assign fault or blame or determine liability, since neither the investigation nor the reporting process has been undertaken for that purpose.

AAIB Bulletins and Reports are available on the Internet
http://www.aaib.gov.uk

This bulletin contains facts which have been determined up to the time of compilation.

Published 8 August 2019

Cover picture courtesy of Stephen R Lynn LRPS
(www.srlynnphotography.co.uk)

ISSN 0309-4278

Published by the Air Accidents Investigation Branch, Department for Transport
Printed in the UK on paper containing at least 75% recycled fibre

CONTENTS

SPECIAL BULLETINS / INTERIM REPORTS

None

SUMMARIES OF AIRCRAFT ACCIDENT ('FORMAL') REPORTS

None

AAIB FIELD INVESTIGATIONS

COMMERCIAL AIR TRANSPORT

FIXED WING

None

ROTORCRAFT

None

GENERAL AVIATION

FIXED WING

ROTORCRAFT

SPORT AVIATION / BALLOONS

None

UNMANNED AIRCRAFT SYSTEMS

None

AAIB CORRESPONDENCE INVESTIGATIONS

COMMERCIAL AIR TRANSPORT

GENERAL AVIATION

SPORT AVIATION / BALLOONS

CONTENTS Cont

AAIB CORRESPONDENCE INVESTIGATIONS Cont

(ALL TIMES IN THIS BULLETIN ARE UTC)

AAIB Field Investigation Reports

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

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

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

ACCIDENT

Aircraft Type and Registration:	Beagle B121 Series 2 Pup, G-TSKY
No & Type of Engines:	1 Lycoming O-320-A2B piston engine
Year of Manufacture:	1968 (Serial no: B121-010)
Date & Time (UTC):	12 July 2018 at 1430 hrs
Location:	0.5 miles north-west of Bembridge Airfield, Isle of Wight
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Serious)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's License
Commander's Age:	69 years
Commander's Flying Experience:	316 hours (of which 31 were on type) Last 90 days - 5 hours Last 28 days - 3 hours
Information Source:	AAIB Field Investigation

Synopsis

Shortly after takeoff the engine lost power and the aircraft made a forced landing in marshland. Both occupants suffered serious injuries. The most likely cause of the loss of power was fuel starvation but the cause of the fuel starvation could not be determined.

History of the flight

The flight was intended to be a return trip to Bembridge from the aircraft base at Kemble Airfield. Having arrived at Kemble, the aircraft was refuelled and the pre-flight checks completed. The pilot and passenger then departed Kemble at 1224 hrs for their flight to Bembridge. They arrived at Bembridge at around 1320 hrs, paid the landing fee and had some refreshments.

At around 1415 hrs, the pilot started the aircraft engine for departure. Whilst completing the pre-takeoff checks, the pilot heard a noise that he had not heard before on the aircraft. He consulted another member of the flying group by telephone who advised him to shut down and re-start to see if the noise reoccurred. The flying group member suggested that he had not heard the noise before either, and if after re-starting there was no repeat of the noise, and all the checks were normal, then there was nothing to suggest the pilot should not take off and fly back to Kemble.

The pilot completed the pre-flight checks once the aircraft had been re-started and both he and his passenger confirmed that everything was normal, there was no repeat of the sound, and all the checks were satisfactory. At 1427 hrs, the aircraft was seen to begin its takeoff roll from Runway 30 at Bembridge by a witness who then lost sight of the aircraft behind some buildings which blocked his view. The witness then departed in their own aircraft from the reciprocal runway and was not aware of any problems with G-TSKY.

The pilot recalled that the takeoff was normal and that as the aircraft passed 300 ft aal in the climb he retracted the flaps as required in the checklist. Shortly afterwards he sensed that the engine power was decreasing rapidly. There was no noise or change of note that he detected. He concentrated on flying the aircraft, lowering the nose and looking out for a suitable landing area. The area ahead did not look particularly flat for a forced landing, but he assessed that he was at too low a height to attempt to manoeuvre the aircraft. He completed some of the forced landing checks but very quickly the aircraft was approaching the ground. There was a loud thump as the aircraft struck the ground. The pilot suffered a head injury which rendered him unconscious for some time, as well as other injuries including to his back and pelvis.

The passenger described the takeoff as “fine” until the aircraft passed the upwind end of the runway. She described the engine “switching off” with no noises or vibrations. The aircraft then began a descent with the pilot “moving some switches”. As the aircraft struck the ground, she suffered injuries to her back. As she could smell fuel, she was fearful of a fire and managed to undo her harness before extracting herself from the cockpit. Due to the pain in her back she was unable to move beyond the wing.

Neither the pilot nor the passenger was able to reach and use their mobile phones. They could not recall hearing the stall warning sound at any time from the loss of power to striking the ground.

The pilot had made a MAYDAY call after the loss of power on Bembridge Airfield’s Air/Ground radio frequency, which was unmanned at the time of the accident. This radio call was heard by the pilot of another aircraft, who contacted Sandown Airfield by radio to report it. Further information was then received on Sandown’s frequency from an aircraft who had noticed the aircraft wreckage. At 1450 hrs, the police were alerted at Sandown Airfield by someone flagging down a patrol car. A helicopter pilot on Sandown’s frequency, who was inbound, passed close by where the accident was reported to have occurred and offered to search. He saw that the aircraft was in marshland beyond the airfield almost aligned with the runway. He was able to land some distance from the wreckage, and he and his two passengers made their way to the aircraft to see if they could offer assistance.

The accident site was difficult to access, located in marshland 580 m from the end of Runway 30 at Bembridge and 105 m right of its centreline. Figure 1 shows the accident site in relation to the airfield.

Figure 1
Accident site location © Google Earth

Sometime after 1450 hrs the helicopter pilot at the accident site told the police emergency call handler that the accident site was not on the airfield. He stated that he could clearly hear the sirens but that they were on the airfield rather than near where the aircraft was located. He attempted to direct the emergency services to the site, but they could not find a route to access the marshland. At 1522 hrs the emergency services began to arrive at the site, firstly on foot and then using specialist all-terrain vehicles. The pilot and passenger were evacuated by two air ambulances which had been dispatched to assist.

Wreckage and impact information

The aircraft had struck the ground on a track of about 310°(M) and then bounced 13 m before coming to rest. The damage to the aircraft indicated that it had struck the ground with a high vertical descent rate and with the right wing low (Figure 2). One of the propeller blades was undamaged, while the other blade was bent aft. There were about 3 litres of fuel remaining in the left inboard wing tank and about 1 litre remaining in the right inboard wing tank. The fuel strainer bowl on the underside of the aircraft had been dislodged and showed evidence of impact damage. Soil samples revealed high concentrations of volatile organic compounds in the area where the engine was located. A environmental company contracted to examine the site estimated that approximately 35 litres of Avgas had entered the subsurface, but it stated that this figure could have been higher.

Figure 2
Accident site, view towards the south-east

Recorded information

There were no radar recordings for the accident flight as the aircraft was below radar coverage. The radio transmissions at Bembridge Airfield were not recorded. The aircraft's arrival at Bembridge was recorded by an aviation app on the pilot's tablet device, but the accident flight was not. The app did not record the start of the flight to Bembridge, or the start of several other flights, possibly because the device had not acquired enough satellites at that stage of the flight to provide a position fix.

The app continued to record the position of the tablet device after landing, including a stationary position on the grass to the north-east of the Runway 30 threshold. Its last recorded location prior to the accident was at 1426 hrs, consistent with the aircraft having lined up on Runway 30 approximately 46 m short of the displaced threshold.

The arrival of the helicopter which provided initial assistance was captured by radar recordings. Its last position prior to landing was at 1450 hrs, after which it was below radar coverage[1]. The helicopter was next detected at 1720 hrs as it departed the area. The recordings also captured the flight paths of the two air ambulance helicopters when they were high enough to be in radar coverage. Their last radar points arriving to the area were at 1549 hrs and 1628 hrs. The first radar contacts on departing the area were at 1655 hrs and 1711 hrs respectively.

Footnote

[1] The lowest altitude for each of the arrivals and departures of the three helicopters was between 500 ft amsl and 1,100 ft amsl. Some of these were not in the immediate vicinity of the accident site. Factors besides altitude can also affect whether radar detects an aircraft at a specific location.

Aircraft information

The Beagle B121 aircraft, known as the Pup, was designed as a single-engined all-metal two-seat aerobatic aircraft and as a four-seat touring aircraft. The first delivery of the Series 1 variant was in 1968. G-TSKY was a Series 2 aircraft with a 150 hp Lycoming O-320-A2B piston engine, and configured with three seats.

G-TSKY was fitted with two 12 imp gal (54.6 litre) inboard wing tanks and two optional 6 imp gal (27.3 litre) outboard wing tanks which feed directly into the inboard tanks. The unusable fuel quantity per tank is 2.3 litres[2]. The fuel passes from the tanks to a fuel selector which can be set to direct fuel from the left, right or both tanks. From the fuel selector, the fuel passes to an electric fuel boost pump, then to an engine-driven pump and then into the carburettor.

The fuel tanks are vented through a single vent on the left landing gear leg which the pilot is required to check on each external inspection. This vent allows air to enter the tanks as fuel flows to the engine, equalising the pressure. If the vent is blocked and fuel continues to flow to the engine, the pressure inside the tank will drop and eventually the fuel pump will be unable to draw any fuel.

The aircraft had electrically operated flaps with three positions: UP, TAKEOFF (10°) and DOWN (40°). According to the aircraft operating manual a stall warning device operates a warning horn when the speed falls to about 5 kt above the stall speed when the flaps are at TAKEOFF or DOWN positions. When the flaps are in the UP position the horn is inhibited, and the manual states that: '*sufficient stall warning is given by aerodynamic buffet*'.

The published stall speeds at maximum weight are:

Flap position	Stall Speed (KIAS)[3]
UP	50
TAKEOFF	49
DOWN	46

The aircraft was certified to BCAR[4] Section K Issue 2 dated 21 March 1967. G-TSKY was being operated on a EASA Restricted Certificate of Airworthiness.

Footnote

2 This figure was taken from the aircraft's original weight and balance sheet which specified a total unusable fuel quantity of 1 imperial gallon. The aircraft operating manual does not specify the unusable fuel quantity.
3 kt indicated airspeed.
4 British Civil Airworthiness Requirement.

Aircraft examination

The engine was removed and taken to an engine overhaul organisation for a strip examination. No defects were found that would explain a significant loss of power. Both magnetos were tested and operated satisfactorily. The sparks plugs were also tested and operated normally. The carburettor had broken into two sections and could not be tested, but a strip examination did not reveal any defects or blockages. The engine-driven fuel pump and electric boost pump were tested and operated normally.

Prior to engine removal the AAIB noticed that the nut connecting the fuel pipe from the engine-driven pump to the carburettor was not wire locked and was loose by 1/8 of a turn. The nut connecting the fuel pipe to the outlet of the engine-driven pump was also not wire locked, but was tight. Both of these nuts had holes for wire locking and according to the aircraft maintenance manual these should have been wire locked.

There were no disconnections in the throttle or mixture control systems. There were no blockages in the engine air intake, and the carburettor heat valve was in the cold position. The fuel tank vents were clear of blockages.

Fuel system tests were carried out by connecting two small fuel tanks to the fuel hoses at the wing roots (both wings had been cut off at the roots during recovery of the wreckage). Using calibrating fluid and the electric boost pump, fuel was pumped through the fuel selector and fuel strainer to a fuel hose forward of the engine firewall. The fuel flow was measured with the fuel selector in different positions between left and right, and in all cases the fuel flow was above the minimum specification. There was a small fuel leak from the fuel selector which was measured at about 30 ml/hr. The non-return valves in the fuel system operated normally.

A test was carried out to see if the nut at the carburettor inlet would leak in the position as found, about 1/8 turn backed off from fully tight. With the electric boost pump on and the other outlet holes blanked off a leak of about 0.34 l/hr was measured at the nut. With the nut backed off slightly more (less than 1 mm radius), the leakage rate increased to 2.25 l/hr. However, when one blanked port was opened, to simulate an open carburettor float bowl, the leak stopped.

Fuel samples from both tanks were tested and were consistent with Avgas 100LL with no significant contamination.

The flap actuator in the right wing was found extended by 3.2 cm which corresponded to 10° of flap deflection.

Fuel remaining

The aircraft owners did not require the recording of fuel remaining after the completion of a flight, nor were they required to do so by regulation. To calculate the estimated fuel on board on departure from Kemble, it was necessary to work forwards from when the aircraft tanks were last filled to capacity (36 imp gal) six days before the accident flight. Using an average fuel flow of 8 imp gal per flight hour[5] and the fuel uplift figures it was calculated that the aircraft left Kemble for the flight to Bembridge with about 31 imp gal of fuel. The flight to Bembridge was around one hour and it is likely the aircraft landed at Bembridge with about 23 imp gal. The pilot reported that he checked the fuel level in Bembridge and recalled that it was just visible in the outer tanks which indicated that the inner tanks were full (24 imp gal). The weight of 24 imp gal is approximately 78 kg.

Weight and balance

The aircraft empty weight, as stated on the weight and balance schedule, was 605.9 kg and the total crew and passenger weight was 185 kg. With an estimated fuel weight of 78 kg, this adds up to 868.9 kg. Together with a small amount of baggage, oil and sundries meant that the aircraft was close to the maximum certified weight of 873 kg. The investigation estimated that centre of gravity was at or about 1 cm forward of the forward limit.

Survivability

Bembridge is an unlicensed aerodrome and is used at a pilot's own risk and discretion. There may be no fire and rescue equipment available at an unlicensed aerodrome or it could be limited to a fire extinguisher for self-help use. Civil Aviation Publication (CAP) 793, '*Safe Operating Practices at Unlicensed Aerodromes*', gives guidance on the provision of emergency equipment within the airfield boundary. There is no requirement to provide a comprehensive off airfield rescue plan or service.

In this accident it took the emergency services just over 30 minutes to find the scene after they received the first report, which was approximately 20 minutes after the accident. It took a further 23 minutes after the first emergency services reached the site before specialist medical assistance could be provided to the pilot and passenger. This was due to problems locating and accessing the marshland area where the aircraft wreckage was located.

Available equipment

The aircraft was equipped with a portable personal location beacon (PLB) which was carried in a bag positioned behind the pilot. A PLB is designed to transmit a distress signal which can alert rescuers to a need for help as well as its GPS location. The PLB carried on G-TSKY required manual activation. The pilot was aware of the carriage of the PLB but could not recall thinking of it after the accident. In any case, the injuries to both the pilot and passenger prevented them from reaching the PLB and therefore from activating it.

EASA regulated aircraft of the same class issued with a first certificate of airworthiness on or after 1 July 2008 are required to be fitted with automatically activated Emergency Locator Transmitters (ELT). These are activated automatically by the forces of the accident and mean that none of the occupants are reliant on someone remembering or reaching the PLB.

Footnote

5 Actual average fuel consumption of G-TSKY over the previous month before the accident flight which closely matched the average figure obtained from the Aircraft Operating Manual.

Both the pilot and passenger were carrying mobile phones. The pilot suffered a head injury in the accident which rendered him unconscious for a short time. His phone was also lost into the footwell of the aircraft during the accident so was inaccessible. The passenger's phone was contained in a bag in the back of the aircraft and due to her injuries she was unable to reach it.

Aircraft procedures

When the engine fails on a single engine aircraft just after takeoff the first thing the pilot must do is to reduce the angle of attack to ensure that the aircraft does not stall. This can involve a significant movement of the control column or stick. The speed can reduce very quickly if positive action is not taken by the pilot. Flying too close to the stall speed may mean the aircraft has insufficient energy for the pilot to arrest the descent before touchdown.

The emergency section of the Aircraft Operating Manual does not contain a procedure specifically for dealing with an engine failure on takeoff. The section entitled '*Forced Landing*' recommends the following actions:

> *Check:*
>
> *1) Mixture lever – CUT-OFF*
> *2) Booster pump – OFF*
> *3) Ignition switch – OFF*
> *4) Fuel cock – OFF*
> *5) Harness – adjust and secure*

The manual suggests maintaining an airspeed of 70 KIAS with the flaps up, reducing to 65 KIAS once the flaps are lowered. With the flaps fully down, the battery master should be switched off with the aim to touchdown at 50 to 55 KIAS.

The pilot of G-TSKY had little time to complete these actions, and to select full flap. Although the aircraft had taken off with the flaps at 10°, the pilot recalled retracting them just before the engine lost power. The flap actuator was found in the flap 10° position, so it is probable that that he lowered them back to 10°, although he has no recollection of doing so.

Meteorology

There is no weather reporting or recording at the airfield.

A Met Office aftercast was obtained for the day of the accident which showed that a ridge of high pressure was dominating the United Kingdom. This gave light winds and benign weather with little cloud. The nearest locations with recorded weather reports were on the mainland at Bournemouth and Southampton Airports. Both reported light winds varying between 170° and 310° at 5 and 10 kt.

The aftercast gave the most likely wind at Bembridge at the time of takeoff as between 220° and 250° at 5 to 10 kt, a temperature of 22°C and a dew point of 11 or 12°C.

Tests and research

Flight test

A flight test in a Beagle Pup Series 2, similar to G-TSKY, was commissioned in order to assess the aircraft's handling qualities and performance with respect to stalling, rates of descent with 10° of flap selected and elevator effectiveness for the landing flare at various speeds. The test aircraft was flown at a similar weight and centre of gravity as G-TSKY when it took off from Bembridge on the accident flight.

The test showed that in a wings-level stall with the flaps up there was distinctive moderate aerodynamic buffet some 3 to 4 kt above the stall speed. In the test aircraft, with the flaps deployed in TAKEOFF or DOWN positions, the audio stall warner sounded at 9 kt above the stall. The Operating Manual stated it should be '*within approximately 5 knots of the stall'.*

A series of idle power descents were flown with the flaps at 10°. At 65 KIAS, which is the recommended glide speed after an engine failure once flaps have been selected, the aircraft descended at 800 ft/min. At 60 and 55 KIAS this was 750 ft/min. Once the aircraft was slowed to 50 KIAS the rate of descent increased to 1,000 ft/min with a noticeable nose-up attitude. The stall occurred at 48 KIAS, which was close to the published figure of 49 KIAS.

The test pilot then flew a series of simulated touchdown flares at altitude with 10° of flap and at various speeds. It was possible to flare the aircraft to zero rate of descent at 65, 60 and 55 KIAS. At 50 KIAS, with the aircraft marginally above the stall speed '*there was no evident flare effect*'. A series of glide approaches were then flown to the runway. At 65 KIAS the test pilot found '*it was easy to level the aircraft during the flare'.* At 60 KIAS the aircraft could again be levelled, and the landing was "satisfactory". At 55 KIAS the flare required to arrest the rate of descent was aggressive and started from a lower height. The test pilot reported that this required finer judgement and resulted in a higher nose-up attitude. He also reported that this was the limiting approach speed at which a landing could be made; at lower airspeed it would not have been possible to completely arrest the descent rate in the flare.

Other information

Missing wire locking

The maintenance organisation was contacted to comment on the missing wire locking on the two nuts between the engine-driven fuel pump and the carburettor. They stated that they had investigated the matter and had visited three airfields and found that none of the Lycoming-engined aircraft, including Beagle Pup and Bulldogs, had any wire locking or had nuts to take wire locking in these positions. They stated that they did not believe the engine manufacturer required wire locking in these locations

The engine manufacturer stated that the fuel pipe between the engine-driven fuel pump and the carburettor on this engine type is an airframe part and not a part supplied by the engine manufacturer. They stated that published information supplied by the aircraft manufacturer should be followed.

Light aircraft manufacturers in the USA such as Cessna and Piper do not require wire locking on the nuts in these locations; and when correctly torqued, there has not been a history of these nuts coming loose.

Stall warning requirements

The Beagle B121 was certified to BCAR Section K Issue 2 which required an "unmistakable" stall warning that did not need to include an aural warning. Until 15 August 2017 the EU Certification Specification 23 for Normal, Utility, Aerobatic and Commuter category aeroplanes (Amendment 4) stated in CS 23.207:

> *'The stall warning may be furnished either through the inherent aerodynamic qualities of the aeroplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself.'*

Amendment 5 to CS-23, which became effective on 15 August 2017, states in CS 23.2150:

> *'The aeroplane must have controllable stall characteristics in straight flight, turning flight, and accelerated turning flight with a clear and distinctive stall warning that provides sufficient margin to prevent inadvertent stalling. A stall warning that is mutable for aerobatic flight phases is acceptable.'*

This latest amendment to CS 23 requires a clear and distinctive stall warning but does not specify what form that should take. However, the new acceptable means of compliance for CS 23 are published in ASTM F3180/F3180M-16, which states in 4.4.2.2[6]:

> *'For Level 2, 3, and 4 aeroplanes, the stall warning shall consist of either:*
>
> *(1) An aural warning in combination with a system that provides tactile feedback through the pilot's controls to deter the pilot from further reducing airspeed or increasing angle of attack, or*
>
> *(2) A voice warning such as "STALL STALL" along with an additional voice callout that occurs prior to the stall warning.*
>
> *(a) The additional voice callout shall be provided no less than 4 s in advance of the stall warning callout assuming a steady deceleration in straight or turning flight for the maneuvers specified in 4.1, and*
>
> *(b) Must not overlap or conflict with the stall warning.'*

Footnote

6 Aeroplane certification levels are:
(1) Level 1 — for aeroplanes with a maximum seating configuration of 0 to 1 passengers;
(2) Level 2 — for aeroplanes with a maximum seating configuration of 2 to 6 passengers;
(3) Level 3 — for aeroplanes with a maximum seating configuration of 7 to 9 passengers; and
(4) Level 4 — for aeroplanes with a maximum seating configuration of 10 to 19 passengers.

Previous Beagle B121 accidents with loss of power

The AAIB has published reports on 23 Beagle B121 accidents (excluding this one) with the earliest having occurred in 1970. Nine involved a loss of power. Of these, six involved the Series 1 B121 aircraft with a Rolls Royce O-200 engine, of which three were attributed to probable carburettor icing, two to insufficient fuel and one with no reason found. Of the three loss-of-power accidents involving the Series 2 aircraft with the Lycoming O-320 engine, one involved probable carburettor icing and of the remaining two, no reason was found.

The AAIB did not report on loss-of-power occurrences that did not result in an accident.

Analysis

Loss of power

No engine defects or mechanical failures were found that would explain a loss of power. The magnetos and spark plugs worked correctly when tested. The atmospheric conditions were not conducive to carburettor icing and the air intake was clear of blockages. Therefore, the most likely cause of the loss of power was fuel starvation. Based on recent fuel uplifts and fuel burn calculations there should have been sufficient fuel onboard, and the findings of fuel in the soil beneath the wreckage support this conclusion. Therefore, some fuel system-related issue probably prevented sufficient fuel from reaching the engine.

A blocked fuel tank vent in the left landing gear leg could have prevented fuel flow. Although the vent was found to be clear it is possible that some debris fell out in the impact. The location of the fuel tank vent, low on the left landing gear leg, could make it prone to picking up debris from a runway, and as both tanks are vented from this single point, a single blockage could result in a loss of power. The pilot reported having removed the fuel tank filler caps prior to departure from Bembridge which would have vented the tanks to atmosphere. If the vent had been blocked it is unlikely that in the short time from engine start to power loss, a sufficient vacuum would have built up in the tanks to prevent fuel flow.

The nut at the carburettor inlet that was loose and not wire locked could have resulted in a leak sufficient to cause a loss of power but not in the position as found. However, it is possible that the nut was tightened in the impact by forces acting at the union when the carburettor separated. It is also possible that some debris entered the carburettor and caused a fuel flow restriction, but that this debris was released when the carburettor broke open on impact.

The nuts between the engine-driven fuel pump and the carburettor should have been wire locked in accordance with the aircraft maintenance manual.

No explanation was found for the “strange” noise heard by the pilot and passenger after the first engine start.

Speed on descent

Flight tests with a similar aircraft to G-TSKY showed that at 55 KIAS, about 7 kt above the stall speed, and the flaps set at 10°, aircraft energy was just sufficient to eliminate a rate of decent in the flare, if a late and aggressive flare technique was employed. If the approach speed had been slower than this or if the flare had been initiated too high, then this would have resulted in a heavy landing or heavy impact.

At 55 KIAS and flaps 10° the stall warner would have been sounding continuously, but neither the pilot nor the passenger could recall hearing it. However, it is known that high stress situations can affect the perception and recollection of warning sounds.

The damage to the aircraft and the ground marks revealed that the aircraft had struck the ground with a high rate of descent, a slight nose-down attitude and right bank. Indications of a high descent rate at touchdown suggest that the aircraft had insufficient airspeed for a successful flare. It was not possible to determine if the aircraft had stalled prior to impact, but it was probably close to stalling when the flare was initiated. If the pilot had maintained the recommended glide speed of 65 KIAS it may have been possible to arrest the rate of decent before touchdown. This would probably have reduced the severity of the injuries sustained by both the pilot and the passenger.

Survivability

There was a delay of over an hour before the pilot and passenger were seen by paramedics. Shortly after the paramedics arrived, the first air ambulance landed at the accident site. Whilst this delay could have been significant given the injuries sustained in the accident, this may have been as fast as could be expected to such an inaccessible site.

The aircraft equipment included a manually activated PLB but neither the pilot nor the passenger remembered that it was available and could not reach it given their injuries, so it was not activated. Leaving a manually activated PLB in a bag in the back of the aircraft means that someone in the aircraft must remember where it is and be able to reach it after an accident. Had the PLB been in plain sight of either occupant and easily reachable, it might have been activated, allowing the emergency services to locate the accident site more rapidly. The carriage of an automatic ELT avoids anyone having to activate the device in the event of an accident.

Both occupants of G-TSKY had a mobile phone but as with the PLB, both devices became inaccessible due to the accident. Securing mobile phones within easy reach will make them easier to access in the event of an accident.

After the engine lost power the pilot made a MAYDAY call which was heard by another pilot on the frequency who then relayed this to Sandown Airfield. This call meant that the emergency services were alerted and could begin to search for the wreckage. This demonstrates the benefit of transmitting a MAYDAY even on local frequencies that may not be monitored all the time, particularly if there is insufficient time to change to a monitored frequency.

Conclusion

The most likely cause of the loss of power was fuel starvation but the cause of the fuel starvation could not be determined. Among the possible causes was a blocked fuel vent on the left landing gear leg. As both tanks are vented from this single point, a single blockage could result in a loss of power which means that checking this vent during the pre-flight walkaround checks is very important.

The pilot’s decision to land straight ahead was consistent with there being insufficient height to turn back. The aircraft did not stall from a significant height, but it is likely that the pilot did not maintain the recommended glide speed. A research flight revealed that conducting the manoeuvre very close to the stall would leave insufficient energy to flare the aircraft and reduce the descent rate sufficiently at touchdown. This emphasises the importance of pitching down immediately to maintain the correct speed in the event of a loss of engine power on a single engine aircraft.

Published: 27 June 2019.

ACCIDENT

Aircraft Type and Registration:	Reims Cessna F172N Skyhawk, G-BGSV	
No & Type of Engines:	1 Lycoming O-320-H2AD piston engine	
Year of Manufacture:	1979 (Serial no: 1830)	
Date & Time (UTC):	10 October 2018 at 1825 hrs	
Location:	Wilfholme, East Yorkshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - 1 (Fatal)	Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	76 years	
Commander's Flying Experience:	586 hours (of which 546 were on type) Last 90 days - 8 hours Last 28 days - 3 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The pilot and passenger were returning to Beverley Airfield, Yorkshire, after a day trip to Midlem Airfield, Scotland. Their departure from Midlem was delayed and consequently it was dark when the aircraft arrived at Beverley. The pilot did not hold a night rating. The pilot telephoned another member of the flying club and arranged for him to illuminate the touchdown area of the grass runway with the headlights of his car. The aircraft was manoeuvring in the final approach area when it was seen to descend rapidly to the ground. Both occupants were fatally injured.

History of the flight

Background

The pilot had arranged to fly with a passenger to visit a relative in Scotland. He planned the flight the previous day and prepared a Visual Flight Rules (VFR) flight log with the en route waypoints, tracks, distances, true airspeed and flight altitudes for both sectors. Heading, groundspeed and time information were not completed on the flight log.

The aircraft took off from Beverley Airfield at 1026 hrs and landed at Midlem at around 1140 hrs. The pilot and his passenger left the airfield some time afterwards. They returned to the aircraft later in the afternoon, but after starting the engine the pilot noted an unusual engine noise and shut down to investigate. He removed the upper and lower engine cowlings and determined that the source of the noise was due to the exhaust pipe becoming detached from the No 3 cylinder[1].

The pilot called his maintenance provider at 1452 hrs to discuss the problem and seek assistance. He described that one of the two threaded exhaust studs in the cylinder was missing and that the nut and washer from the remaining stud were also missing, although the exhaust gasket was still present. His maintenance provider was unable to provide immediate assistance and advised the pilot to seek local assistance. The pilot contacted an LAA Inspector who was present at the airfield and had the required repair hardware. The LAA Inspector provided the parts to the pilot but explained that, as G-BGSV was not an LAA Permit aircraft, he was unable to sign a Certificate of Release to Service (CRS) for the repair[2].

The pilot was observed to reattach the exhaust pipe and refit the engine cowlings. There was no further contact between the pilot and his maintenance provider.

At some time during the afternoon, the pilot also contacted a club member friend at Beverley to discuss the problem with him. The friend texted the pilot at 1542 hrs to ask whether the problem was resolved and at 1601 hrs he received an answer from the pilot to say he was just leaving. The aircraft departed Midlem Airfield around 1610 hrs.

The accident flight

The aircraft climbed to and maintained 5,000 ft for the flight. It flew in a generally south-easterly direction until 1638 hrs, when the pilot contacted Newcastle Radar and requested a transit through their airspace. He was asked to route in a southerly direction initially and subsequently in a south-easterly direction (Figure 1).

At 1710 hrs Newcastle Radar requested the pilot set a transponder code of 7000, advised that Durham Tees Valley was closed until 1730 hrs and suggested he should continue with London Information on frequency 125.475 Mhz.

The pilot contacted London Information at 1711 hrs. The communications following the initial contact are shown at Table 1.

Recorded radar shows the aircraft squawk changing from 7000 to 1177 at 1712:52 hrs and then back to 7000 at 1714:51 hrs.

Footnote

1 The No 3 cylinder is the rear cylinder on the right side of the engine.
2 As G-BGSV had an EASA Certificate of Airworthiness, only an appropriately-rated EASA Part 66 Licenced Engineer or a person authorised by the aircraft's Continued Airworthiness Management Organisation could have signed the CRS.

Station	Time	Transmission
G-BGSV	1711:30	UM GOLF BRAVO GOLF SIERRA VICTOR IS A ONE SEVEN TWO FROM MIDLEM IN THE SCOTTISH BORDERS WE'RE JUST WE'VE JUST LEFT NEWCASTLE WE'RE HEADING TOWARDS BEVERLEY IN EAST YORKSHIRE WE'D LIKE TO TO CROSS THE ER DURHAM TEES VALLEY AIRSPACE WE UNDERSTAND ITS CLOSED WE'D LIKE A BASIC SERVICE PLEASE
LONDON INFORMATION	1711:50	GOLF SIERRA VICTOR ROGER REMAIN OUTSIDE CONTROLLED AIRSPACE DURHAM TEES VALLEY I'LL GIVE THEM A CALL SQUAWK ONE ONE SEVEN SEVEN MODE CHARLIE BASIC SERVICE WHAT IS YOUR ALTITUDE AND YOUR EVENTUAL ESTIMATION FOR BEVERLEY
G-BGSV	1712:10	ER AND WE ARE AT FLIGHT LEVEL FIVE ZERO UM AND WE'RE GOING TO BE ABOUT AN HOUR TWENTY MINUTES TO BEVERLEY
LONDON INFORMATION	1712:20	GOLF SIERRA VICTOR ROGER
G-BGSV		COULD YOU REPEAT THE SQUAWK PLEASE
LONDON INFORMATION	1712:30	SQUAWK ONE ONE SEVEN SEVEN MODE CHARLIE BASIC SERVICE
G-BGSV		I GOT THE ONE ONE THEN WHAT
LONDON INFORMATION		ONE ONE SEVEN SEVEN ELEVEN SEVENTY SEVEN
G-BGSV		ELEVEN SEVENTY SEVEN
LONDON INFORMATION	1713:40	GOLF SIERRA VICTOR LONDON INFORMATION
G-BGSV		GOLF SIERRA VICTOR
LONDON INFORMATION	1713:50	GOLF SIERRA VICTOR DURHAM TEES VALLEY ARE OFFICIALLY CLOSED UNTIL TIME ONE SEVEN THREE ZERO FIFTEEN MINUTES TIME
G-BGSV	1714:00	FIFTEEN MINUTES TIME I'LL BE THERE THERE ABOUT THEN
LONDON INFORMATION		ROGER IN THAT CASE THEN SUGGEST YOU MAINTAIN A LISTENING WATCH ON DURHAM TEES VALLEY ONE ONE EIGHT DECIMAL EIGHT FIVE ZERO AND CALL BEFORE ENTERING
G-BGSV	1714:20	ER ONE ONE EIGHT EIGHT FIVE
LONDON INFORMATION		AFFIRM SIR ONE ONE EIGHT EIGHT FIVE ZERO SQUAWK SEVEN THOUSAND
G-BGSV	1714:30	EIGHT FIVE AND SQUAWK SEVEN THOUSAND THANKS FOR YOUR HELP
LONDON INFORMATION		NO PROBLEM I WILL SPEAK TO DURHAM TEES VALLEY AND LET THEM KNOW THERE'S A GOOD CHANCE YOU'LL BE IN THE CENTRE OF THEIR AIRSPACE IF THEY REOPEN IN FIFTEEN MINUTES
G-BGSV	1714:40	THAT'S VERY KIND THANK YOU GOLF SIERRA VICTOR

Table 1

Communications between London Information and G-BGSV

All times are UTC

At 1717 hrs the aircraft turned from its south-easterly track to a south-westerly track and continued in that direction for 11 minutes before turning south and then south-east onto a direct track to Beverley. This routeing took the aircraft some 15 nm further to the west of the outbound track and clear of Durham Tees Valley airspace.

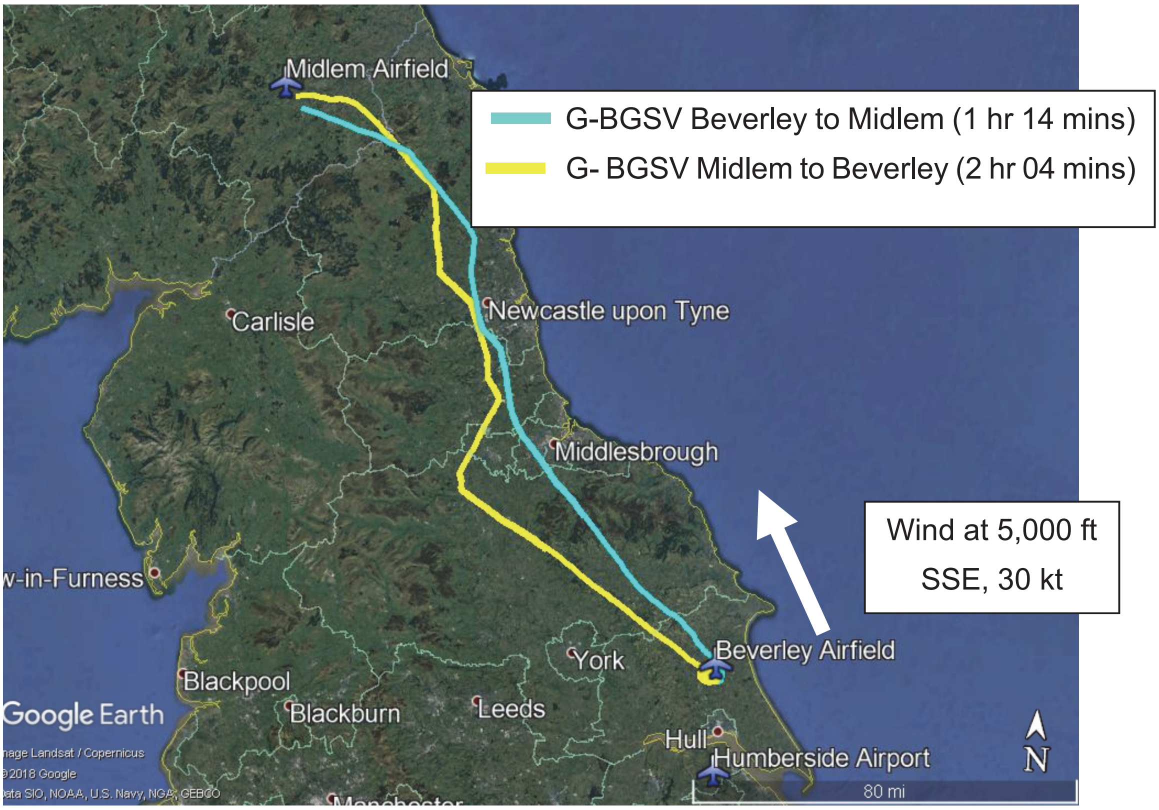


Figure 1

G-BGSV flights of 10 October 2018 from radar recordings

The aircraft arrived overhead Beverley Airfield at 1814 hrs and started to circle in the vicinity at a height of around 1,000 ft amsl. Sunset on 10 October was at 1715 hrs, it was dark and there was no moon. The pilot telephoned one friend from Beverley Airfield and then, being unable to reach him, telephoned the club member friend who he had texted just before he left Midlem. The club member friend answered the call and agreed, at the pilot's request, to drive to the airstrip and shine his car headlights on the runway. He also reported having asked the pilot what his intentions were if he was not able to land. The pilot advised him that he had sufficient fuel for Humberside but would land at Beverley if he could.

The club member friend arrived at the airfield soon afterwards and parked at the western end of Runway 12 with his headlights shining along the arrow indicating the threshold, Figure 2. He was not able to enter the clubhouse and turn the building lights on because, in the rush, he had left the keys at home. On arrival at the airfield, he tried to telephone the pilot again but did not make contact.

Figure 2
Displaced threshold area Runway 12

The club member friend stood by his car and watched the aircraft manoeuvring overhead; he could follow its progress by the position lights which were lit. He could see it circling to the west of the airfield and descending, then it suddenly descended vertically and disappeared from his view. He felt certain it had crashed and alerted the emergency services by telephone; the call was logged at 1825:20 hrs. He continued to try and call the pilot's telephone without success. He alerted other members of the club and a local search was initiated.

The police informed the Aeronautical Rescue Coordination Centre (ARCC), who contacted the Distress and Diversion Cell (D&D) at 1845 hrs. The D&D log shows that they requested a radar replay of the event and were provided the aircraft's last known position, which was passed to the ARCC and the Yorkshire Air Ambulance at 1909 hrs. This position was confirmed to D&D by Humberside Airport at 2000 hrs.

A significant ground and air search commenced. The aircraft was located at 2247 hrs in a small copse 1.2 nm to the northwest of Beverley Airfield. Both occupants had been fatally injured in the impact.

Accident site and wreckage examination

The accident site was located in a copse adjacent to a stream (Figure 3). The aircraft had struck the ground in a nose-low, left bank attitude and the impact heading was approximately 065°M. Following the initial impact, the aircraft had travelled a further 20 m, coming to rest against a tree. Due to its severity, the initial impact was not survivable for the aircraft occupants.

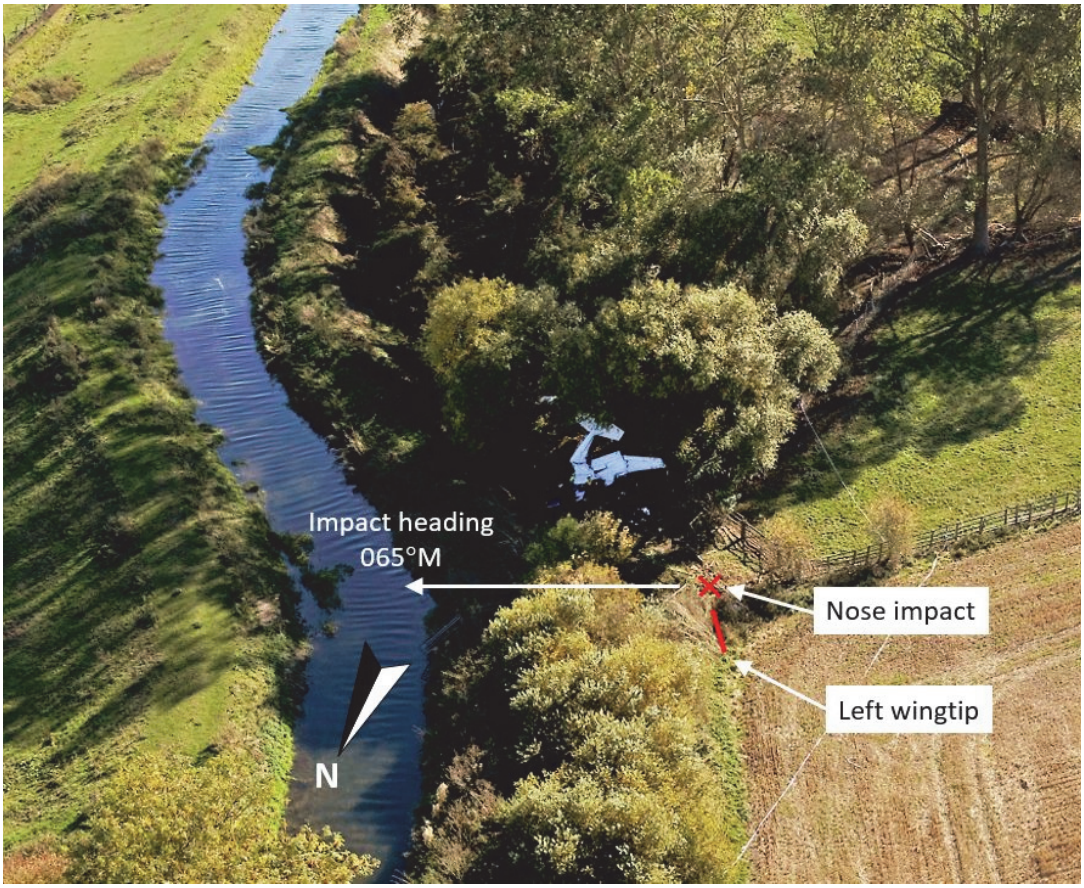


Figure 3
Accident site

Examination of the aircraft at the accident site showed that it was structurally intact at impact and that all major components of the aircraft were present within the wreckage trail. The left wing was considerably more damaged than the right wing, consistent with the left bank impact attitude.

The aircraft's flying controls were examined and determined to be continuous between the cockpit controls and the control surfaces apart from a tensile overload failure of the aileron control cable sustained during the accident. The flaps were fully retracted. The elevator trim tab was set close to its neutral position.

The aircraft's propeller had detached during the initial impact; the blades were bent rearwards and the outer 20 cm of the tips had broken off, consistent with the propeller being driven under significant power by the engine when the accident occurred. This finding was further confirmed by the engine tachometer instrument needle, which was observed to be embedded against the instrument dial at a reading of 2,500 rpm.

The aircraft's primary altimeter was recovered and the subscale was set to 1013 hPa. The aircraft's secondary altimeter, located at the bottom of the instrument panel, was also recovered and its subscale was set to 1015 hPa.

The fuel selector valve was set to the left wing tank. No fuel remained in the left wing tank due to leakage from a fracture of the wing fuel line. Approximately seven litres of fuel were recovered from the right wing tank; this fuel had the appearance and odour of 100 LL AVGAS aviation fuel.

The engine was visually examined, and no pre-accident abnormalities were noted, although it was not possible to rotate the engine's crankshaft due to accident damage. Both exhaust pipes on the right side of the engine had been bent rearwards in the initial impact, pulling out the inner exhaust studs, which had been released. The No 3 cylinder outer exhaust stud, washer and nut were present, and the exhaust pipe and gasket were securely attached to the cylinder. There was no evidence of any exhaust gas leakage from the joint with the No 3 cylinder.

Recorded information

A GPS with a moving map display and a mobile phone were recovered from the aircraft wreckage. Both devices were damaged in the accident and attempts to recover data were unsuccessful.

The aircraft's position and Mode S altitude[3] were recorded by several radar heads throughout both flights of 10 October. This data was provided to the AAIB by NATS with good coverage of both flights apart from the last few miles around Midlem Airfield. The Claxby radar head is positioned 27 nm to the south of Beverley Airfield at 670 ft amsl with good coverage of the area, recording the aircraft as low as 100 ft amsl[4] during the departure to Midlem.

Recorded radar altitude received from the aircraft's transponder uses a pressure datum of 1013 hPa which has been corrected to the reported QNH on the day of 1010 hPa. All altitudes quoted in this report are amsl.

Mobile phone records were recovered for the pilot's phone which revealed at 1808:08 hrs, while 8.5 nm north-west of the airfield, the pilot made a phone call to a friend. The call was unanswered and went to the friend's voicemail. Figure 4 shows the radar track from 1809:30 hrs and when the phone call ended, the aircraft was 3 nm north-west of Beverley Airfield. A second call was made between 1812:45 and 1813:50 hrs; this was the answered call to the club member friend.

Footnote

3 Mode S altitude was recorded to the nearest 100 ft (ie ±50 ft).
4 Beverley Airfield elevation is 5 ft amsl.

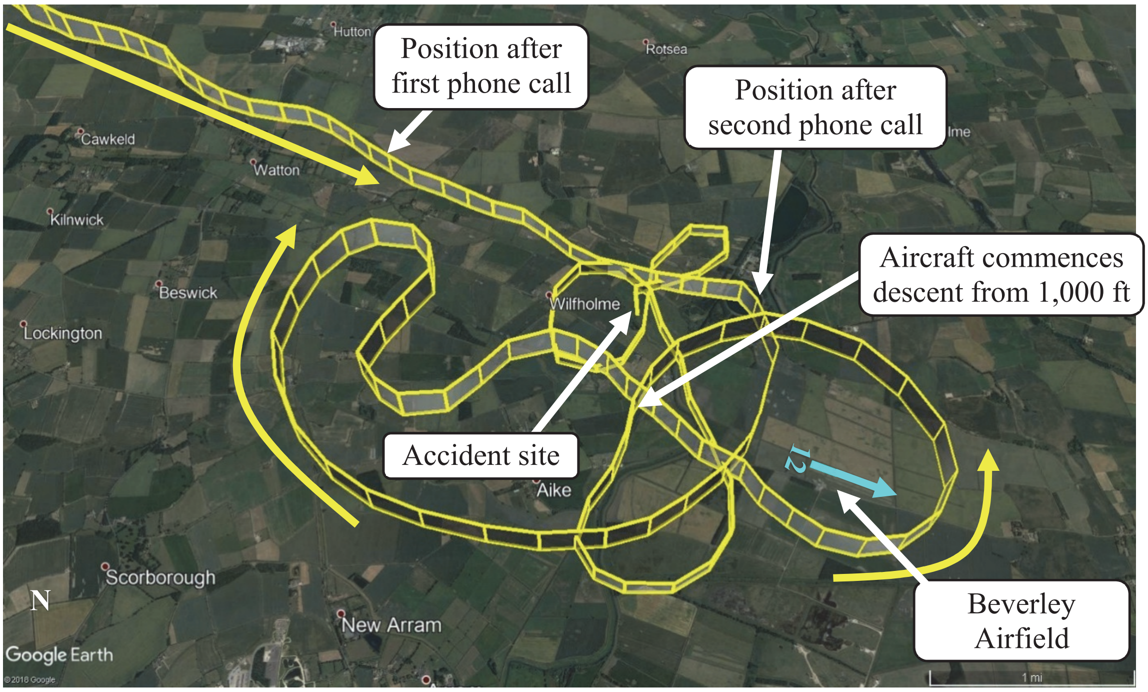


Figure 4

G-BGSV radar track showing arrival overhead Beverley Airfield

The aircraft did not overfly the runway but at 1814:10 hrs turned to the right approximately 650 m from the end of Runway 12 at 1,000 ft. It then turned north-west, tracking out 2.8 nm and then back towards the airfield, reaching the south-east end at 1819:44 hrs. The aircraft then turned to the left and after passing the extended centreline of Runway 12, commenced a descent from 1,000 ft at 1820:31 hrs.

After levelling at 500 ft, the aircraft then performed a left-hand orbit at between 300 and 500 ft over a period of approximately[5] 1 minute 12 seconds; a turn rate of approximately 5° per sec. (Figure 5). At the end of this orbit, the radar recorded a single return with the aircraft at 100 ft. The subsequent recorded altitude eight seconds later was 400 ft representing a vertical speed of 2,250 ± 750 ft/min.

The aircraft then performed a turn to the right through 223° over approximately 40 seconds at between 200 and 400 ft. Radar position is of limited accuracy[6] so an accurate groundspeed could not be calculated at the end of the flight. However, throughout this 40 second turn to the right, the average groundspeed was calculated as 82 kt.

Footnote

5 Claxby radar is recorded every 8 seconds.

6 NATS have stated that they work to Eurocontrol standards and performance for random errors is usually within ±140 m for slant range and ± 0.16° for azimuth for 98% of cases.

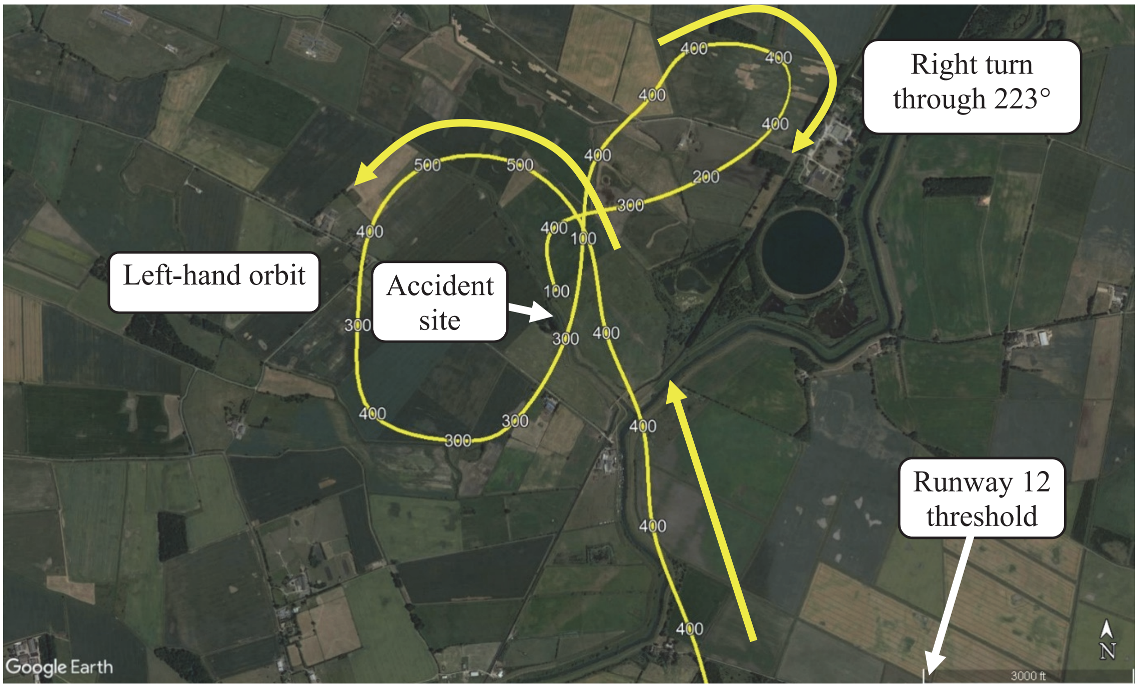


Figure 5

G-BGSV radar track from 1822:37 hrs showing altitudes amsl (± 50 ft)
(Note that the earlier position information has been removed for clarity and track has been smoothed).

The final recorded position was at 1825:14 hrs with the aircraft at 100 ft, having descended from 400 ft over the 8 second radar sweep. Considering the radar altitude accuracy, this represented a vertical speed of -2,250 ±750 ft/min. The final recorded radar position was approximately 90 m from the accident site and 1.2 nm north-west of the Runway 12 threshold. The aircraft had been circling in the region of Beverley Airfield for 11 minutes 14 seconds.

Aircraft information

The Cessna F172N is a high-wing, four seat light aircraft powered by a Lycoming O-320 piston engine. It has a fixed tricycle landing gear and a two-bladed, fixed pitch aluminium alloy propeller. G-BGSV had accumulated 3,695 flying hours from new at the time of the accident. The annual inspection and airworthiness review had taken place on 22 March 2018 and the aircraft had completed 36 flying hours following this inspection.

The aircraft has a fuel capacity of 152 litres (40 USG). It was flown on 29 September 2018 by a co-owner who advised he had started a flight with full fuel tanks and flown for one hour. The Cessna 172 aircraft typically burns around 32 litres/hr. The refuelling records at Beverley Airfield show that on the morning of the accident the pilot refuelled the aircraft with 35.88 litres of Avgas. It is likely therefore that the aircraft was full of fuel on departure, giving an endurance of around 4 hrs 45 mins.

The Pilot's Operating Handbook provides stall speeds for the aircraft at maximum weight, power off, shown in Table 2:

Power Off	Stall indicated airspeed		
	Angle of bank 0°	Angle of bank 30°	Angle of bank 45°
Flap 0°	47 kt	51 kt	56 kt
Flap 10°	44 kt	47 kt	52 kt

Table 2

Stall speeds at selected Angle of Bank and Flap positions

Meteorology

At 0950 hrs the pressure recorded at Humberside Airport (20 nm to the south of Beverley Airfield) was 1015 hPa. The 1820 hrs METAR at Humberside was: surface wind from 100°M at 8 kt, visibility 6,000 m, no significant cloud, temperature +15°C, dewpoint +13°C and pressure 1010 hPa. The former RAF Leconfield (3 nm south-west of Beverley Airfield) retains a meteorological recording station and the 1750 hrs report indicated: surface wind from 090 °M at 5 kt, visibility 4,500 m, haze, temperature +14°C, dewpoint +12°C and pressure 1010 hPa.

The local time of sunset at Beverley Airfield was 1715 hrs and local moonset was at 1718 hrs.

An aftercast provided by the Met Office indicated that the wind at 5,000 ft along the flight route would have been south-south-east at around 30 kt.

The forecast weather at Newcastle Airport for the morning of 11 October 2018 was fine with southerly winds, becoming strong winds and rain later in the day.

Airfield information

Beverley Airfield is an unlicensed grass airfield. It is home to a general aviation flying club which offers training on light aeroplanes and microlights. The single grass runway is orientated 12/30. Runway 12 is 710 m in length and 30 m in width; a displaced landing threshold gives a landing distance available of 627 m.

The runway is not lit and the airfield is located in a rural area with a lack of cultural lighting. Wind turbines to the south are illuminated with red lights and a telephone mast 1,500 m south-east of the airfield is also lit. A power line 102 ft aal crosses the approach to Runway 12, 1,170 m from the threshold.

Humberside Airport is 20 nm to the south of Beverley Airfield. It is an international airport providing services for general aviation, commercial helicopter and airline flights. The published operating hours are from 0510 hrs to 2015 hrs, during which time aerodrome lighting and Air Traffic Control services are available.

Pilot information

The pilot had held a Private Pilot's Licence (PPL) for 25 years and possessed a valid Class 2 medical certificate.

He acquired a share of G-BGSV in 1993, after qualifying for his licence, and nearly all his subsequent flying was in this aircraft. He carried out a course of Instrument Meteorological Conditions (IMC) training in G-BGSV, qualifying for the rating in April 1994. The most recent renewal of this rating was in August 2001, valid for 25 months. No night flying was recorded in his logbook and he did not hold a night rating. The pilot's last recorded flight into Humberside was on 23 August 1995.

For the five years prior to the accident the pilot had flown 12 hours per year on average, nearly all from and to Beverley Airfield, with occasional landings away at other airfields. The pilot was very familiar with Beverley and contributed a lot of his time to maintenance and upkeep of the airfield.

The passenger was not qualified as a pilot, although he had flown with the pilot on a few occasions. He was a long-standing friend and had agreed to accompany the pilot on the flight but had told him that he needed to be back home that evening.

Search and rescue

A significant ground and air search was launched after the pilot's friend called the emergency services. The search took just over 4 hours and 20 minutes to find the aircraft. This search was a challenging operation in the dark, with a number stretches of water to cross and limited road access to the area. In addition, the aircraft wreckage was located under trees in a copse, with a limited wreckage trail visible from the air (Figure 3). The aerial assets tasked with this search reported that they overflew the accident site twice during the search but were unable to locate it.

Radar data for AAIB analysis

Radar data provided by NATS to the AAIB as part of this investigation is provided by a dedicated analysis team who work office hours on a different site to D&D. This team has access to recordings of raw radar data which is that as read by the radar head, which NATS refer to as 'sensor derived coordinates'. This is position of a return as sensed by the radar head with no additional processing. The last known position provided was approximately 90 m from the accident site.

D&D response

D&D is the UK emergency centre. It forms part of an RAF Unit co-located within the London Area Control Centre, which is operated by NATS. It is a 24/7 operation with a number of roles which include the monitoring of frequency 121.5 Mhz to provide assistance to pilots flying within UK airspace who are in distress, in urgent need of assistance, or experiencing difficulties. The unit also undertakes tracing action for missing/lost aircraft.

Once informed of this event, D&D sourced coordinates of the last known aircraft position from radar and passed them to the ARCC who coordinated the search. The position passed to ARCC was 53° 54.3'N, 000° 23.13'W. This is shown on Figure 6, along with the final radar position provided to the AAIB by NATS and the accident site.

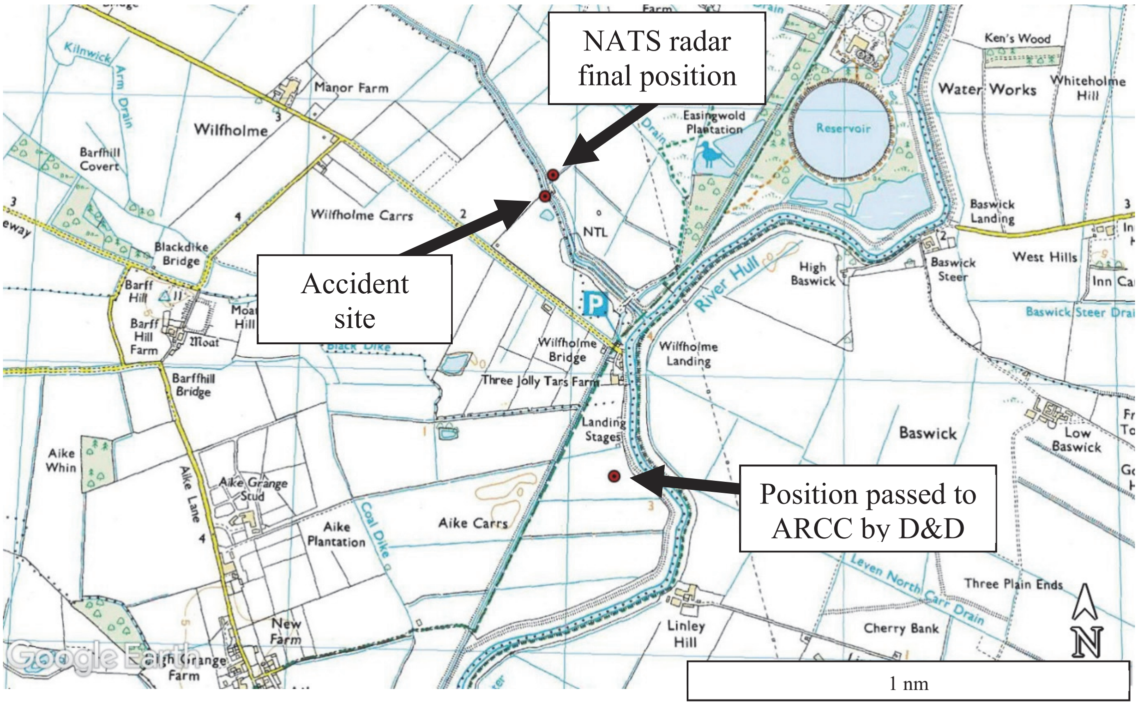


Figure 6

Final radar positions and G-BGSV accident site location

Radar data provided to D&D is required at short notice, so is provided by a team in NATS who are on the same site as D&D. This NATS team upload the requested data to a laptop, usually within 10 minutes, and then physically pass it to D&D. The radar data provided is referred to as the 'Node' or 'Multi-Radar Tracker (MRT)' data which is the information as displayed to the radar controllers. The MRT contains an algorithm that can combine positions sourced from multiple radar heads into one which improves the position accuracy and integrity.

The MRT can also account for instances when the radar signal from an aircraft is lost. In this case, the MRT will 'coast' the track onwards to a predicted position, based on the aircraft's flightpath prior to the radar position being lost. This is referred to as 'coasting'.

For G-BGSV, the last known position acquired by D&D was from the Claxby radar head which was 'coasted' a further 1 km to the south of the accident site. D&D confirmed that they corroborated this position with Humberside Airport who were using the same data.

D&D were not aware at the time of the accident of the concept of coasted radar or that uncoasted position information was also available from NATS.

Analysis

Engineering

Assessment of the aircraft's wreckage showed that the aircraft was structurally intact at impact and that there had been no pre-impact disconnection or failure of the flying controls. Damage to the propeller combined with evidence obtained from the aircraft's engine tachometer showed that the engine had been producing significant power at the point of impact. There was no evidence of any exhaust gas leakage from any of the exhaust pipe joints to the engine's four cylinders, including the joint that was repaired at Midlem Airfield.

Witness evidence of the aircraft's illuminated position lights, combined with Mode S transponder data received from the aircraft, showed that power was available to the aircraft's electrical system in the moments before the accident occurred.

Operational aspects

The pilot had held an IMC rating, which lapsed in 2003. He did not have a night rating and no night flying time had been recorded in his logbook. Therefore, flying in the dark would have been an unfamiliar and a demanding task for the pilot. There were several opportunities during the afternoon for the pilot to have cancelled or diverted the flight but he continued with his original plan despite the onset of darkness.

When the departure was delayed from Midlem, it should have been apparent that the aircraft would arrive at Beverley Airfield after dark, where no lighting was available. The pilot's first option was to abandon the plan to return the same day and stay locally at Midlem.

It is not known what information he had obtained about the weather conditions but the forecast for the next morning was fine. However, the flight to Midlem had taken only 1 hour and 14 minutes, and if he had not allowed for the effects of wind on the flight time he may have thought the return flight would be similar. Heading, groundspeed and time information had not been completed on his flight log. Alternatively, he may not have been aware of the time of sunset or was over-optimistic about how long it would remain light enough to see after sunset.

At 1712 hrs, the pilot reported to London Information that he was about 1 hour and 20 minutes from Beverley; it is not clear whether he realised that it would be dark at that time. The pilot altered course to the west, apparently to avoid Durham Tees Valley airspace which was unexpectedly closed, but this did not materially affect the arrival time at Beverley. Once he was south of the Durham airspace there were not many airfields available en route or nearby for a diversion.

As the flight continued the pilot would have realised that it was growing dark and at some point, he must have recognised that it would be night flying conditions on arrival at Beverley Airfield. However, the weather was fine and ambient light after sunset would have been reasonable for a while, which may have delayed recognition of his predicament. A logical course of action would have been to divert the flight before the onset of darkness, but if this opportunity was missed, then he still had the option to divert to an airfield with lighting. The pilot could have sought assistance in this situation from D&D who would have been able to direct him to an airfield with lighting.

Sometime during the flight the pilot is likely to have formulated his plan to attempt to land at Beverley by the lights of a car. There was no evidence that he had ever flown at night before. When he arrived overhead Beverley Airfield, he contacted another club member by telephone, who agreed to drive his car to the airfield and light the runway. The pilot did have the option of diverting to Humberside, as evidenced by his response that he had enough fuel to go there in the event he wasn't able to land.

It remains unexplained why the pilot did not decide to divert to Humberside, but there are reasons why it may have appeared a daunting prospect. He last flew to Humberside in 1995. Since then, the airport has grown and is now a busy international airport, so he would have been unfamiliar with the airport procedures and environment, as well as being unqualified to fly at night. These factors may have made Humberside appear to be a more difficult option than landing at Beverley, where he was very familiar with the airfield.

There were some indications that the pilot was fully focussed on flying the aircraft and finding the airfield, perhaps to the detriment other flying tasks. The primary altimeter was found set at 1013 hPa, and not to the local QNH of 1010 hPa as would be expected. This would add approximately 100 ft to the indicated altitude and could make the pilot think that he was higher than he actually was. Also, it appears the aircraft was descending and manouevring towards a final approach when the accident occurred. By this stage of the flight it would be expected that some flap would have been deployed, but the flaps were found in the fully retracted position.

In the final stages of the flight, the aircraft completed an 360° orbit to the left, followed by a steeper turn to the right. Between the two turns there was a period of height instability when the aircraft first descended rapidly and then climbed rapidly, suggesting a possible temporary loss of control. On completion of the turn to the right the aircraft flew approximately straight and level before entering a descending turn to the left, in the vicinity of the final approach course.

The evidence from the eyewitness, and the aircraft wreckage, suggest that there was a sudden loss of control and then an impact in a nose-down, left-wing-low attitude. The radar data indicated that during the last forty seconds of flight, prior to the final left turn, the aircraft was flying at an average speed which should have given a comfortable margin above the stall, even in a turn with flaps retracted. It is likely therefore that the pilot became disorientated when in a descending turn near the final approach and allowed the nose to pitch down too steeply.

Final radar position

Analysis of radar data after the accident showed the final radar position as 90 m from the accident site. The position passed to the ARCC by D&D was 1 km to the south of this site; a position which was confirmed by D&D with Humberside Airport. The difference in position was due to information being sourced from different sources within NATS and that the D&D

information was affected by coasting. D&D were unaware of this at the time but have since discussed this with NATS. Search conditions were challenging, and the accident site was not seen from the air due to the tree coverage at night. As a result, uncoasted position information was unlikely to have reduced the search time for the aerial assets. D&D have commenced a review to consider the use and the feasibility of uncoasted data and whether it is available at short notice.

Conclusion

The takeoff for the return flight to Beverley was delayed for technical reasons and, as a result, the aircraft arrived overhead the airfield after dark. The pilot, who did not have a night rating, was aware there was an option of diverting to nearby Humberside but, perhaps because of his unfamiliarity with Humberside, he decided to attempt to land at his home airfield Beverley. He positioned to land on grass Runway 12 which was unlit, except for the headlights of a car pointing at the threshold. While manoeuvring in the final approach area at low level the pilot became disorientated, leading to a steep turning descent into a small area of woodland.

Published: 18 July 2019.

ACCIDENT

Aircraft Type and Registration:	AS350B2 Ecureuil, G-PLMH
No & Type of Engines:	1 Turbomeca Arriel 1D1 turboshaft engine
Year of Manufacture:	1989 (Serial no: 2156)
Date & Time (UTC):	13 June 2018 at 0911 hrs
Location:	Loch Scadavay, North Uist, Western Isles
Type of Flight:	Specialised Operation
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Helicopter destroyed
Commander's Licence:	Airline Transport Pilot's Licence (Helicopters)
Commander's Age:	59 years
Commander's Flying Experience:	9,260 hours (of which 1,892 were on type)[1] Last 90 days - 127 hours Last 28 days - 37 hours
Information Source:	AAIB Field Investigation

Synopsis

Whilst the helicopter was performing an underslung load operation at Loch Scadavay the boat it was carrying became unstable and flew upwards, causing the lifting line to strike the helicopter's tail rotor. The helicopter became uncontrollable and descended rapidly into the loch, fatally injuring the pilot.

The physical characteristics of the boat and the method by which it was carried increased the probability of it becoming unstable.

The helicopter operator has taken a number of safety actions mainly relating to its operational procedures and training. It has also temporarily curtailed the carriage of selected types of unstable or potentially unstable loads.

History of the flight

Background information

The pilot and the task specialist ground[2] (TSG), departed from their home base of Inverness the day before the accident and completed a 'Helicopter External Sling Load Operation' (HESLO)[3] (Figure 1) at Rangehead in South Uist.

Footnote

1 Hours based on information described later in this report.
2 TSG - Performs tasks on the ground directly associated with a specialised task. The terms 'groundcrew' and 'ground handler' are used interchangeably in the operator's documentation.
3 HESLO - helicopter flight for the purpose of transporting external loads by different means. For ease of reference, and for consistency with the operator's Specialised Operation (SPO) manual, this report refers to HESLO as the carriage of underslung loads only.

Figure 1
Example of a HESLO operation

That afternoon, the crew[4] were requested by Operations[5] to perform a second job in North Uist the following day. That job was to transport a boat (Boat 1) for a regular client from Loch Scadavay to Loch Hunder, a distance of around 2 nm (Figure 2). A 'jobsheet'[6] and relevant maps were emailed to the pilot. This included the estimated weight of Boat 1 of 500 kg. During a phone call that evening, the client asked the pilot if a second boat (Boat 2) could be added to the job the following day.

Lifting of Boat 1

The crew stayed overnight locally and the next morning departed from Rangehead in G-PLMH at 0821 hrs, heading for a jetty at Loch Scadavay, 14 nm to the north-east. Whilst en route, the pilot advised ATC that he would be operating two lifts at not above 500 ft, just to the north of the extended centreline of Benbecula Airport Runway 24. They landed at 0829 hrs, shut the helicopter down, and met with the client and other individuals, including two fish farm employees. Boat 1 was already present and Boat 2 was yet to arrive.

The TSG reported that boats were known for being difficult loads. He assessed Boat 1 and discussed with the pilot how to lift it. Of Boat 1's two lifting eyes, they agreed to use the one on its bow in order to achieve a 'vertical' lift, which was the preferred orientation. The lifting eye looked suitable for this.

Footnote

4 Although the helicopter was being operated 'single-crew', for ease of reference, this report refers to the pilot and the TSG as a 'crew'.
5 The operator's Operations department.
6 Document produced by the operator detailing a job using the best information available at the time.

The fish farm employees had to be flown to Loch Hunder first, for them to eventually unhook the transported boat(s) from the helicopter. After receiving a safety brief, they and the pilot departed in G-PLMH at 0845 hrs. Shortly thereafter, the pilot reported to ATC that he was starting the lifting operation. ATC advised that the wind at Benbecula Airport was from 180° at 13 kt, to which the pilot replied "COPIED, FEELS A LOT STRONGER THAN THAT". Three minutes later the helicopter landed adjacent to the jetty at Loch Hunder, where the two employees disembarked.

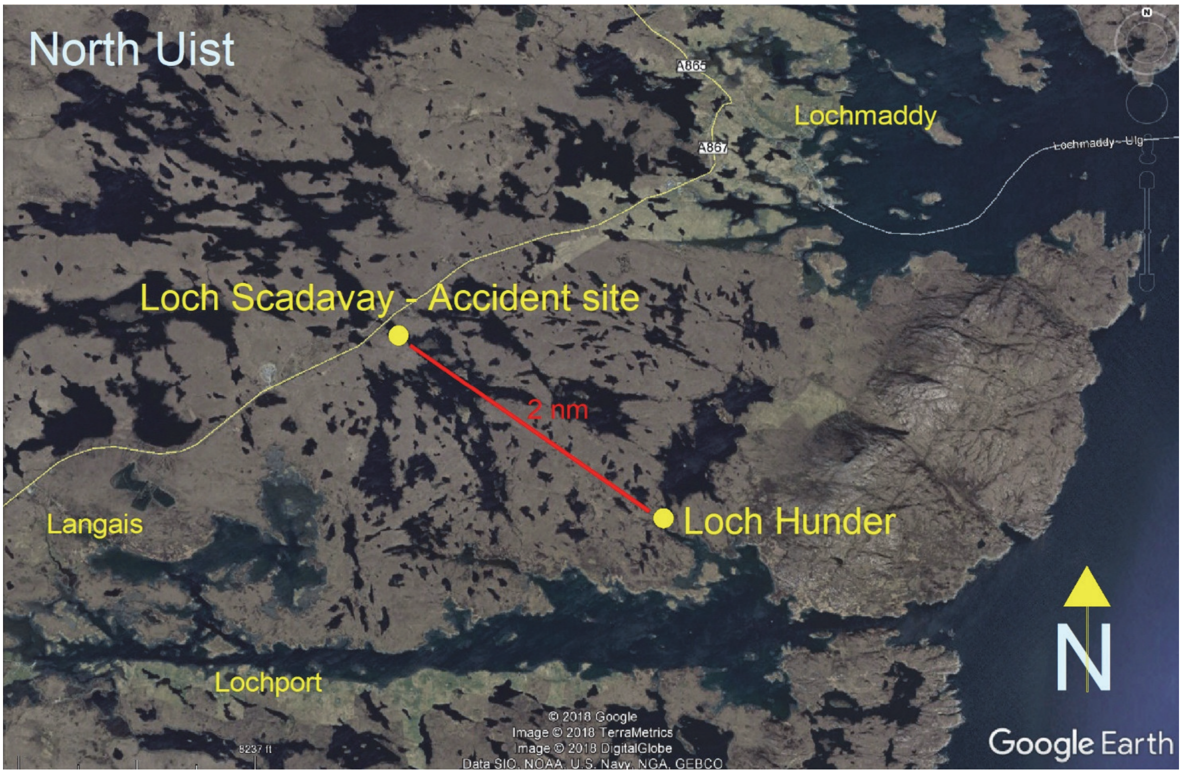


Figure 2

Loch Scadavay (lifting site) and Loch Hunder (drop off site)

The helicopter returned to the lifting site and its rotors stayed running. The TSG, who was in radio contact with the pilot, attached Boat 1 using a 10 m long lifting line. The boat was lifted by the bow in a vertical orientation. The TSG checked the load whilst the helicopter hovered, and transmitted "good lift, OK". Boat 1 was subsequently delivered at 0855 hrs.

Lifting of Boat 2

While the helicopter was away, Boat 2 arrived by trailer. This boat was noticeably smaller and lighter than Boat 1, and the TSG reported that the single lifting eye on its bow did not appear strong enough to support it in a vertical orientation. When the helicopter was returning to Loch Scadavay, the TSG radioed the pilot asking him to shut down the helicopter on arrival, as he wanted to discuss the rigging method and if the pilot was prepared to accept the load. The pilot advised ATC that he was going to land and shut down. When ATC asked when he would be lifting again, the pilot stated: "THEY WANT ME TO DO ANOTHER LIFT BUT I'M NOT CONVINCED IT'S PRACTICAL, SO I'M JUST GOING TO ASSESS IT AND ONCE I KNOW WHETHER I'M going to lift it or not, i'll get back in touch". This was acknowledged by the ATCO. The helicopter landed at Loch Scadavay at 0858 hrs.

The TSG described Boat 2 as "one of those loads" and proposed transporting it on its side, with the strops tied in place with ropes. The TSG recalled the pilot agreeing with the rigging method and making a general comment about boats being challenging. He did not recall the pilot verbalise doubt over lifting it, or a 'go/no go' decision. They agreed on the importance of flying with Boat 2 slowly.

The pilot returned to the helicopter and started the engine. The TSG attached Boat 2 to the helicopter with the 10 m lifting line, hoisting the boat on its side. He asked the pilot to lift slowly so he could check the load. The TSG transmitted "good to go" and the helicopter moved away. Recorded data showed that, at 0910:56 hrs, the helicopter was positioned adjacent to the jetty at Loch Scadavay at an altitude of about 100 ft amsl (70 ft agl). Its groundspeed was 6 kt (Figures 3 and 4). On a course towards Loch Hunder of about 120° T, the helicopter progressively climbed at a rate of 340 ft/min whilst the groundspeed increased at a rate of 1.8 kt/sec. A few seconds later, at 0911:04 hrs, the pilot transmitted to ATC that he was airborne with an underslung load. This was the last radio transmission received from G-PLMH.

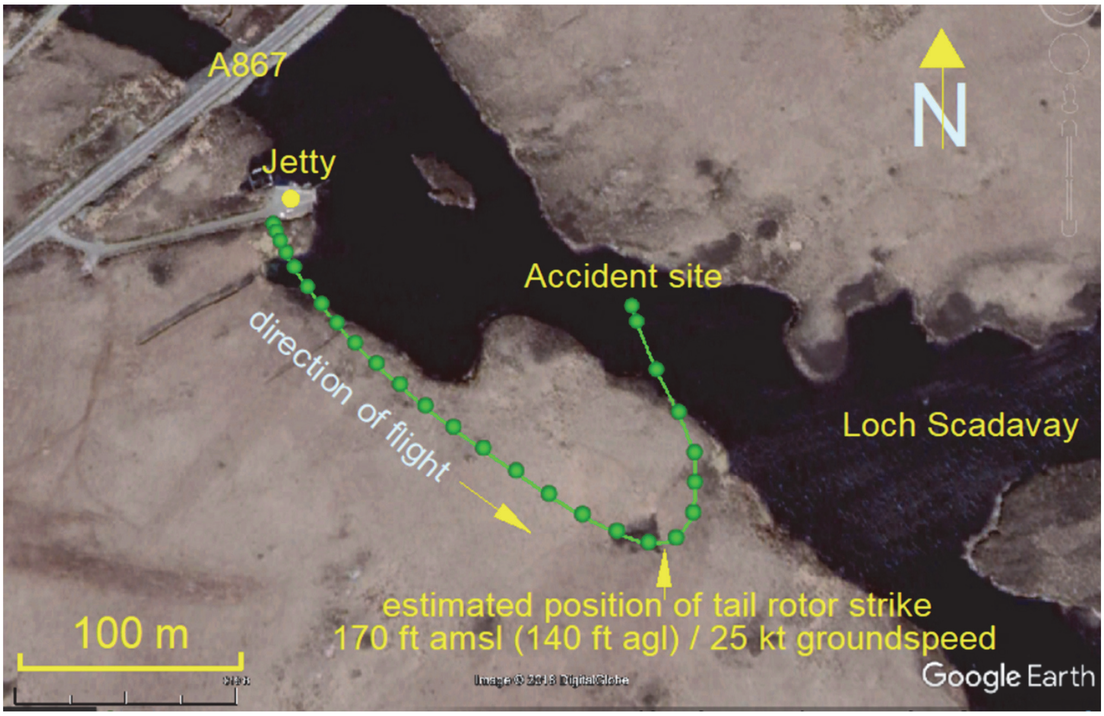


Figure 3

GPS-derived track of accident flight

At 0911:12 hrs, the helicopter had climbed to an altitude of about 180 ft amsl (150 ft agl) and its groundspeed was 36 kt. There were a number of eyewitness accounts of the lifting of Boat 2. These indicated that it started to swing and spin soon after departure. The TSG immediately radioed "slow down, slow down" to the pilot. Although he did not receive a reply from the pilot, it appeared to the TSG that the helicopter slowed down. Recorded data showed that the helicopter's groundspeed reduced to 25 kt, at an altitude of about 170 ft amsl.

Eyewitnesses reported that within seconds of Boat 2 spinning, it lifted in to the air independently of the helicopter, like a "kite". It paused momentarily, then lifted further up and over the tail boom of the helicopter. One witness remarked "[it] all happened really fast".

The helicopter moved erratically and altered track increasingly to the left. It momentarily maintained altitude, before entering a steep nose-first descent towards the loch on a track of about 340°. The helicopter struck the water with a descent rate of about 3,600 ft/min and a groundspeed of 40 kt. It came to rest on its left side, almost fully submerged. The pilot, who was wearing an immersion suit, was fatally injured.

Subsequent inspection of the wreckage revealed that the load and lifting line appeared to have been jettisoned from the helicopter's lifting hook.

Recorded information

Sources of recorded information

Recorded radar information was available from a ground-based site located at St Kilda. This recorded the helicopter's positioning flight from the MoD Rangehead located on South Uist to the pick-up point at Loch Scadavay on North Uist. The helicopter's subsequent flights were not recorded by radar.

The helicopter was fitted with a GPS tracking system[7]. This provided 12 snapshots of GPS-derived position, altitude and groundspeed of the helicopter's movements on the day of the accident; the first data point was recorded at 0820 hrs and the last was recorded at 0858 hrs.

Data was successfully recovered from the pilot's portable tablet computer[8] that was found submerged near the helicopter. This was installed with a flight navigation software application[9] that provided a track log of the accident flight and previous flights, with GPS-derived position, track, altitude and groundspeed recorded at a rate of once per second. Under normal operation, flight recording started when the derived groundspeed was greater than 5 kt and recording stopped when the tablet computer remained stationary for a period of 30 seconds.

RTF recordings of the pilot's communications with ATC at Benbecula Airport were also available.

Footnote

[7] http://spidertracks.com
[8] Apple-manufactured iPad mini 4 model A1550.
[9] Airbox RunwayHD flight navigation software application.

Accident flight

GPS-derived data salient to the accident flight are presented in Figure 4.

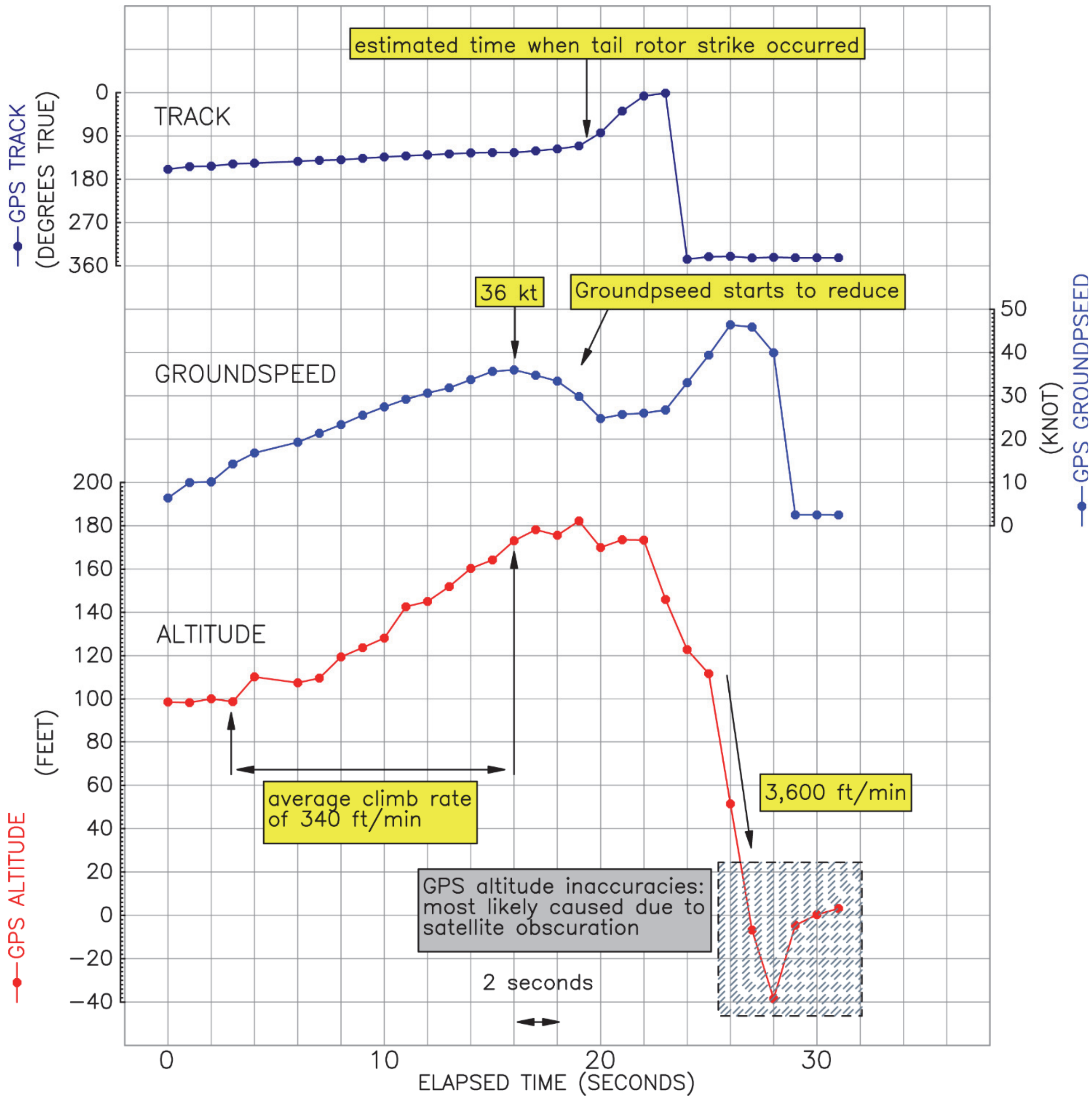


Figure 4

GPS-derived data from the accident flight

Comparison of first and second boat lift

The recorded GPS data for the first boat lift was compared with the accident flight (Figure 5). The first boat lift occurred 20 minutes prior to the accident lift. The track of the helicopter during both flights was almost identical. Therefore, if the wind direction and speed had not altered significantly in the 20-minute period between the two flights, the groundspeed during both flights may be directly compared.

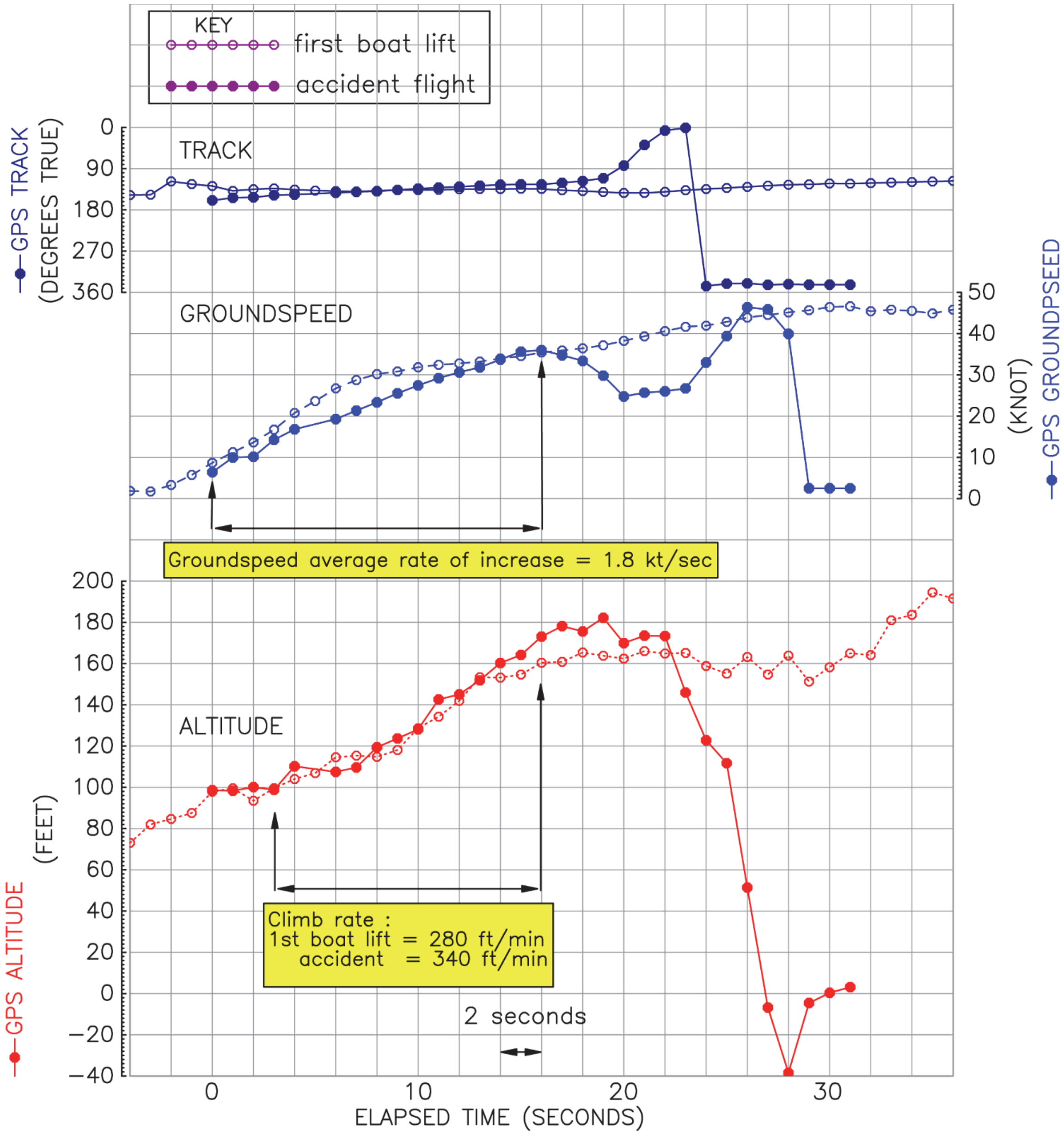


Figure 5

Comparison of GPS data from first boat lift and accident flight

Alignment of the two flights indicates that the helicopter's groundspeed of 6 kt was identical at the time that the helicopter was at 100 ft amsl. Over the next 16 seconds, the groundspeed during both lifts increased to 36 kt, which equates to an average rate of about 1.8 kt/sec. Although the average rate of groundspeed was almost identical up to 36 kt, the initial rate of increase during the first boat lift was not as linear as that of the accident flight, with a slightly higher rate.

As the groundspeed increased to 14 kt, the helicopter started to climb from 100 ft amsl during both lifts. When the groundspeed was at 36 kt, the helicopter had climbed during the first boat lift to about 155 ft and about 170 ft amsl during the accident flight; this equates to an average rate of climb of 280 ft/min and 340 ft/min respectively.

After reaching 36 kt, the groundspeed continued to increase at a rate of just less than 1 kt/sec during the first boat lift. During the accident flight, the groundspeed reduced to 25 kt in 4 seconds.

In summary, the rates of change of groundspeed and altitude during the lifting of both boats were almost identical.

Lifting site

The lifting site was a jetty at Loch Scadavay, which is around 7.5 nm north-east of Benbecula Airport (Figure 6).

Figure 6
Lifting site from the air (circled)

Meteorology

The weather at Benbecula Airport around the time of the accident was reported as:

> At 0850 hrs: wind from 180° at 15 kt, 9,000 m visibility in light rain, scattered cloud at 1,600 ft, broken cloud at 2,500 ft, temperature 11°C, dewpoint 10°C, QNH 1009 hPa.
>
> At 0920 hrs: wind from 180° at 14 kt, 9,000 m visibility in light rain, few clouds at 900 ft, scattered cloud at 1,600 ft, broken cloud at 2,500 ft, temperature 12°C, dewpoint 11°C, QNH 1008 hPa.

The weather was forecast to deteriorate during the day of the accident because 'Storm Hector' would reach the UK the following morning. The TSG said that, because of this, the pilot had brought forward the planned fuel uplift at Benbecula Airport by 30 minutes.

Personnel

Pilot

The pilot held a valid EASA Class 1 medical. He held an EASA ATPL(H) and was appropriately qualified on the AS350, and for the HESLO flying he was undertaking.

The pilot had been flying helicopters professionally since 1986, including military, offshore, and air ambulance. He had flown for the operator previously, but his most recent employment began in September 2016.

According to a document[10] containing the pilot's flying experience prior to joining the operator in 2016, along with the hours he subsequently accrued during his employment, the pilot's total helicopter flight time was around 9,260 hrs. The operator's records suggest the pilot's total AS350 flight time was around 1,890 hrs. Before joining the operator in 2016, the pilot quoted a total of 2,100 hours in underslung loads. The operator reported that he had subsequently performed an estimated 4,072 lifts for them.

Task Specialist Ground

The TSG had worked in helicopter SPOs since 2005. He joined the operator in June 2006, and they described him as being very experienced.

Description of the helicopter

The AS350B2 is a single gas-turbine engine powered helicopter (Figure 7). It is operated by a single pilot and carries up to five passengers. It is fitted with a three-blade main rotor and a two-blade tail rotor; all the rotor blades are of composite construction. The flying controls are hydraulically powered but have manual reversion capability. The main landing gear consists of two fixed skids.

G-PLMH was fitted with an external hook on the underside of the fuselage to enable underslung loads to be carried. An external mirror allowed the pilot to view the underslung load. The external hook was fitted with an emergency release which could be operated readily by the pilot in case the load needed to be jettisoned.

Because the planned operations were over water, the helicopter had manually activated, gas-inflated flotation devices fitted to its skids. A life raft was also carried.

Footnote

[10] The pilot provided a breakdown of his flying experience to the operator before commencing employment there.

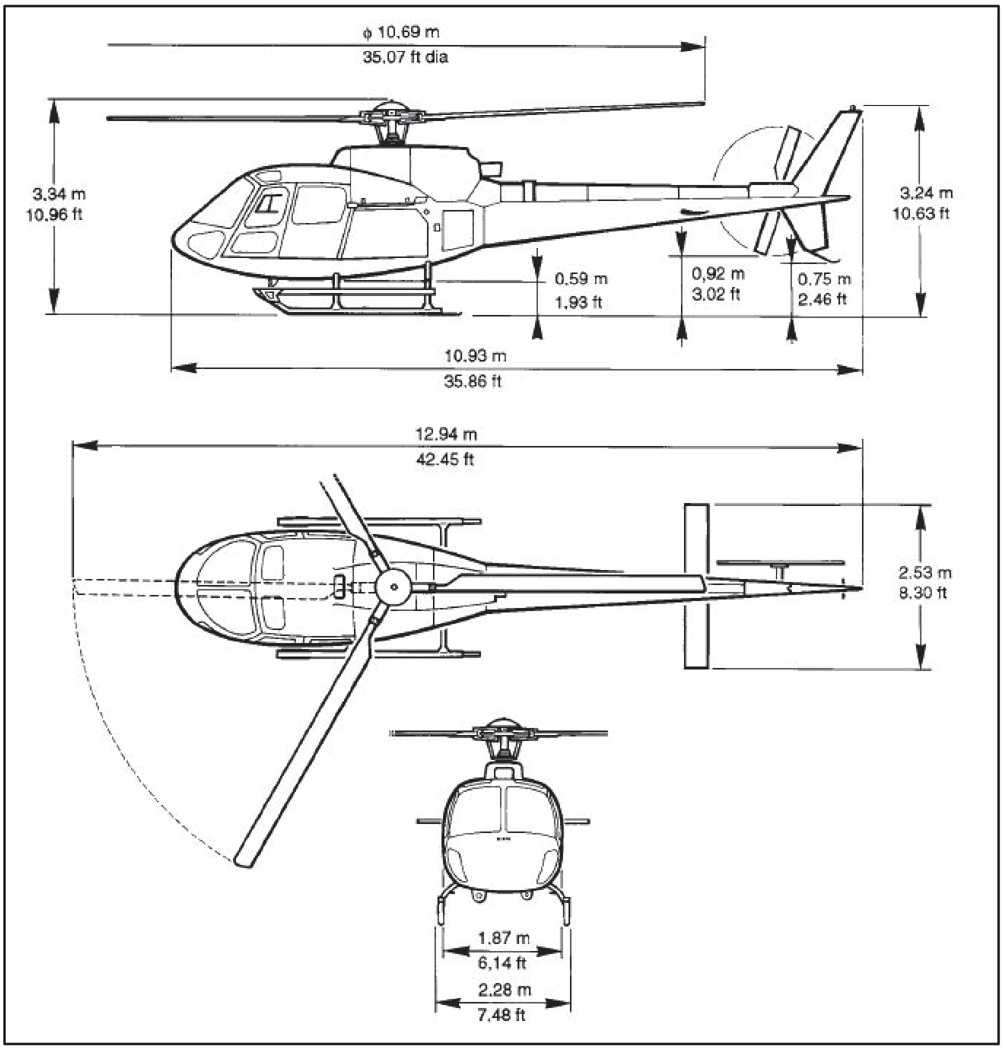


Figure 7

General view and dimensions of helicopter

Maintenance

The helicopter was maintained in accordance with an approved maintenance programme and a review of the maintenance records did not identify any anomalies.

The last scheduled maintenance inspection was a 100-hour inspection, completed on 12 June 2018. The helicopter then flew for approximately 2 hours before the accident flight without any defects being noted; 1.7 hours on 12 June 2018 and approximately 0.3 hours before the accident flight on 13 June 2018.

Lifting equipment and loads

Lifting line

A 10 m long chain was being used to carry the loads. The top end had a swivel joint and an approximately 1 m long rope section built in to act as a shock absorber. The bottom of the chain was fitted with a weight and a guarded hook.

Boat 1

Boat 1 was approximately 4.9 m long, 2.0 m wide and weighed 420 kg. An outboard motor weighing approximately 45 kg was fitted on the transom. It was lifted solely by the attachment on its bow. A similar boat, but without an outboard engine fitted, is shown in Figure 8.

Figure 8

A boat similar to Boat 1 (arrow indicates lifting eye location)

Boat 2

Boat 2 was approximately 4.4 m long, 1.4 m wide and weighed 192 kg. The mooring ring on the bow was not considered by the crew to be strong enough to lift the boat, so the lifting hook was connected to the boat using two strops, at approximately 1/3 of the length in from each end of the boat. These were secured in place by rope to stop them moving on the curved surfaces of the boat's hull (Figure 9). The strops were arranged such that the boat would be carried on its side.

Figure 9

Boat 2 showing arrangement of lifting strops
(cradle added for storage purposes)

Accident site

The helicopter came to rest in Loch Scadavay lying on its left side and mostly submerged (Figure 10). Its life raft had automatically inflated and remained tethered to the wreckage. The manually-operated flotation devices on the helicopter's skids had not been activated. Boat 2 remained connected to the wreckage by the lifting chain and after floating initially, it eventually sank.

Debris, including parts of the tail rotor, cockpit area and parts of the boat were found on the shore to the south-west of the wreckage. Pieces of foam filling from composite panels and the rotor blades were scattered over a wide area by the wind.

Figure 10

General view of wreckage in Loch Scadavay

Initial assessment of the wreckage

An evaluation of the wreckage in-situ was carried out by an expert recovery diver. Images from a helmet-mounted camera were available for viewing by shore-based personnel. The lifting chain was found to be wrapped around the tail boom and horizontal stabilisers (Figure 11). Its upper end had been released from the hook on the underside of the helicopter, and its lower end remained attached to the strops secured to Boat 2.

The pilot's flying helmet[11] was found floating next to the wreckage and was still attached to the helicopter by its audio communication electrical leads.

Footnote

[11] The helmet had an integral headset and was plugged in to the helicopter's communications system.

Figure 11

Diver's view of lifting chain wrapped around tail boom, as found

Wreckage recovery

The wreckage was raised using flotation bags and towed close to the shore before being lifted out of the water by crane. A preliminary examination was carried out prior to the wreckage being transported to the AAIB's facilities.

On-site examination of the wreckage

The cockpit area of the helicopter was severely disrupted. The pilot's seat composite structure was torn from the floor mountings on its right side (Figure 12).

Figure 12

Pilot's seat showing damaged mounting

The tail rotor blades showed witness marks along the leading edges from contact with the lifting chain (Figure 13).

Figure 13

Remains of a tail rotor blade showing witness marks from contact with the lifting chain (yellow strop is from the recovery operation)

Detailed wreckage examination

A further examination of the wreckage including the powerplant and its drivetrain, flying control integrity and structure did not reveal any pre-accident anomalies.

Medical and pathological information

A post-mortem examination of the pilot found that he had died because of a severe head injury and drowning. The post-mortem found no other factors that could have contributed to the accident.

Survivability

Flying helmet

In accordance with operator's policy, the pilot had been wearing a flying helmet. After the accident it was found with minor scratches, with no evidence of a significant impact. The chin strap buckle was not secured. The TSG could not recall noticing if the pilot's helmet chin strap had been fastened during the duty.

Pilot's seat

The pilot's seat consisted of a composite structure which was attached to the floor by seat rails. The pilot's harness lap strap was attached to fittings on the floor and the shoulder straps were fitted to the seat structure.

On 25 February 2010, the EASA issued Safety Information Bulletin (SIB) 2010-05, '*Eurocopter AS350 and AS355 helicopters – Improvement of Pilot's and Co-pilot's Seats*'. This SIB informed operators that as a result of accident investigation findings relating to seat attachment failures, the manufacturer had developed seats offering improved safety which were available as an optional modification. The improvements related to improved seat and attachment strength and optional energy-absorption.

The SIB noted that the standard seats complied with the minimum performance standard of the applicable certification basis, but that this modification would enhance occupant's safety.

Since the certification of this helicopter type in 1978, certification standards have increased the requirements for seat strength considerably. Any new type undergoing certification would have to meet the current requirements.

The seats in G-PLMH had not been modified to the improved standard and nor were they required to be.

HESLO information

Specialised Operation

HESLO is considered a 'Specialised Operation' (SPO). Commission Regulation (EU) 965/2012 defines SPO as:

> *'any operation other than commercial air transport where the aircraft is used for specialised activities such as agriculture, construction, photography, surveying, observation and patrol, or aerial advertisement.'*

An operator must hold a declaration[12] to perform SPO operations, and further individual authorisations for SPO activities which are defined as being 'High Risk Commercial Specialised Operations' (HRCSPO)[13]. The accident duty was conducted under the auspices of the operator's single SPO declaration.

HESLO has four categories[14], depending on factors such as the length of the lifting line and complexity of the operation. The lifting of Boats 1 and 2 was being performed under HESLO 1 'Short line' (20 m or less).

CAA CAP 426

The CAA's CAP 426 'Helicopter External Load Operations' contains advice for operators, pilots, and persons supervising the securing and detaching of loads.

Footnote

12 The CAA is the competent authority for SPO in the UK.
13 HRCSPOs typically involve particular risk to third parties on the ground.
14 https://www.easa.europa.eu/sites/default/files/dfu/Annex%20to%20Decision%202017-012-R.pdf [accessed 20 Feb 2019]

Section 5, *'Certificate of Airworthiness Limitations'* states:

> *'In the absence of specific details of loads, it should be assumed that only dense loads with predictable aerodynamic characteristics have been carried. In cases where it is intended to carry loads of irregular shape or low density the advice contained in paragraphs 6.18, 6.19 and 6.20 should be followed to determine the safe flight characteristics.'*

Section 6.17 explains the *'Acceptance of a Load for Flight'*:

> *'The final responsibility for the acceptance of any load for flight rests with the captain of the helicopter concerned. The masses of slung loads are to be made available to the captain before flight to enable accurate flight planning. The total mass of a slung load is always to be determined accurately.'*

Section 6.19 *'Flying Limitations and Load Stability'* contains the following advice:

> *'The weight of the cargo should not be less than 227 kg (500 lb) in total and this in turn should be related to the drag profile of the load. Certain low drag high-density loads with a total cargo weight of less than 227 kg may prove acceptable. The safe carriage of any ultra-low density or ultra-lightweight load will depend upon the speed at which the maximum allowable trail angle is attained and at which any deterioration in load handling characteristics takes place.'*

That section also lists factors which affect the maximum permitted speed at which a load may be flown. These include: *'load motion that can cause unacceptable stresses on the helicopter or interfere with control'* and *'the drag of the load which results in the maximum safe trail angle being reached'.*

Section 6.20 'Load Oscillation' includes the following advice:

> *'Helicopter accidents have been caused by violent oscillations of underslung loads. The problem is complex and not fully understood so it is only possible to give general advice on corrective actions.*
>
> *…Should pilots encounter difficulty in stabilising a load, they should either lower it to the ground or jettison it promptly.*
>
> *…Load oscillations in forward flight result from a combination of the stability characteristics of the load and the forward speed of the helicopter. Loads of low volume and high density do not normally pose a problem, but large volume loads of low density and irregular shape are liable to start oscillating at a certain critical airspeed. The initial acceleration with an underslung load of this nature must, therefore, be made slowly, using extreme caution, in order that a safe approach towards this unknown critical speed is achieved. If the load starts to oscillate, airspeed must be reduced by at least 10% of the speed at which the oscillations began.'*

Manufacturer's information

In 2017, Airbus Helicopters published Safety Information Notice No. 3170-S-00 which contains safety advice on HESLO.

Operator's information

HESLO description

The operator's SPO Manual described HESLO under a series of SOP[15] headings. The 'HESLO General SOP'[16] applied to all HESLO activities. Specialised HESLO activities had additional SOPheadings. As there was no specific SOP for the carriage of boats, the accident duty was performed under the HESLO General SOP.

The SPO Manual described HESLO as being an *'inherently hazardous activity'*.

Training

<u>Pilots</u>

The operator explained that it recruited HESLO pilots from a small worldwide pool, who were already experienced and proficient. Pilots would receive familiarisation training on the operator's culture and procedures, and then undergo flight training on commercial jobs, with a phased introduction to increasingly demanding tasks. The operator indicated that because of the wide variety of working backgrounds of its pilots, it emphasised ingraining its own safety culture.

The operator explained that operators in general are responsible for designing their own HESLO training packages. Part D of its SPO Manual listed the HESLO 1 training syllabus as sets of subjects under section headings. One subject was *'SMS including Risk Assessment and typical hazards and dangers'*. A section entitled *'Different types of load and how to sling'* included the subject *'light loads'*. Furthermore, a section on *'Swinging Loads / Spinning Loads'* listed the subjects *'Unstable loads and their limiting speeds'* and *'Large, light loads can be made to swing by wind gusts'*.

The training related to these subjects was not documented and would take place as a discussion between the instructor and the pilot.

Pilots new to the company would begin by lifting high-density, stable loads and progress to more unstable loads. The HESLO General SOP included guidance on the carriage of fencing and palleting, but not on boats, which were transported by the operator relatively infrequently. There was no documented advice on generic methods for 'unstable or potentially unstable loads' (UoPULs)[17].

Footnote

[15] SOP – Standard Operating Procedures.
[16] Examples of these were 'HESLO SOP Fire Fighting' or 'HESLO SOP Carriage of Live Fish'.
[17] The operator used the term "UoPUL" in the documentation it produced after the accident, which is summarised in the Safety Actions section of this report.

One subject in the HESLO 1 syllabus was *'Training in human factors principles (this will usually be a pilot CRM course)'.* That CRM course was entitled *'Single Pilot CRM / Pilot Decision Making'* and was provided by an external training provider. The operator's policy was for pilots to complete this as a 1-day course immediately after joining the company, and thereafter as half-day recurrent training. The operator stated that, whilst the initial course is valid for 3 years, it held the recurrent training annually. The most recent CRM course which the accident pilot undertook was on 10 November 2017. Some of the content of the CRM training is discussed in a later section of this report.

<u>TSGs</u>

The TSG reported that he had not received specific training on boats, commenting that TSG training tended to be generic because every lift is different.

He indicated that, with the operator's activities being so specialist, the employees themselves tended to be industy experts hence there was limited benefit to using external training providers.

HESLO teamwork

The 'HESLO General SOP' described the HESLO crew composition as being the *'pilot'* – who is *'assisted by Task Specialists Ground, and sometimes by a Task Specialist Air'* (TSA)[18]. It stated:

> *'…It is the pilot's responsibility to assess the suitability of each load for safe carriage in flight. He can be assisted in this duty by a company ground handler but the responsibility remains his. He should be particularly careful of loads on pallets, in fertiliser bags, rigged by polypropylene slings, or which, by virtue of their light weight and large surface area, are likely to be unstable in flight. Pilots should consider the use of nets with such loads.'*

The TSG's *'Function on site'* in the SPO Manual involved the preparing and checking of loads, and the completion of load-related work whilst under the helicopter. TSGs maintain radio contact with pilots when possible, using radio phraseology to assist the pilot in manoeuvring the helicopter, and in the case of an emergency.

The introduction to the *'Ground Handlers Manual'* stated:

> *'Aerial work is very much a team effort; just as a pilot must be expected to have the aircraft and airborne equipment under control, groundcrew should be fully in charge of what is happening on the ground. Groundcrew are the eyes in the back of the pilots head and can often be aware of situations occurring that the pilot is not or cannot be aware of. The groundcrew are, therefore, a very important half of the load lifting team.*

Footnote

18 Task Specialist Air - performs specialised tasks on board or from the aircraft.

> *The nature of the job is such that each situation is different and will present a different set of problems and hazards. It is therefore impossible to lay down a set of rules to cover every eventuality; indeed what may apply in one circumstance may be entirely inappropriate in another. There are however some general modes of conduct which universally apply and a proper understanding of what is involved in the various operations [the operator] undertakes is necessary for tasks to be completed satisfactorily. The aim is to keep ourselves and the customer happy, safely.'*

The operator described the teamwork between a HESLO pilot and TSG as an "orchestrated sequence of events" and recognised its similarity to a multi-crew[19] operation.

The SPO Manual indicated that TSAs acting as observers on specific jobs were required to undergo formal CRM training, stating:

> *'Crew Resource Management* [CRM] *techniques facilitate effective co-operation between the pilot and observer, which can greatly enhance safety.'*

The TSG training syllabus included the heading *'Human factor principles',* and the Ground Handler's Manual contained a section on *'Interpersonal Communication'*. TSG's did not undergo formal CRM training. However, the operator reported that prior to the accident it had already committed to extending CRM and HF training to TSGs and, further, to all staff obliged to receive training. It intends to bring more of its CRM training 'in-house' and stated that a company-wide understanding of how behaviour, attitude and performance can affect decision making, and therefore safety, is highly desirable.

Operations procedures for load carriage

Job sheet and method statement

In accordance with the operator's procedures, after providing a quote to the client, the Operations team sent a jobsheet to the pilot. This contained the logistical arrangements[20] for lifting Boat 1. Boat 2 was unknown to the operator prior to the accident.

A generic method statement had been created for the client in 2012, applicable to HESLO jobs. It outlined the method of operation in general terms, along with relevant risk assessments[21]. It did not pertain to the technical aspects of lifting underslung loads by helicopter.

The operator stated that unusual aspects of a load would often be picked up at the quotation stage. It defined the maximum weight of an underslung load on the AS350 as 950 kg. It did not specify a minimum weight, but reported that an estimated weight of 200 kg or less

Footnote

[19] An aircraft operation that requires at least two pilots.
[20] For example, client details, relevant locations, and estimated weight of the load.
[21] For example, 'HESLO General', 'Groundhandler General' and 'Refuelling'.

would tend to prompt a discussion about the structural characteristics of a load concerning the speed and distance for transporting it. A member of the Operations team commented that he would flag up such a load to the pilot concerned.

The operator explained the nature of HESLO work meant that clients often asked crews to perform additional lifts 'on the day'. In such cases, a pilot would make a decision based on factors such as the suitability of the load, fuel, and time available. The pilot would then communicate the resulting number of lifts back to the Operations team for invoicing[22]. The operator stated that it would only expect to be told about additional lifts if other jobs or resources might be affected.

Risk assessments

Each HESLO SOP contained applicable generic risk assessments (RAs). For the HESLO General SOP these included a 'HESLO General' RA and additional, more specific RAs, for example, *'Task Specialists Rotors-running'*, *'Slinging over Powerline'* and *'Pallet Loads'*.

The *'Safety Management System (SMS) Risk Assessment Form'* for the HESLO General RA listed applicable hazards, alongside their control measures, with a 'final risk' designated by a 'traffic light' format[23]. One hazard and its control measures were described as follows:

> *'Load strikes Tail Rotor (includes flight with an empty chain) and results in loss of control and crash causing death and injury to occupant(s)'.*
>
> *Training and Checking*
>
> *Adherence to* [Helicopter Flight Manual] *speed limit of 80kts*
>
> *Speed reduction in turbulence*
>
> *Mirror*[24]
>
> *Take particular caution, especially with airspeed, for light and unstable loads'*

That hazard was given a final risk of 5 ('amber'), which is derived from a severity score of 5 ('catastrophic') multiplied by a likelihood score of 1 ('rare'). Amber is defined as

> *'…stop, think. If management available obtain permission OR go ahead if you consider it safe and inform management when you return to base'.*

The operator commented that HESLO mainly operates in the 'amber' band.

Footnote

22 Clients would normally be quoted a price 'per lift'.
23 Red, amber or green, based upon a combination of severity and likelihood.
24 External mirrors are fitted to HESLO helicopters to give pilots a view of underslung loads.

Section 8.13.1 of the SPO Manual, 'Risk Assessments', stated:

> *'In addition, pilots (assisted by Task Specialists) shall make a local informal (unwritten) Risk Assessment of the work to be carried out bearing in mind the environment and circumstances pertaining on that day. For HESLO pilots this local RA is recorded on the… Daily Site Briefing and Risk Assessment form… which is returned to Operations for filing.*

The form would generally be completed at the start of a duty and did not pertain to the loads themselves.

A Daily Site Briefing and RA form for the accident duty was not subsequently located.

Information on unstable load carriage

The operator's HESLO expert indicated that when carrying a UoPUL he would recommend increasing the airspeed incrementally, checking the load in the mirror at each stage, to a limited maximum airspeed. Using an example of some fencing being transported, the control measure was to fly at 40 KIAS, rather than 60 KIAS.

The *'Emergency Procedures'* section of the operator's SPO Manual stated:

> *'If the pilot experiences a serious emergency, engine failure etc., he will… Jettison the load…'*

The TSG estimated that he had assisted with slinging around 12 boats and described them as unpredictable. Vertical lifts were preferred because in a horizontal, 'boating' orientation they might behave like a "wing".

Safety Management System

The operator reported that it designed and promoted its own safety management system (SMS)[25]. This included a 'blog' where all employees could comment and share information on safety related matters. The pilot was reportedly an active participant.

The TSG commented that the operator's safety culture was good, and that reporting was encouraged for all personnel.

Decision making surrounding the carriage of loads

Human factors

The European Helicopter Safety Team (EHEST) produced a training leaflet entitled *'Decision Making for Single Pilot Helicopter Operations',* which stated:

> *'Certain biases are very well known in an operational context, such as the willingness to please a customer or to complete the mission…'*

Footnote

25 SMS – Systematic approach to managing safety, including the necessary organisational structures, accountabilities, policies and procedures.

'Plan continuation bias' is the unconscious cognitive bias to continue with the original plan. It may obscure subtle cues which indicate that underlying conditions and assumptions have changed[26]. EHEST's document suggests that plan continuation bias often occurs in dynamically changing conditions.

EHEST's leaflet also discusses the following:

> *'Heuristics are simple mental rules used to solve problems and make decisions, especially when facing complex problems, incomplete information and time constraints… Studies indicate that pilots often take decisions using a heuristic approach based on past experience instead of thoroughly analysing the situation. With acquiring experience, most of what we do gets 'routinised' and is performed in an automated manner.'*

The document outlines strategies which benefit decision making, including single pilot CRM training, the application of standard operating procedures (SOPs), and the use of decision making aids, explaining:

> *'SOPs… provide pilots with pre-planned responses that manage the risks and break the "chain of events" leading to accidents...'*
>
> *'Decision aids are easy to remember lists intended to support the decision maker... They are particularly beneficial in the case of critical and stressful situations.'*

The FAA cites some example decision making aids[27]:

> *'Pilots can help perceive hazards by using the PAVE checklist of: Pilot, Aircraft, enVironment, and External pressures. They can process hazards by using the CARE checklist of: Consequences, Alternatives, Reality, External factors. Finally, pilots can perform risk management by using the TEAM choice list of: Transfer, Eliminate, Accept, or Mitigate.'*

Information from the operator

The *'Single Pilot CRM / Pilot Decision Making'* course used by the operator included sections on *'Decisions…'* and *'Decision Making Models'*, and included decision making aids, such as *'DECIDE'*, which stands for *'Detect... Estimate… Choose… Identify… Do… Evaluate'*. It suggested that the *'Evaluate'* step helps to avoid plan continuation bias.

The operator reported that it was very familiar with the concept of structured decision making. The 'Training' part of its Operations Manual stated that pilot decision making is assessed as follows:

Footnote

26 https://www.skybrary.aero/index.php/Continuation_Bias [accessed 1 April 2019]
27 https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/phak/media/04_phak_ch2.pdf [accessed May 2019]

> *'…If more time is available, it should be an Analysed decision (ie How much Time is available for the decision? Diagnose what the challenge is. Assess what options are available. Decide which option to implement? Does he Review how the option is progressing to see if it's working as he intended?'*

The accident pilot's training records did not reveal any problems in decision making. Under *'Decision Making'* in his most recent Operator Proficiency Check *'CRM Assessment'* form, the assessor had written *'Very Very professional. A Very comprehensive flight. Excellent TEM'*[28].

The operator indicated that a balance must be struck between pilots 'sharing' their decisions, but also being respected for the decisions they make. An individual pilot's experience and contextual factors 'on the day' mean that decision making varies. On-site crew often cannot contact Operations due to the lack of a mobile phone signal.

Section 8.13.3.6.2 of the SPO Manual stated:

> *'If work cannot be carried out safely even after additional control measures are put in place, or it is not possible to put in place additional control measures, or it is not possible to arrange an alternative safe system of work then the pilot is to inform the client and Operations that the work cannot be carried out.'*

Section 8.3.31 of the SPO Manual stated:

> *'Our pilots understand that the purpose of our flying is to carry out that mission because that's how we stay in business. It's easy to say that "safety comes first" (without thinking about it) but there is a difficult balance to be struck between the attention a pilot pays to safety and the attention he pays to the mission.*
>
> *Perhaps the best way to reach that balance is to have in one's mind the idea that there are two separate functions (safety v mission) and that they are not equal – the mission will occupy a lot of time but failure will have only relatively modest monetary consequences, whereas safety will require action only occasionally but may have very big consequences indeed (also in business terms, if consequent reputational damage is taken into account).'*

The operator believed that the accident crew did as expected by identifying Boat 2 as being potentially unstable and stopping work to discuss it.

Footnote

[28] TEM – Threat Error Management.

Analysis

Engineering

Analysis of the wreckage indicated that the lifting chain had contacted the tail rotor blades, severely damaging them. Because of this damage, the tail rotor would no longer be effective in controlling the torque of the main rotor and would most likely have caused severe vibration. The lifting chain became entangled around the tail boom and stabiliser surfaces despite it being released from the helicopter's lifting hook by the pilot.

The weight of the lifting chain and the attached boat at the end of the tail boom would mean the helicopter was outside of its balance limits and would have become uncontrollable.

Load characteristics

The TSG described boats as known for being difficult loads. Their aerodynamic shape gives them the propensity to behave like a wing.

The CAA advised that load oscillations can result from a combination of the stability characteristics of the load and the forward speed of the helicopter. Loads weighing less than 227 kg should be low drag and high-density. The safe carriage of particularly low-density or lightweight loads depends upon the speed at which the maximum achieved trail angle is attained, and at which any deterioration in load handling characteristics occurs. Therefore, the acceleration of such a load must be made slowly and cautiously.

As boats, both loads were relatively high drag and low-density, but Boat 2 was significantly lighter than Boat 1 and weighed less than the guideline 227 kg. Furthermore, Boat 2 could not be carried in the preferred orientation. Both of these factors meant that the aerodynamic effects would have been greater on Boat 2, hence there was a significantly increased risk of it becoming unstable at a lower airspeed.

The operator stated that when lifting a UoPUL it would advise increasing airspeed incrementally, checking the load in the mirror at each stage, and using an airspeed limit – for example, 40 KIAS, when using a 10 m lifting line. G-PLMH's groundspeed for both boats increased at a similar, linear, rate. Using Benbecula Airport's forecast wind of 180° at 14 kt, the helicopter reached an estimated airspeed of around 57 KIAS with Boat 1, and the accident occurred with Boat 2 at an estimated 43 KIAS. The pilot commented that the wind at his location felt stronger than that reported, therefore the airspeed could have been higher than estimated. The characteristics of Boat 2 and the method in which it was carried created a load which became unstable so suddenly that any precautions taken by the crew were insufficient to prevent the accident.

Although the pilot appeared to have jettisoned Boat 2 from the helicopter, eyewitness accounts of it lifting quickly suggest there was insufficient time for this action to have had an effect.

A company-standard 10 m lifting line was used to lift the boats. It is possible that a longer line would have given the crew more time to react in the event of the load becoming unstable.

Operator's culture, procedures and training

The operator's safety culture was described by the TSG as good. Its SMS included an informal way for crews to share safety related information, and the pilot was reported to be an active participant in this.

The operator's SPO Manual contained specific guidance for some types of loads and operations, and its training syllabus contained subjects relevant to UoPULs. However, there were no formal procedures for the carriage of boats, or for UoPULs in general.

The operator reported that, after the accident, it temporarily curtailed the carriage of boats, caravans and aeroplanes. It has also made significant changes to its operational procedures, which are listed in the Safety actions section of this report.

The safety actions which relate to load characteristics include the addition of guidance to the SPO Manual, the HESLO 1 training syllabus, and the Ground Handler's Manual on: the identification of UoPULs, preparation and acceptance of UoPULs, rigging of UoPULs, and flying techniques for UoPULs. Some of the items discussed are: low-density loads, aerodynamic shape, load orientation, and methods of rigging loads for increased stability. The operator has increased the length of the standard lifting line for UoPULs to 20 m, with a combined airspeed limit of 60 KIAS. Where shorter lifting lines are required, the limit is 40 KIAS and, for some operations, 30 KIAS. Incremental airspeed accelerations of 10 KIAS must be used, continually watching the UoPUL in the mirror. If the status of the load changes at any time, the airspeed must be reduced to below 40 KIAS, and if the line goes slack, the load must be jettisoned.

Decision making

HESLO pilots have ultimate responsibility for the acceptance and carriage of loads.

The operator stated that operators in general design their own HESLO training courses. It normally recruited HESLO pilots already with HESLO expertise and their training consisted of a familiarisation on company procedures, followed by a structured introduction to flying tasks. Due to the varied work experience of its pilots, the operator emphasised ingraining its safety culture. Much of the training content was discussion-based, and was not necessarily documented.

The TSG explained that the operator's staff themselves tend to be the HESLO experts. Further, the operator stated that the variety of the work made it difficult to lay down rules to cover every eventuality. Therefore, pilots made their own decisions on the acceptance of loads based on their experience, and those decisions were generally "respected" by the operator. The Operations' procedures supported pilots' decision making, for example, by flagging up unusual loads, but its information was limited to that available beforehand. Therefore, the single pilot nature of the operation, the variety of the work, and often remoteness of locations, meant that HESLO pilots often made decisions in relative isolation.

For the accident duty, Boat 1 had been processed by Operations, its estimated weight was given to the pilot, and it was available for inspection by both crewmembers before work began. As could sometimes occur, Boat 2 arrived after work had started. It had bypassed the filter of Operations and, despite it looking lighter, the crew may not have been aware of its probable weight. Therefore, much of the decision making for Boat 2 occurred in the dynamic, working, environment, and initially when the pilot was not present.

There was no evidence that the crew were predisposed to accept Boat 2 for flight. The crew had exhibited caution by stopping working to discuss it, in line with the operator's expectations. However, this occurred with the customer and others present, and in deteriorating wind conditions, which the pilot had indicated felt stronger than that reported by ATC. The control measure discussed by the crew was to fly Boat 2 particularly slowly, but the helicopter's eventual flight profile for both boats was almost identical. Therefore, in the dynamic conditions, plan continuation bias may have masked the changes in the underlying conditions and assumptions for Boat 2, for example, the weight and rigging method. Other biases, such as those to satisfy the customer and/or to complete the mission, could have been present.

It is possible that the 'inherently hazardous' nature of HESLO activities can become 'routinised', leading experienced pilots to use a heuristic, and less structured approach to their decision making. The operator was familiar with structured decision making and this was discussed in the 'Single Pilot CRM/Pilot Decision Making' course completed by the pilot. However, given the potentially isolated and complex nature of HESLO decisions, and the possibility for incomplete information and time constraints, additional assistance for pilots in structuring their decisions could be beneficial.

In line with EHEST's advice on SOP's, the written guidance on UoPULs produced by the operator after the accident will provide some *'pre-planned responses to manage risk'*. This could benefit structured decision making, for example, when considering load density, weight and structural characteristics, in combination with rigging method and control measures. This could be particularly beneficial when presented with additional loads on the day.

The operator's new guidance includes the following items: TSGs must alert pilots to UoPULs and they must examine such loads together; adequate time must be allowed for the assessment, rigging, and application of control measures for UoPULs; both pilots and TSGs appreciating the increased time for delivering a UoPUL and managing customer expectations accordingly; and it states *'the company will support any pilot who declines to carry* [a UoPUL] *on the grounds that he is not able to put in place adequate control measures'.*

'Decision Making Aids', like *'DECIDE'* or those described by the FAA, can structure decision making in critical and stressful situations.

The operator has subsequently undertaken to document guidance on decision making. It intends to select a generic decision making aid and endorse its use by pilots, TSGs, operations officers and managers.

CRM

The operator's SPO Manual described TSGs as a 'very important half of the load lifting team', who 'should be fully in charge of what is happening on the ground'. TSGs provide technical assistance in manoeuvring the helicopter, and the operator described the teamwork between them and pilots as an "orchestrated sequence of events". Whilst at the time of the accident TSGs did not receive formal CRM training, the accident TSG was very experienced and, upon inspecting Boat 2, initiated stopping work to discuss it with the pilot.

The operator explained that, whilst CRM training for TSGs was not in place at the time of the accident, it had already undertaken to bring its CRM training more 'in-house' and extend it throughout the organisation. It intends to incorporate its chosen decision making aid in to CRM training. Training for TSGs and pilots could involve practising structuring decisions together, which result in a verbalised 'go/no go' decision and, where applicable, a summary of control measures. CRM training may assist less experienced TSGs to initiate safety related discussions.

Survivability

<u>Pilot's flying helmet</u>

The post-mortem found that the pilot had sustained a severe head injury. He had been wearing a protective flying helmet but there was no evidence of a significant impact on it, and examination revealed that its chin strap had been unfastened at the time of the accident. It is therefore likely that the motion and forces experienced during the accident sequence had dislodged the helmet from the pilot's head and it was no longer protected. It is possible that the pilot forgot to re-fasten his chin strap after vacating the helicopter to discuss Boat 2.

The donning of flying helmets was already mandated by the operator. As a result of this accident, it released a Safety Information notice stating that flying helmets must fit and be properly secured.

<u>Pilot's seat</u>

The pilot's seat structure had failed, compromising the degree of restraint of the pilot in the accident. The seat met the standards required at the time of certification, but standards have improved over time. However, the new standards only apply to helicopters certified at the time they are in force and do not have to be retrospectively applied to previously certified helicopter designs. The manufacturer had made available an improved, stronger seat and its fitment was optional. It had not been fitted on this helicopter and nor was it required to be.

It is not possible to determine in this case what the effect, if any, the stronger seats would have had on the pilot's survivability.

Conclusion

The accident occurred because the helicopter's underslung load became unstable and flew up, striking the helicopter's tail rotor. The helicopter became uncontrollable and descended rapidly into Loch Scadavay.

The load, which was a boat, became unstable because of a combination of its low weight, low-density, and aerodynamic shape, with the linear acceleration of the helicopter to an airspeed above 40 KIAS.

The pilot sustained a severe head injury during the accident. It appeared that his helmet had become dislodged because the chin strap was unfastened.

Safety actions

As a result of this accident, the operator has taken a number of safety actions intended to prevent similar accidents in the future. It has:

- Temporarily curtailed HESLO operations involving the carriage of boats, caravans and aeroplanes.
- Released a Safety Information notice reminding pilots and TSAs that helmets must be worn onboard, which must fit and be properly secured at all times.
- Increased the length of the standard lifting line for UoPULs to 20 m, with an associated airspeed limit of 60 KIAS. Where shorter lifting lines are required, the airspeed limit is 40 KIAS and, for some operations, 30 KIAS.
- Added a section on *'Identification of Unstable or Potentially Unstable Loads (UoUPL)'* to its HESLO 1 pilot training syllabus. This contains sections on low-density loads and aerodynamic shape, and refers to load orientation. It states that *'any change in the status of a load in flight calls for an immediate reduction of speed below 40 KIAS'.*
- Significantly expanded its SPO Manual and Ground Handler's Manual guidance on the preparation and acceptance of loads to emphasise UoPULs. This includes information on low-density loads and aerodynamic shape, and methods of rigging loads to increase their stability, eg cargo nets, and amalgamation.
- Provided guidance in its Ground Handler's Manual which explains that pilots and TSGs should examine UoPULs together. Adequate time must be allowed to assess and rig UoPULs, and to put adequate control measures in place. Customer expectations should be managed accordingly.
- Added a section on flying techniques for UoPUL to its SPO Manual, which includes: accelerate in 10 KIAS increments; continually observing the load in the mirror; if the line goes slack, jettison the load; and states that *'the*

company will support any pilot who declines to carry [a UoPUL] *on the grounds that he is not able to put in place adequate control measures'.*

- Undertaken to continue with its plan to extend its CRM training throughout the organisation and bring more of that training 'in-house'.
- Undertaken to produce written guidance on decision making. Furthermore, to select and endorse a decision making aid company-wide and incorporate it in to CRM training.

Published: 18 July 2019.

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 Helicopters AS 350, VP-CIH
No & Type of Engines:	1 Lycoming LTS101-600A-3A
Year of Manufacture:	1981 (Serial no: 1411)
Date & Time (UTC):	30 August 2018 at 1540 hrs
Location:	Owen Roberts International Airport, Grand Cayman
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 1 Passengers - 4
Injuries:	Crew - None Passengers - None
Nature of Damage:	Tail rotor gearbox actuating rod failure
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	Not known
Commander's Flying Experience:	19,000 hours (of which 10,000 were on type) Last 90 days - 34 hours Last 28 days - 11 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The AS 350 helicopter suffered tail rotor control problems in flight due to a rupture of the tail rotor gearbox (TGB) actuating rod. The pilot carried out a successful run-on landing. On 20 March 2019 the EASA issued Airworthiness Directive 2019-0060, mandating an inspection of TGB actuation rods to check for cracks.

History of the flight

The helicopter was carrying out a 20-minute sightseeing tour of Grand Cayman with the pilot and four passengers on board. Whilst descending through 500 ft and turning onto final approach for George Town Aerodrome, the pilot felt that the tail rotor pedals were not producing the correct yaw response, so he aborted the approach and informed ATC he would be returning to Owen Roberts International Airport. On the approach to the latter he tested the directional control, which did not respond correctly, so he informed ATC that he planned to conduct a run-on landing and requested fire service attendance. On assessing the condition of the grass surface, he decided it was too soft to achieve a safe run-on landing and so he flew another circuit, followed by a run-on landing on Runway 26. This was carried out successfully and at the end of the run the pilot exited to the left onto the grass to clear the runway for following traffic. All occupants disembarked without injury.

Aircraft/component examination

During examination of the helicopter it was found that the TGB actuating rod (part number 350A27191003) had ruptured at the aft end (Figure 1). No other damage was evident from the in-depth inspections of the airframe and flight controls requested by the helicopter manufacturer. The manufacturer reported that this was the first such event on the AS 350 that they were aware of.

Figure 1

Photo showing rupture at aft end of TGB actuating rod

The failed component was forwarded to the manufacturer, where a defect investigation was carried out under the supervision of an investigator from the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA).

It was established that the rupture of the TGB actuating rod was associated with the uncoupling of the steel sleeve inside the external aluminium alloy tube. An anomaly in the internal structure of the material of the rod was identified, along with the presence of cracks in a cold worked area. The same TGB actuating rod is used on AS 355 helicopters.

Safety action

As a result of these findings, on 20 March 2019 the EASA issued Airworthiness Directive 2019-0060, mandating dye penetrant crack checks of TGB actuating rods on affected AS 350 and AS 355 helicopters.

SERIOUS INCIDENT

Aircraft Type and Registration:	DHC-8-402 Dash 8, G-FLBC
No & Type of Engines:	2 Pratt & Whitney Canada PW150A turboprop engines
Year of Manufacture:	2009 (Serial no: 4257)
Date & Time (UTC):	28 January 2019 at 0930 hrs
Location:	En route from East Midlands Airport to Edinburgh Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 4 Passengers - 59
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	32 years
Commander's Flying Experience:	6,504 hours (of which 6,227 were on type) Last 90 days - 175 hours Last 28 days - 57 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During the climb the crew noticed a high rate of increase in the cabin altitude, accompanied by physical air pressure sensations. The CABIN ALTITUDE warning occurred shortly thereafter. An emergency descent was conducted and the aircraft continued to its planned destination.

History of the flight

On the sector before the incident flight, the aircraft had suffered a minor problem with the pressurisation system. The crew of the incident flight had been in communication with Company Maintenance Control regarding this issue.

The aircraft departed East Midlands at 0900 hrs on a scheduled flight to Edinburgh. The initial departure was routine. On passing approximately FL150 in the climb, a rapid cabin altitude climb rate developed and the crew felt the associated atmospheric effects. This was quickly followed by a CABIN ALTITUDE warning.

The crew donned oxygen masks, began an emergency descent and made a MAYDAY call to ATC. The cabin crew were informed when the emergency descent was complete, in accordance with SOP, and there was a discussion to establish the cabin environment and crew welfare. The cabin crew made a PA, reading from the emergency PA aide memoire. The flight crew completed the '*Rapid Depressurisation or Emergency Descent'* checklist and this directed them to the 'M*anual Pressurisation'* QRH checklist which was actioned. Unable to control the pressurisation manually they completed the *'Unpressurised Flight'* QRH checklist.

With sufficient fuel and suitable weather en-route the commander decided to continue to Edinburgh. The commander briefed the cabin crew on the event and his intentions and made a PA to the passengers. The initial MAYDAY was downgraded to a PAN and the flight concluded with an uneventful approach and landing in Edinburgh. The airport fire service had been alerted and the crew established communication with them after landing. The fire chief took a statement from the commander, and the passengers disembarked shortly afterwards.

It was established subsequently that there was a hole in the lower lip of the rear baggage door seal. There were no further occurrences following the change of seal.

Conclusion

The aircraft suffered a cabin depressurisation during the climb caused by a hole in the rear baggage door seal. The crew carried out an emergency descent and continued to their destination.

SERIOUS INCIDENT

Aircraft Type and Registration:	Sikorsky S-92A, G-CKXL
No & Type of Engines:	2 General Electric Co CT7-8A turboshaft engines
Year of Manufacture:	2014 (Serial no: 920242)
Date & Time (UTC):	23 August 2018 at 1120 hrs
Location:	On Approach to the Brae Bravo platform, northern North Sea
Type of Flight:	Commercial Air Transport
Persons on Board:	Crew - 2 Passengers - 17
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	56 years
Commander's Flying Experience:	10,968 hours (of which 2,453 were on type) Last 90 days - 62 hours Last 28 days - 26 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The pilots were operating the S-92A helicopter on a multi-sector route between platforms in the Brae field in the northern North Sea, approximately 150 nm north-east of Aberdeen. On the third sector from the East Brae platform to the Brae Alpha platform, the pilots mis-identified the Brae Bravo platform as the destination and made an approach to the hover above the deck of the platform. The radio operator on the Brae Bravo platform told the pilots that they had made an approach to the wrong deck; following clearance to depart, the pilots continued the flight without further incident.

The operator stated that it would conduct additional training addressing the task management requirements and complexity during shuttling[1] to prevent a recurrence.

History of the flight

The pilots reported at 0900 hrs for a multi-sector flight carrying passengers and freight to the Brae field. The routing was Aberdeen/Dyce (EGPD) – Brae Bravo platform (BRAB) – East Brae platform (EBRA) – Brae Alpha platform (BRAA) – Aberdeen/Dyce (EGPD). This

Footnote

[1] Shuttling is the act of flying between installation helidecks which are less than 10 nm apart.

was the 3rd line training[2] flight for the co-pilot (P2) following conversion to type. The operator had allocated a Sikorsky S-92A, registration G-CKXL, to the flight.

The pilots conducted pre-flight planning, which covered a detailed briefing on the weather, confirmed the routing, and consulted the Heli-deck Directory[3] (HD). The pilots assessed that all three landings required a similar approach path, routing around the flare-stacks on the northern side of the platforms and turning left to land on the helideck in a southerly direction, while accepting light cross-winds. Owing to the wind direction, all the landings were required to be flown from the left seat (LHS). Consequently, the PIC decided that he would occupy the right seat (RHS) carrying out the Pilot Monitoring (PM) role, while the P2 would occupy the LHS carrying out the Pilot Flying (PF) role.

During start-up, the crew entered the route into the Flight Management System (FMS) using the operator's standard route structure amended manually to reflect the in-field routing. The first sector to the BRAB was conducted without incident. On the second sector, the PIC took control of the helicopter from the P2, who was experiencing handling difficulties, while in the hover over the EBRA helideck. During the turn-around on deck, the PIC debriefed the P2 on the handling of the approach. The pilots confirmed the routing to the next destination as the BRAA in accordance with standard operating procedures (SOPs) and noted that the needles[4] slaved to the FMS were pointing in the expected direction.

The P2 flew the departure from the EBRA on a southerly heading before turning right, whereupon the PIC, acting as PM in the RHS, saw the platform as expected. The PIC noted the FMS needles pointed in the expected direction, and visually identified the platform ahead, mentally noting "there's the rig and the flare-stack to fly around", as had been discussed during the pre-flight planning phase. However, he had mis-identified the BRAB, instead of the BRAA beyond, as the destination.

The P2 proceeded to fly manually, without 'coupling'[5] the helicopter. After listening to the approach and landing briefing given by the P2, the PIC used the time available to coach the P2 on the handling of the approach. The pilots carried out Shuttle Final Checks[6] during the transit to minimise interruption during the final stages of the approach, except for the final 2 items, which involve arming the floats and confirming the deck name. (This is normal practice owing to the float arming IAS limitation on the S-92). At this stage the PIC noted the FMS needles still pointed towards the platform and matched his mental picture.

The P2 flew around the flare-stack to the north, turning left onto the approach and flew to the hover over the helideck. Throughout, the radar remained switched off, as permitted by the Shuttle Final Checks. Although the floats were armed during the final stages of the

Footnote

2 See section – Line Training.
3 See section – Heli-deck Directory.
4 A needle is a pointing device displayed on the electronic compass displays, and which indicates the direction of the navigation aid to which it is slaved.
5 Coupling is the process whereby the flight director is engaged through the use of an automated flight control system to provide automated control of the helicopter's flight controls.
6 These are an abbreviated version of the Final Checks only used when flying between platforms less than 10 nm apart.

approach, the P2 did not read the deck name. (The PIC was unable to see the helideck throughout the latter stages of the approach and did not prompt the P2 to confirm the platform). Whilst G-CKXL was in the hover, the radio operator of the BRAB contacted the pilots on the radio logistics[7] frequency to advise that they had made an approach to the BRAB platform. The pilots acknowledged and, following confirmation from the radio operator that they could proceed, they departed the BRAB. The remainder of the flight was completed without further incident.

Personnel

The commander of the flight was an experienced offshore commander and line training captain (LTC), conducting line training for the P2. The P2 was an ab-initio pilot who had recently converted to type. This was his 3rd line training flight.

Brae field

The Brae field consists of 3 platforms - Brae Alpha (BRAA), Brae Bravo (BRAB), and East Brae (EBRA) – roughly aligned in a north-east/south-west direction.

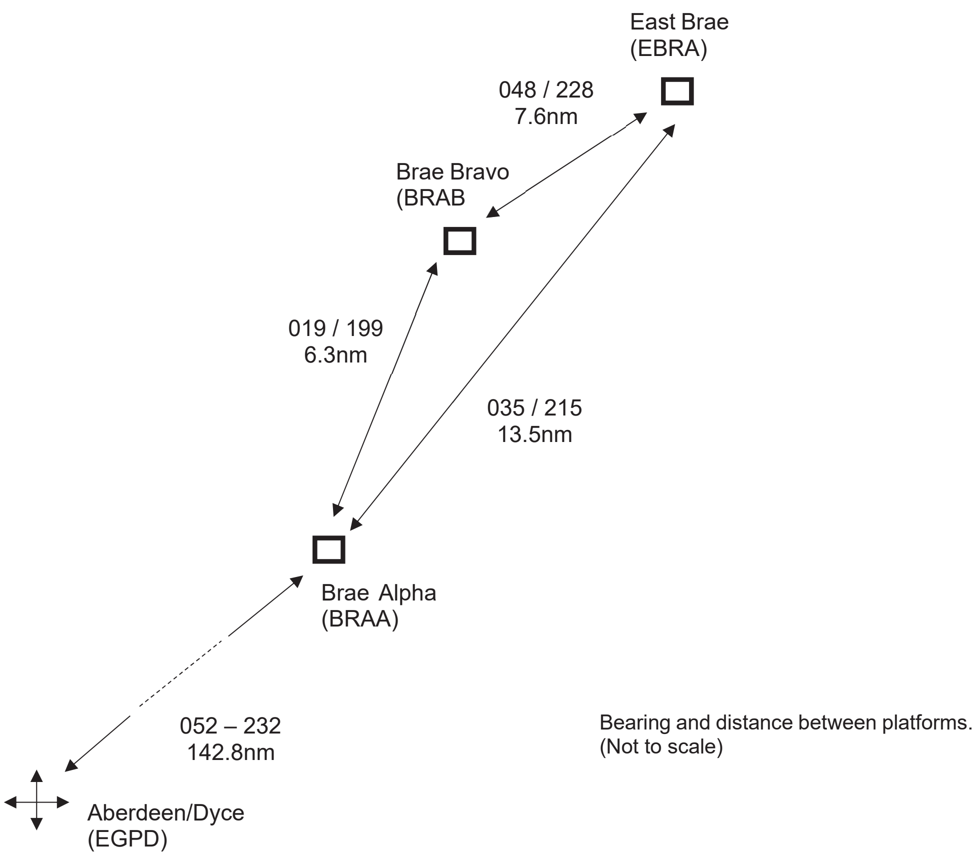


Figure 1

Brae Field

Footnote

7 Crews communicate with the with the radio operator of the platform through the logistics frequency referred to as "Log" allocated to the area in which the offshore installation is located.

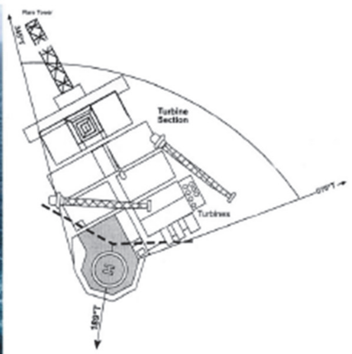
Brae platforms

The platforms share a similar physical configuration and infrastructure, with the helideck on each platform situated on the south-south-west corner with similar helideck headings of 198º. However, each of the platforms exhibit two distinct differences:

- **Flare-stacks**. The EBRA platform has a flare-stack that rises diagonally from the north-west side, whereas the BRAA platform has two flare-stacks that rise diagonally from the north-west and north-east corners. Meanwhile the BRAB platform has a single flare-stack that protrudes horizontally from the lower side of the platform to the north-west.

HELIDECK INFORMATION PLATE

HELIDECK Elev 242 ft	VAR 0	POSITION N58 47.5 E001 20.7	Brae B		
HEIGHT OF INSTALLATION: 414 HIGHEST OBSTACLE WITHIN 5NM: Miller 541			VHF Traf 123.65 Log 129.125	NDB 362 BBV	Issue Date 30 May 2018
FUELLING INSTALLATION: Yes STARTING EQUIPMENT: Yes			Operating Company Marathon		Issued By Helideck Certification Agency
HELIDECK D value: 22.8 P/R/H Category: F Max Weight: 21.0					



Wind (T°)	Kts	Limitation /Comment
• 345-070 • 345-070	• 20-45 • 45+	Platform • Table 1 (T) if overflight of 5:1 infringements listed below are unavoidable • All types use Table 2 weights • No landings • Daylight Only
		Non Compliance
	5:1	Anti turbulence panel NW corner Foam monitor platform on South corner & East side Various deck structures below helideck East side
	Misc	No circle and H Lights Fitted

Copyright HCA

Figure 2

Brae Bravo Platform (HCA)

- **Derricks**. The EBRA and the BRAB platforms each have a single vertical derrick while the BRAA has 2 vertical derricks on the same side of the platform as the flare-stacks. Each of these derricks are 'skidded' and can be moved left and right to the full extent as well as inwards to a more limited extent to allow access to the various well slots on the platform.

Heli-deck Directory

The Helicopter Certification Agency[8] (HCA) is the organisation responsible[9] for the inspection and certification of all helidecks on offshore vessels and installations operating in UK waters on behalf of the oil companies, helicopter operators and other clients. It conducts helideck inspections on a 2-year cycle and uses the guidance in Civil Aviation Authority (CAA) publication (CAP) 437 *'Standards for Offshore Helicopter Landing Areas'*[10] as the basis for the criteria for certification and the format of the HD.

Flight crews use the HD as a guide primarily for the purposes of flight planning. The HD consists of the Helicopter Landing Area Certificates, Heli-deck Information Plates and the Heli-deck Limitations List (HLL), which includes any Temporary Limitation Notices (TLNs), for all helidecks. These provide details of any helideck limitations together with pictorial representations (photographic and diagrammatic where available) of each offshore location and its helicopter landing area, recording all necessary information of a permanent nature using a standardised template[11]. The HD entries show the most recent status of each helideck concerning non-compliance with applicable national standards. Flight crews utilise the information provided in the HD to identify key issues that may affect the safe operation of the flight during approaches and departures to and from the helidecks.

During the pre-flight briefing, the pilots consulted the HD, and reviewed the HCA plates for the platforms as well as Annex 1 to Part E in the (HLL). These provided the pilots with deck information, limitations, wind sectors, restrictions arising from turbulence and non-compliances for the Brae platforms. While the pilots did discuss the flare stacks, they did not use the plates primarily to identify the platforms.

Footnote

[8] www.helidecks.org
[9] As required by EASA under Annex V to Commission Regulation (EU) 965/2012 Part SPA Subpart K Helicopter Offshore Operations (HOFO). This only came into force in July 2018.
[10] CAP 437 presents the criteria required by the UK CAA in assessing the standards of offshore helicopter landing areas for world-wide use by helicopters registered in the UK.
[11] CAP 437 was updated in September 2018 with the introduction of Part SPA.HOFO and the format for the template will be based on the advice given in AMC1 SPA.HOFO (115).

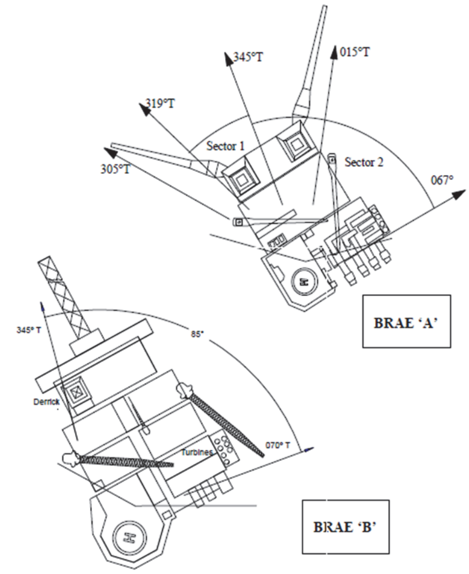
Helideck Limitation List (HLL)

Restrictions for Brae A	
Flare sector 305°- 015°T If both flares flaring at full output.	Landings prohibited in this sector
If wind from 305°- 345°T	Only eastern flare on full output
If wind from 346°- 015°T	Only western flare on full output
Crew should be aware of the effect of turbulence that can be caused by the difference in wind strengths between the top of the derrick and the helideck.	

SECTOR	W/V	Limitations & Comments
319-345°T	30-45	All types Table 2 weight
	>45	Nil Landings.
345-067°T	20-30	All types Table 2 weight
	31-40	Helipad weight (S92 = 24,000lbs)
	>40	Nil Landings

Restrictions for Brae B

SECTOR	W/V	Limitations & Comments
345-070°T	20–45	All types Table 2 weight
	>45	Nil Landings



HLL – Issue 02	Part E – Annex 1	October 2015

Figure 3

HLL Part E Annex 1 – Restrictions for Brae A (HCA)

Navblue Charts+

The operator's electronic flight bag (EFB), which is provided on an iPad mini platform, includes an iPad app called 'NAVBLUE Charts+ (an AIRBUS Company)', provides the pilots with electronic versions of IFR terminal plates, en-route charts and offshore installation and vessel plates, similar to those in the HD produced by the HCA. This is available to pilots for consultation at any stage of flight. At the time of the flight, the pilots also had access to paper copies.

Meteorology

The weather in the Brae field was forecast to have southerly winds at about 20 kt with scattered cloud above 1,500 ft. 20 minutes after the incident the weather at the BRAA was recorded as CAVOK with a wind direction of 200º(M) and a strength of 21 kt.

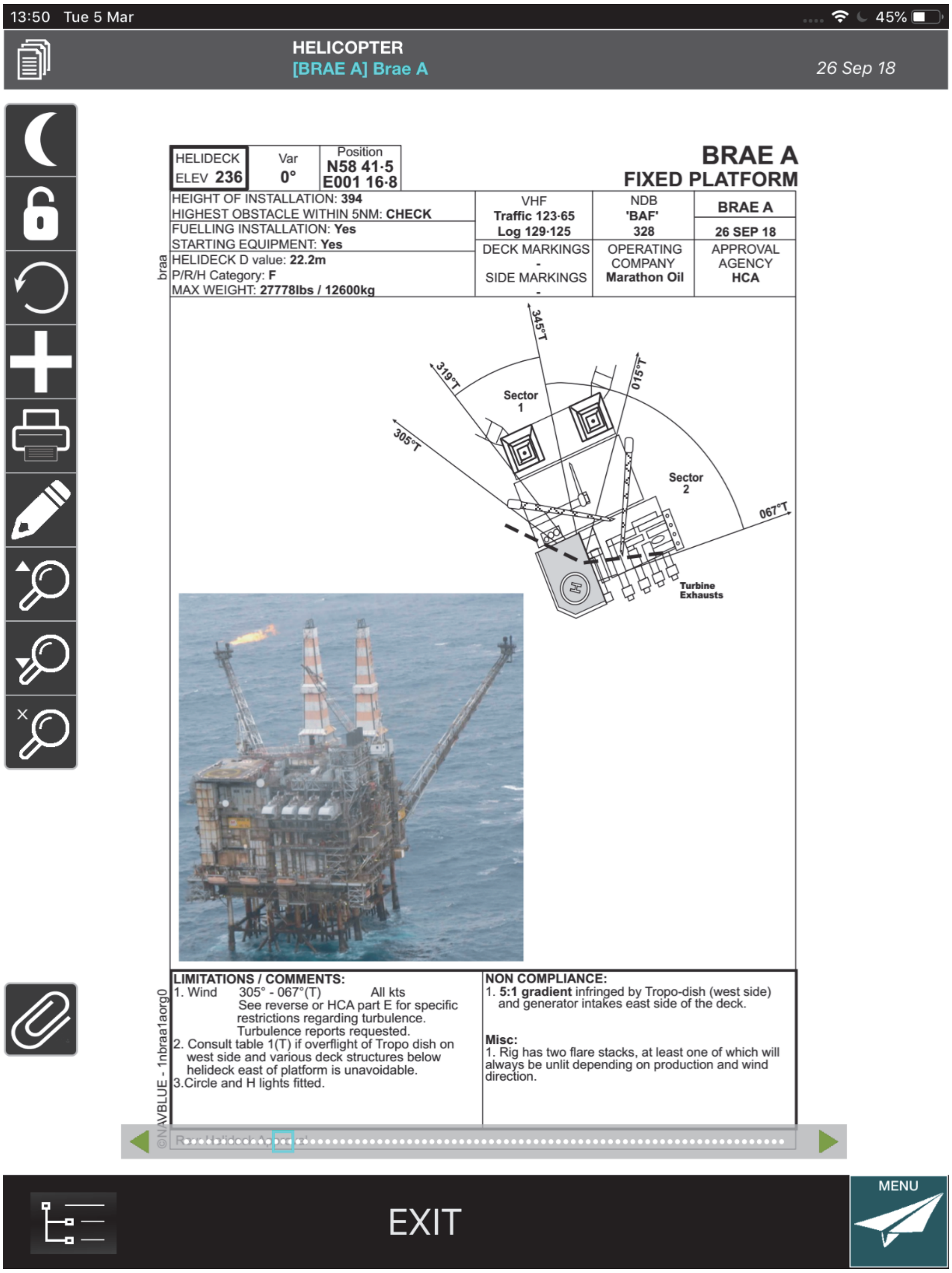


Figure 4

Brae Alpha platform (Navblue Charts+)

Aids to navigation

The FMS, providing GPS guidance, is the primary electronic aid to navigation while operating offshore. It is loaded with a standard aviation database together with the operator's specific database appropriate to the area of operation. Guidance is achieved when the FMS is selected as the primary navigation source to which the helicopter automation is 'coupled'. The flight plan, together with the offshore installations as GPS waypoints, can be overlaid on the navigation screens, which can also display the radar picture at the same time. This enables GPS waypoints to be overlaid on radar returns. There is also the ability to select the FMS as the navigation aid source for the needles on the compass displays, whereby the direction and distance to the active waypoint in the FMS can be displayed. This replicates the display of other electronic navigation aids, such as an NDB needle, and enables the GPS to replace the NDB as the primary means for platform identification. These techniques enable pilots to maintain situational awareness and ensure correct identification of the installations, particularly in low visibility, while operating offshore.

Communications

Pilots communicate with the radio operator of the offshore installation through a logistics frequency. A separate traffic frequency is used for the passing of flight-watch[12] details, enabling flight crews to maintain awareness of other flights operating to different installations in the same area, and to obtain 'helideck availability'[13] from the helideck crews[14]. These frequencies are not specific to the offshore installation but are determined by the area in which it is located. Pilots communicate to the installation on these frequencies using their second VHF radio and monitor both frequencies using both VHF radios once the radar service provided by ATC has been terminated while offshore.

Line training

Line training is conducted whenever a pilot is new to the operator, role, or area of operation. It seeks to develops the skills and knowledge of the pilot and standardise him in the operating procedures as laid out in the Operations Manuals (OM). The focus during the early sorties of line training for an ab-initio pilot is on the handling of the helicopter by the pilot, both through use of automation and manual flying, but with a greater emphasis on manual flying at appropriate stages, while, at the same time introducing the operating flow of a sortie.

Operator standard operating procedures

Prevention of wrong-deck landings (WDLs) are specifically addressed in the OM Part A, using a 5-stage process, which states:

*'**A1 8.2.10 The Avoidance of Wrong Deck Landings (WDL)***

1. As part of the pre-flight planning process discuss the routeing in relation to the other platforms or rigs nearby and the possibility of a WDL. This should include approach directions and deck orientations. If the destination is a NUI, then consideration must be given to completing a pre-landing orbit to confirm identity, weather permitting;

Footnote

[12] Flight-watch is a service provided by the platforms in the absence of a radar service being provided by ATC.
[13] Flight crews request 'deck availability' from the helideck crew of the destination platform to establish that the helideck crew have prepared the helideck and are ready for the helicopter to land.
[14] The helideck crews are responsible for the manning and running of helideck operations and are led by a Heli-deck Landing Officer (HLO).

2. *Always put the full route in the FMS, using route discontinuities to ensure the next destination is held. Where possible, add other nearby locations to improve situational awareness. What is possible will depend upon aircraft type and guidance will be added to each Part B.*

3. *Confirm that the route as planned matches the route manifested by the client and the route programmed into the FMS.*

4. *Pilot monitoring to use the HCA app on company iPads as part of the approach brief. A quick review of the picture, layout and any limitations serve as a useful prompt.*

5. *Finally, read the name on the destination and cross-check with the other pilot against GPS/FMS bearing and distance. This really is the final barrier and has prevented a number of WDL's. Pilots need to be wary of 'expectation bias'; i.e. seeing what you expect to see'*

Analysis

The incident arose from the pilots initially misidentifying and selecting of the BRAB as the destination and subsequently not detecting this incorrect selection.

Prevention and recovery controls.

Analysis identifies the following prevention controls proved ineffective:

- The pilots did not explicitly establish a shared understanding of the potential for incorrect platform selection during the pre-flight planning phase through the use of the HCA plates to establish key identifying features and differences between the platforms;
- The pilots did not maintain adequate situational awareness in-field and did not make appropriate use of cues by reference to the electronic navigation tools available and which would have alerted them to the incorrect selection of the destination platform:
    - No reference was made to the FMS range to the platform displayed in the navigation source on the multi-function displays (MFD) which is on both the primary flight display (PFD) and Nav pages displayed, nor to the FMS routing displayed on the MFD showing the Nav page;
    - The radar remained in standby; this further reduced the likelihood of the attention of the pilots being drawn to the MFD with the Nav page displayed, which also shows the FMS routing.
    - The pilots did not make use of the Navblue Charts+ app on the operator's EFB during the brief on the deck of the EBRA iaw SOPs.

- The WDA path being flown to the BRAB by the helicopter at the time that ‘deck availability’ was requested and given could not be detected by the helideck crew on the BRAA.
- The pilots did not detect and recognise the WDA through reading the platform name in accordance with SOPs.

However, the following recovery controls successfully prevented the WDA from being converted into a WDL.

- The BRAB radio operator advised the pilots of a WDA, when the helicopter was in the hover above the helideck;
- The pilots responded appropriately.

Several factors led to these prevention controls being ineffective:

1. **Platform alignment**. Although the FMS routing was correct and the display of the FMS needle pointing in the correct direction was checked by the pilots, the alignment of the BRAB and the BRAA platforms, coincident with the routing, undermined the assurance of this check; the BRAB, being the nearest platform, was the most salient target. This alignment may also have contributed to the BRAA being obscured behind the BRAB. This deprived the pilots of adequate situational awareness following departure from the EBRA at the point which the PIC visually acquired the BRAB and selected it incorrectly as the destination, as well as the ability of the pilots subsequently to identify this error.

2. **Platform characteristics**. The three platforms in the Brae field share an overall visual similarity in configuration and infrastructure. This lends the BRAB to display many decoy characteristics with the other platforms in the field. Each of the platforms do have distinctive differences, in particular the BRAB with its horizontal flare boom. However, when approached from certain directions, these differences are unlikely to be sufficiently obvious, following an incorrect selection of one of the platforms as the destination, to override the existence of any expectation and confirmation bias during a high workload environment, and to enable the pilots to trap any selection error. The skidded nature of the derricks could mean that the location of the derrick would be marginally inward from the edge of the deck or on the opposite lateral corner from that indicated on the plate. When approached from certain directions, this might fundamentally alter the visual aspect from that determined at the pre-flight planning stage by the pilots through consultation of the plates. However, on this occasion, because of the direction of the flight path flown, any differences are unlikely to have had any influence.

3. **Helicopter Directory**. The limitations of the HD hinder the use of the plates by pilots to identify key features for the purpose of visual identification of the platform. The helidecks are reviewed on a 2-year inspection cycle and the photographs used are not routinely updated and may therefore present a visual image that is many years old. Visual aspects, such as platform colour, and the location and visual aspect of the name signs may have changed in the intervening period from when the photograph was taken. The direction from which the photographs were taken is not consistent throughout the HD. There is no reference to the skidded nature of the derricks in the plates. Together, these undermine the ability of the crew to use the plates as a means for establishing visual identification cues.

   The differences between the platforms are not obvious from the plates and require closer scrutiny to identify key identification features. While the pilots did discuss the flare stacks, the plates were not drawn upon primarily for means of identification; the PIC considered the pictures are only of benefit if approaching from the same direction as that of the photograph of the plate. He noted some plates do not even provide photographs and many platforms look very similar.

4. **Operator EFB.** The pilots had an electronic version of the plates for the platforms available to them in the cockpit through the Navblue Charts+ iPad app on the operator EFB. However, the information provided did not differ in quality or in visual imagery to that provided by the HCA plates which the crew consulted during the flight planning phase. It is considered unlikely that further consultation of the plates in the app by the crew during the brief on the deck of the EBRA would have highlighted the key identification features that had not been previously detected during the flight planning phase. Its use by the pilots during the transit to corroborate correct identification of the platform would have been inappropriate due to the short sector and associated high workload

5. **Familiarity**. A perceived sense of familiarity by the PIC, from previous flights to the Brae platforms, combined with the time pressures that exist, particularly in early line training sorties, to achieve an on-time departure, are likely to have overridden a more detailed scrutiny of the HCA 'plates' during briefing, which would most likely have led to the highlighting of the differential characteristics of the platforms.

6. **Weather**. The wind direction combined with the similar position of each of the helidecks on the platforms established similar approach paths. This created the same mental model for the PIC for each approach. The good in-field visibility enabled the pilots to place a lesser reliance upon the FMS as the means for navigation and destination selection, particularly when airborne, when the workload required a focus on helicopter handling and monitoring of the PF by the PIC.

7. **Use of FMS**. The pilots entered the correct routing into the FMS which matched the route manifested by the client. In addition, the pilots correctly followed procedures by inputting a discontinuity[15] after the destination platform to ensure that the FMS did not cycle, during the transit, to the next waypoint.

After the initial confirmation of the route and noting the direction of the FMS needles while on deck of the EBRA, the PIC subsequently identified the destination platform visually. With the good visibility and the short nature of the sector, the choice by the P2 to fly manually was appropriate for the stage of training. However, this choice removed the protection that the use of FMS guided automation would have afforded the crew while potentially highlighting the incorrect visual selection of the destination when the helicopter would have flown past the BRAB towards BRAA.

The pilots did make use of the directional information that the FMS needles provided, but at the time, owing to the alignment of the platforms, there was not enough disparity between the direction of BRAA and that of the BRAB to highlight to the crew that they had selected the incorrect platform as the destination. The pilots did not draw upon the distance clues provided by the FMS, which could have alerted them to the incorrect selection of the BRAB as the destination.

8. **Expectation and Confirmation Bias.** The confirmation of the route by the pilots on the deck of the EBRA, that established in which direction the destination platform lay, set up the expectation by the PIC that the destination platform would be sighted during the right turn following a southerly departure. This expectation was subsequently met by the proximity of the BRAB, with its decoy-pairing characteristics.

The similar approach paths for each of the platforms had set up the conditions for confirmation bias to take hold once the incorrect selection of the destination had been made. In the words of the PIC, on seeing the BRAB, he mentally noted "there's the rig and the flare-stack to fly around". This matched the approach flight path that had been identified in the pre-flight briefing.

9. **Workload**. Two elements contributed to a very high workload that hindered the ability of the pilots to make the correct selection, and then to trap this incorrect selection.

    a. **Shuttling**. The sortie was a multi-sector flight involving in-field shuttling. This involves a high intensity workload both for the PF from the helicopter handling perspective while flying between platforms, as

Footnote

[15] A discontinuity is a means to freeze the flight plan from progressing to the next waypoint in the route.

well as for the PM, owing to the compressed sector times to conduct the required checks while monitoring the flight path and the handling of the helicopter by the PF. These factors would have afforded a very short opportunity for the visual acquisition and scrutiny of the BRAB by the pilots. This led to its incorrect selection as the destination.

b. **Line training**. This sortie was the 3rd line trip for conversion to role for the P2 following conversion to type. The focus of the PIC, as the PM, was the monitoring of the handling of the helicopter by the P2, specifically during the final stages of the approach to a platform. This placed a very high workload on the PIC as LTC, while acting as PM, and led to reduced scrutiny by him when selecting the BRAB as the destination. Once selected, the PIC focused on the more immediate priority of the safe handling of the helicopter to the detriment of other sortie management priorities, including the confirmation of the helideck name, in accordance with SOPs. This effectively removed the opportunity for the pilots to trap the incorrect selection of the BRAB as the destination.

10. **Multi-crew environment.** At this early stage of line training with an ab-initio pilot, many of the defences that are derived from operating in a multi-crew environment were undermined or effectively removed. The P2, as PF, primarily would have been concentrating on the manual flying of the helicopter. He would have had limited capacity to contribute to the broader elements of sortie management, through providing additional scrutiny of the selection and identification of the platform. The P2's focus on the helicopter handling in the final stages of the approach will have drawn his attention away from reading the name of the platform on the helideck, as required by SOPs.

11. **Brae Alpha platform helideck crew.** The HLO of the BRAA would not have been able to identify that a WDA was being made at the time that the pilots requested 'deck availability'. The helicopter would have been at about 7 miles distant from the BRAA, at which range it is highly unlikely any of the helideck crew would have sighted the helicopter; nor would they have been able to detect an incorrect flight-path. In this situation, visual identification by the helideck crew cannot be guaranteed as a reliable prevention control. The request and confirmation of 'deck availability' regularly occurs at or beyond the visual line-of-sight of the helideck crew and before the turn onto the final flight path is made, as this action is carried out by the PM at an appropriate point in the approach.

12. **Brae Bravo platform radio operator.** Although a WDL was averted by the radio operator on the BRAB alerting the pilots that they had made a WDA, this occurred at a very late stage when the helicopter was in the hover over the deck of the BRAB. At this point, there would have been no helideck

crew on the BRAB to visually identify the flight path of the helicopter and for the HLO to alert the pilots that a WDA was being made. (The helideck crew would have completed their helideck duties following the departure of the helicopter from the BRAB earlier in the sortie.) The radio room primarily monitors radio calls, rather than visually identifying helicopter traffic.

Conclusion

The pilots made a wrong-deck approach to the Brae Bravo platform during an in-field shuttle. This incident arose from the pilots initially misidentifying and selecting the Brae Bravo platform, instead of the Brae Alpha platform, as the destination and subsequently not detecting this incorrect selection. Several prevention controls that should have alerted the pilots to the incorrect platform selection and subsequently aided them in idenitifying the incorrect-selection proved ineffective.

Contributing factors included platform alignment and characteristics, coupled with inadequate identification by the pilots of the key features and differences of the platforms in the Brae field. The choice to fly the short sector manually and to navigate visually, which was appropriate for the good in-field visibility and this stage of line training, resulted in an increased workload for the PIC, as PM, and reduced the attention given to the electronic cues that existed in the cockpit. The short sector provided a very small window of time for the pilots to identify, select and confirm the destination platform with little subsequent opportunity to review. The inherent nature of the early stages of line training increased the workload on the PIC, as PM, and effectively nullified the protections afforded from operating in a multi-crew environment. This high workload, combined with the overriding influences of expectation and confirmation biases, undermined the ability of the pilots to make the correct identification in the first place and then, subsequently, to trap this incorrect selection.

This event highlights the challenges that exist while flying off-shore, even during benign conditions, during a typical sortie flown in the early stages of line training. Many of these factors highlighted above have previously been identified[16] as typical factors that contribute to wrong-deck landings.

Safety action

The operator identified the following safety actions to be carried out:

- Training to highlight complex requirements of shuttling and need to concentrate on all aspects of SOPs
- Highlight of importance of following checklists at appropriate times.
- Review shuttle checks
- Highlight task management during the brief for a shuttling line training flight

Footnote

16 Wrong Deck Landings Research and Investigation Report dated 11 December 2015; Jarvis Bagshaw limited, commissioned by CHC on behalf of HeliOffshore.

ACCIDENT

Aircraft Type and Registration:	Cessna 150L, G-OKED	
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine	
Year of Manufacture:	1973 (Serial no: 150-74250)	
Date & Time (UTC):	23 November 2018 at 1420 hrs	
Location:	Clipgate Farm Airfield, Kent	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Slight damage to end of propeller blade, collapsed nosewheel landing gear and damaged engine cradle	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	78 years	
Commander's Flying Experience:	747 hours (of which 166 were on type) Last 90 days - 15 hours Last 28 days - 2 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

Approaching the grass runway with a tailwind the pilot extended more flap to regain the intended glidepath, then retracted it partially. The landing flare was longer than expected and the aircraft skidded on the damp grass surface before hitting a hedge. Subsequent inspection revealed that the flap had retracted more than intended. Retracting flap while continuing an approach may be hazardous.

History of the flight

The purpose of the flight was to check the serviceability of the aircraft's radios, which took longer than the pilot expected. On return to the airfield at Clipgate Farm the pilot established the aircraft on the approach to Runway 20, at an airspeed of 65 mph and with flap 30° set. When he determined that the aircraft was higher than intended, he selected flap 40°. Then, after regaining his intended glidepath and maintaining 65 mph, he re-selected what he thought was flaps 30°. He stated that he used the flaps in this way to increase drag temporarily, as he would with a glider's airbrake.

The weather conditions were hazy, and because the sun was shining in the pilot's eyes he could not read the airspeed indicator during the final stages of the approach.

The pilot recalled that the flare lasted longer than he expected. After landing, applying brakes caused the aircraft to skid on the grass and it collided with a hedge at the end of the runway. He described the impact as light, but the nosewheel hit a tree stump which broke its mounting support tubes. The aircraft tipped forward and the propeller became embedded in the ground.

The pilot reported that although the windsock appeared limp, there may have been a tailwind above the trees which he had forgotten to consider during the approach. Also, on re-inspecting the grass runway surface after the accident, he believed it was damper than he had originally thought.

After the accident, the aircraft's flaps were found set at 20°, not 30°. The pilot surmised that, when he retracted the flaps during the approach, he did so further than intended.

The pilot considered that he was distracted by frustrations with the radios, and that he should have gone around and landed on the reciprocal runway.

Analysis

A tailwind component and a damper than expected runway surface would both increase the aircraft's landing distance. Landing with less flap extended would reduce drag and increase the airspeed at which the aircraft could be flown safely, which would also increase the landing distance required.

Conclusion

The pilot used flap as an airbrake, then retracted it partially before landing. This, a tailwind during the approach and a damp runway, increased the landing distance required and the pilot was unable to stop the aircraft in the distance available.

Use of flaps as airbrakes

Unlike airbrakes, which can be used to increase drag or decrease lift (or both) over a range of airspeeds, the extension of flaps usually increases lift, increases drag and reduces the airspeed at which an aircraft can be flown safely. Retracting flaps whilst continuing an approach may be hazardous, particularly if the pilot inadvertently retracts them more than intended.

ACCIDENT

Aircraft Type and Registration:	Escapade Kid, G-CGTZ
No & Type of Engines:	1 Aixro XF40 rotary engine
Year of Manufacture:	2010 (Serial no: ESCAWKID 002)
Date & Time (UTC):	20 April 2019 at 1430 hrs
Location:	Calton Moor Airfield, Staffordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to the left landing gear and wingtip
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	63 years
Commander's Flying Experience:	203 hours (of which 4 were on type) Last 90 days - 2 hours Last 28 days - 1 hour
Information Source:	Aircraft Accident Report Form submitted by the pilot

Calton Moor Airfield is situated on ground which gently slopes away to the south. The pilot of G-CGTZ flew an approach to land on grass Runway 06 after a flight in the local area. He stated that he flared the aircraft late and this, combined with the slope across the runway, resulted in a hard landing on the left landing gear causing it to buckle; the left wingtip also suffered damage. No injuries were sustained by the pilot.

ACCIDENT

Aircraft Type and Registration:	Flylight Lightfly-Discus, G-CEOL	
No & Type of Engines:	1 Polini Thor 250 piston engine	
Year of Manufacture:	2007 (Serial no: 1)	
Date & Time (UTC):	27 February 2019 at 1134 hrs	
Location:	The Holy Loch, near Oban, Argyll	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Wing damaged and front strut bent	
Commander's Licence:	National Private Pilot's Licence	
Commander's Age:	63 years	
Commander's Flying Experience:	310 hours (of which 16 were on type) Last 90 days - 4 hours Last 28 days - 4 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

The pilot reported that the aircraft took off from a farmer's field. When over the middle of the adjacent loch, he decided to perform a water landing but he omitted to raise the wheels and the aircraft pitched forward on touchdown, before capsizing to the left. Following the capsize, the pilot climbed onto the upturned hull. Although a variety of emergency services responded, in the event the aircraft could be towed to shore.

The pilot reported that he normally carried out a '**WOODS**' check before a water landing. This consisted of the following items:

(1) **W**ind (direction and strength)

(2) **W**heels

(3) **O**bstructions

(4) **O**bjects

(5) **D**epth

(6) **S**ecurity

On this occasion, as there was negligible wind, the pilot had inadvertently skipped past the wheels check. He stated that in future he would retract the undercarriage after takeoff once a safe height was passed.

ACCIDENT

Aircraft Type and Registration:	P and M Aviation QuikR, G-IMHK
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2009 (Serial no: 8462)
Date & Time (UTC):	8 September 2018 at 1130 hrs
Location:	Bute Airfield, Isle of Bute
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Extensive damage to the pod, rear-wheel fairings, wings, engine covers and fuel tank and to a length of wooden fence
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	41 years
Commander's Flying Experience:	371 hours (of which 42 were on type) Last 90 days - 21 hours Last 28 days - 6 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

During landing the left wing of the microlight struck the ground. The pilot was unable to correct the resulting veer to the left and the aircraft suffered significant damaged when it hit a fence and ditch. A gust of wind had probably caused the right wing to lift.

History of the flight

Bute airfield is an unlicensed private grass strip on the Isle of Bute. On the day of the flight, there was good visibility with westerly winds at 15 kt.

The pilot of G-IMHK, a P&M QuikR microlight, executed a normal landing to Runway 27 at Bute with the control bar pushed fully forward on the 'round-out'[1]. On touchdown, the right wing lifted causing the left wingtip to strike the ground and the aircraft to veer to the left from the drag of the left wingtip. The pilot sensed that the force on the right-wing increased as it lifted and became more exposed to the wind, hindering his ability to level the wings.

Footnote

[1] Described as the moment of flare at the point of touchdown.

The pilot attempted unsuccessfully to counter the veer to the left by applying nosewheel input to the right, assisted by braking, and attempting to level the wings. This resulted in the aircraft becoming unstable and tipping over towards its port side. The pilot centred the nosewheel and increased braking, regaining stability and slowing down. At this point the pilot managed to lift the left wing off the ground. With the fence-line approaching, he attempted to go around but was unsuccessful due to the slow speed of G-IMHK. The pilot estimated the aircraft hit the fence-line at about 30 mph; the aircraft's nosewheel entered the ditch and the aircraft toppled over.

Uninjured, the pilot was able to evacuate the aircraft. G-IMHK incurred extensive damage to the pod, rear-wheel fairings, wings, engine covers and fuel tank. The aircraft damaged two wooden fence posts and 5 ft of wire fencing.

Conclusion

It is likely a gust of wind lifted the right wing of G-IMHK on landing. As the right wing lifted, the underside became more face-on to the wind, increasing the force acting on it and hindering the pilot from levelling the wings. The veer to the left increased the instability created by the force acting on the wing; the pilot's actions to then steer to the right would have increased this instability further. Faced with the approaching fence-line, the pilot decided to go around when the aircraft had insufficient airspeed to execute this manoeuvre successfully.

ACCIDENT

Aircraft Type and Registration:	Pegasus Quantum 582, G-MZDE
No & Type of Engines:	1 Rotax 582-40 piston engine
Year of Manufacture:	1996 (Serial no: 7238)
Date & Time (UTC):	26 February 2019 at 1150 hrs
Location:	Kenyon Hall Farm airstrip, Warrington
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - 1 (Serious)
Nature of Damage:	Damage to wing keel, leading edges, control frame, sail, trike keel, nosewheel, wheel spat and nose cone
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	292 hours (of which 262 were on type) Last 90 days - 2 hours Last 28 days - 2 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

Shortly after takeoff the engine reduced power and then stopped. The pilot attempted to turn back into the airfield but contacted tall trees and struck the ground heavily.

History of the flight

The pilot was making the flight to revalidate the aircraft's Permit and he checked NOTAMs, weather and the aircraft's weight and CG.

The pilot reports that the engine start and power checks were normal and he started the takeoff run using full engine power, with about 360 metres available. The aircraft reached flying speed within about 100 metres. The initial stage of the climb was normal but as the aircraft approached the end of the runway, at about 200 feet, the pilot heard a change in engine note and felt a reduction in power. He tried a small reduction in throttle, then advanced to full throttle to see whether this would restore power, at the same time pulling on the control bar to maintain airspeed. At this point he thought there was enough height to turn back into the field for a landing.

The engine, however, did not recover but stopped and as the pilot continued the approach back into the field one of the trike wheels clipped the upper branches of a tree and the aircraft pitched sharply downward. The pilot considers that at this point they were only just above the minimum flying speed and they struck the ground hard, with the trike pitching forward and coming to a rapid stop. The pilot was able to get out of the aircraft, which was badly damaged, but the passenger was experiencing pain in her foot. The pilot was able to help the passenger out of the aircraft and she was later treated in hospital for a fractured ankle.

Analysis

The pilot gave a full and clear account of the accident. In assessing the accident, he considered that he had made an error of judgement in turning back to the airfield, rather than continuing into an open field about 20° to the left of the runway heading. Although this field looked quite rough, the pilot considers that it would have been preferable as it would have given him more airspeed in hand and thus better control for the landing. He also considered that, although he met the criteria for carrying a passenger, he was not properly current and had not recently practiced a forced landing.

The pilot later gave an update to the AAIB on tests he had carried out on the engine. He had carried out four cycles of start-up, warm-up and maximum rpm running of the engine and each time it had performed without fault. It was therefore not apparent what had caused the power loss on the accident flight.

ACCIDENT

Aircraft Type and Registration:	Thruster T600N 450, G-OBAX
No & Type of Engines:	1 Jabiru 2200A piston engine
Year of Manufacture:	2001 (Serial no: 0051-T600N-053)
Date & Time (UTC):	27 February 2019 at 1330 hrs
Location:	Balado Airfield, Kinross
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Damage to propeller and both wings. Engine shock-loaded
Commander's Licence:	National Private Pilot's Licence
Commander's Age:	69 years
Commander's Flying Experience:	132 hours (of which 127 were on type) Last 90 days - 1 hour Last 28 days - 0 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

After startup the engine developed high power, which the pilot could not reduce. The aircraft travelled over 100 metres very rapidly down an inclined taxiway, with the pilot having very limited control, and collided with a parked digger.

History of the flight

The pilot's intention was for a local flight of about 90 minutes, including some practice circuits. After completing a preflight inspection he started the engine and found that, instead of settling into an 'idle', the engine developed high power straight away. The pilot quickly checked the throttle and choke positions, which appeared to be in the expected positions. Despite pulling back hard on the throttle lever with his left hand, the aircraft moved forward with what appeared to be full power, against the pressure the pilot was exerting with his right hand on the handbrake on the control column.

The aircraft's ground speed increased quickly and the pilot attempted to direct the aircraft down the incline of the grass taxiway leading to Runway 07/25. His control was limited and it was a struggle to maintain the aircraft's direction and its wings-level attitude against the crosswind and to prevent it from flying. At the same time he was attempting to switch off the left and right magnetos, to stop the engine, which was difficult as the magneto controls were located behind the control column. Before reaching the runway there was a parked digger in the path of the aircraft. It would normally have been no problem to avoid this digger but, with the limited directional control, the aircraft struck the digger, just as the pilot was able to switch off the magnetos. The aircraft came to an abrupt stop, having travelled over 100 metres very quickly. However, as the cockpit ended up under the arm of the digger, the pilot was able to exit the aircraft uninjured.

Analysis

The pilot considered that during his pre-starting checks he was able to move the throttle control lever through its normal range and the cause of the throttle and power problem after starting was unclear. However, he also commented that it was possible for the seat cover to move and that this could impede rearward movement of the lever. He also commented that he should have been quicker to switch off the magnetos and this would have been more instinctive and easier to find and operate if it had been a 'key'-type ignition switch and starter.

Miscellaneous

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

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

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

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

Published June 2014.

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

Published September 2014.

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

Published July 2015.

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

Published August 2015.

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

Published October 2015.

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

Published March 2016.

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

Published September 2016.

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

Published March 2017.

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

Published March 2018.

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

Published November 2018.

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

All times are UTC

GLOSSARY OF ABBREVIATIONS

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

Air Accidents Investigation Branch