AVIATION INVESTIGATION REPORT
A00P0103

LOSS OF CONTROL

AVNORTH AVIATION LTD.
DE HAVILLAND DHC-2 C-GAXE
HOTNARKO LAKE, BRITISH COLUMBIA
19 JUNE 2000

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Summary

The de Havilland DHC-2 (Beaver) floatplane, serial number 841, departed Hotnarko Lake, British Columbia, at about 1630 Pacific daylight time. The pilot and six passengers were on board, with fishing gear and fish. Soon after take-off, the pilot entered a left turn. Before the turn was completed, the aircraft rolled, without command, further left to about 40 degrees of bank and the nose dropped. The aircraft did not respond to initial pilot inputs and continued in a left, diving turn toward the trees at the edge of the lake. The pilot tried to get the aircraft back onto the lake. The aircraft started to recover from the bank and the nose started to come up; however, the aircraft struck the lake surface before a level attitude could be regained. It broke apart on contact with the water and sank soon after. The pilot and four of the passengers managed to free themselves from the wreckage, but only three passengers and the pilot managed to swim to shore. One passenger slipped below the water surface before reaching the shore and drowned. Two passengers remained in the aircraft below the water surface, one secured by his seat belt, and drowned.

Ce rapport est également disponible en français.

Other Factual Information

On the day of the accident, the area weather was being influenced by an upper trough of cold, unstable air. Witnesses report that the wind was from the northwest at about 20 knots with gusts to about 40 knots. There were "cat's paws" on the west end of the lake in the lee of rising terrain.[1] Other weather phenomena were unremarkable. Hotnarko Lake is near mountainous terrain in the interior of British Columbia. The highest terrain is to the northwest of the lake.

The pilot was the owner and operator of a lodge that offered fly-in fishing. At the time of the occurrence, he was employed as a pilot by Avnorth Aviation Ltd. He had received recurrent training on the type in the previous month and was certificated to operate the DHC-2, however a flight medical had not been conducted within the previous six months, as prescribed for commercial operations. He had about 10 years' experience operating in the area with float planes, with about 100 hours' flying time on the Beaver aircraft, including operations into Hotnarko Lake.

The pilot took off in the Beaver from Avnorth Aviation Ltd. on Nimpo Lake on the morning of the accident. He flew across the lake to his lodge where he picked up the six sport fishermen and gear. They flew to Hotnarko Lake where the fishermen disembarked for a day's fishing; the pilot flew back to Nimpo Lake. At about 1600,[2] the pilot flew to Hotnarko Lake to retrieve the fishermen and their gear. These flights were unremarkable. The winds were about 20 to 30 knots, with gusts to 40 knots from the northwest. Waves on the lake were about two feet high, with white caps. The gear loaded on the aircraft included three outboard motors, fuel, fish, and personal items. One passenger sat in the right front seat next to the pilot, three passengers sat on the bench seat in the middle, and two passengers sat in the aft hammock-style seat. All of the occupants, except one, apparently had their seat harnesses on; however, none was wearing a life jacket. The passenger seated in the aft seat, on the left side, had not found one end of his seat belt and had not secured his harness for the flight.

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[1] "Cat's paws" are marks on a water surface made by bursts of downward flowing wind.

[2] All times are Pacific daylight time (Coordinated Universal Time minus seven hours).

The pilot taxied the aircraft downwind approximately three-quarters of a mile before starting the take-off in a northwesterly direction into wind. The aircraft reached about 50 miles per hour (mph) indicated airspeed, became airborne, settled back onto the lake momentarily, then became airborne again. At about 100 feet above ground level, the pilot reduced power to 2000 revolutions per minute and 30 inches of manifold pressure and retracted the flaps.[3] The Pilot Operating Handbook (POH) for the DHC-2 states that as soon as safe altitude has been attained, pilots should reduce power to 33.5 inches of mercury and 2200 rpm if the aircraft is fully loaded, or 30 inches of mercury and 2000 rpm for normal weight. Pilots should then slowly increase airspeed to 70 knots (80 mph) and retrim. At 500 feet above ground level, pilots should set the flaps to 10 degrees and retrim. The aircraft was reportedly climbing at 300 feet per minute and indicating 80 mph. The pilot then commenced a left bank that was reported to be about 10 degrees. Soon after, the aircraft suddenly banked further left to about 40 degrees and the nose dropped. The pilot applied full right aileron and full right rudder. The aircraft did not respond to these control inputs and continued in the steep left bank, descending toward the trees at the edge of the lake. The pilot then pushed the flight control forward and turned into the left bank, attempting to get to a bay on the left and to avoid the trees. The aircraft then responded to right aileron and a pull-back on the controls but had not reached a level-flight attitude. About 15 feet above the lake, the pilot retarded the engine throttle. The aircraft struck the lake surface left wing first, with the nose down, broke apart, and flipped over.

On impact, the pilot's upper torso rotated around the left shoulder harness and the right side of his head struck an object in the cockpit. He started to lose consciousness but revived when the cold lake water entered the aircraft. The pilot was the first person to reach the surface after extricating himself from the submerged aircraft wreckage. He pulled one passenger free from the aircraft and directed him to hang onto the aircraft float. Two other passengers got out of the aircraft and were also clinging to a float. The pilot attempted to extricate another passenger, who appeared to be unconscious, but could not free him from the sinking wreckage. Of the five persons that were able to exit the aircraft, four were able to swim to shore. The parts of the aircraft that had remained afloat sank soon after the survivors reached shore. The following day, a dive team found two of the passengers still in the sunken wreckage. One was still secured to the centre seat by his seat belt.

Avnorth Aviation personnel were monitoring the company radio and had not heard the accident aircraft call departing Hotnarko Lake, so they dispatched an aircraft to the lake. It arrived at the lake at about 1800, identified the submerged aircraft wreckage and the survivors, called for assistance, and landed to help. Four of the seven persons involved in the accident survived. Medical examination determined that the three passengers who did not survive died from drowning.

Following the accident, the aircraft and the cargo were retrieved. Calculations using standard weights for the pilot, passengers, and fuel, together with the weight of the cargo, show that the aircraft was about 385 pounds above its maximum gross take-off weight of 5090 pounds. The calculated weight does not include the weight of the fish and some baggage and equipment that remained in the lake. At the time of the accident, the centre of gravity (C of G) was about 2.7 inches aft of the aft limit of 6.1 inches.

The aircraft was equipped with eight inflatable life jackets, located in pockets above the door exits. The pilot had briefed the passengers before the first flight in the morning, but no life jackets were removed or used during the flight or the survival sequence.

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[3] When flaps are extended, the camber of the wing is effectively increased, allowing the aircraft to be flown at a lower speed before the stall occurs. A Transport Canada training manual indicates "extreme care must be taken when retracting the flaps in flight, especially near the ground, because flap retraction will result in a sudden loss of lift and changes in the aircraft's balance."

Inspection of the aircraft wreckage at the TSB regional wreckage examination facility revealed that all the aircraft control mechanisms functioned properly except where there was impact damage. There was no sign of mechanical failure or power loss before impact. The wing flaps were found to be at the cruise setting (up), and the fuel selector was on the centre tank. The cast-aluminium feet of the centre seat were broken, and the seat was detached from the cabin floor. The aircraft survival kit was secured in the tail section, aft of the baggage compartment.

The airspeed indicator was examined and revealed a mark that is consistent with it indicating 58 mph at impact. The stall speed, with the flaps up and the wings level, is 60 mph for this type of aircraft.

Washington-based Aeronautical Testing Service Inc. (ATS) is an aeronautical consulting and manufacturing company involved primarily in the engineering, development, and manufacture of modifications for general aviation aircraft. ATS completed flight tests on the DHC-2 aircraft as part of a vortex generator design for that aircraft type. These tests evaluated the stall characteristics, stall warning, and controllability of the stall in accordance with the requirements of the original *British Civil Airworthiness Requirements.*[4]

The flight test report of that activity indicates that with a forward C of G, the stall characteristics of the aircraft were acceptable. However, with an aft C of G and with power on, the characteristics were found to be unacceptable in wings-level, turning, and accelerated stalls.

When an aircraft is manoeuvred with an aft C of G, there is more pitch-up authority than with a forward C of G.[5] This permits a higher rate of pitch-up acceleration with the flight controls, which can force the aircraft into a deeper stall than would occur in an aircraft with a forward C of G position. When the aircraft stalls in a climbing turn, the high wing is at a greater angle of attack than the low wing and, therefore, stalls first. This results in a rolling motion toward the high wing, creating asymmetric lift and drag. The down-going wing will stall further as a result of less lift and more drag than the up-going wing. A deeper stall, generated by aft C of G, will aggravate these asymmetries, increasing aircraft rolling and yawing moments into the down-going wing. In addition, the aft C of G reduces the distance from the C of G to the centre of pressure of the vertical fin, thus reducing directional control authority, making recovery more difficult.

The TSB released safety studies in 1993 (SSA93001) and 1994 (SS9401) that made 16 recommendations aimed at reducing the number of seaplane accidents and improving the survivability of occupants should a seaplane accident occur. These studies cover issues of underwater escape and cold-water survival that are still issues in seaplane operations in Canada.

On 02 March 2000, the TSB sent a Safety Advisory Letter (A000003-1) to Transport Canada highlighting the demonstrated problems associated with underwater escape from aircraft. The letter referred to a de Havilland DHC-2 floatplane accident (TSB Report No. A98P0215) where five persons drowned because they did not escape from the submerged aircraft cabin.

In 1999, Transport Canada conducted "An Evaluation of Stall/Spin Accidents in Canada." Based on that study, Transport Canada changed the emphasis in its pilot training plans. These changes aim to improve pilots'

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[4] The DHC-2 aircraft was designed and certified to meet *British Civil Airworthiness Requirements*, published in 1945.

[5] TSB Report No. A94O0316: Bellanca Scout C-GQIM.

abilities to recognize stall situations and to increase their knowledge and skills to prevent stalls from occurring. An underlying rationale for these changes was that accident statistics showed that a large percentage of stall-type accidents occurred during take-off and landing and at an altitude from which recovery was not possible. This shift in training emphasis is expected to improve pilots' awareness of impending stalls and should aid in reducing the accident rate through stall prevention rather than through stall recovery skills.

Analysis

Because of the force of gravity and the nose-down (diving) turn before impact, the aircraft likely reached a higher airspeed at impact than when control was lost. This suggests that the aircraft's airspeed was probably below 58 mph when control was lost. Since the stall speed for this aircraft in the configuration at the time control was lost is about 60 mph, it is concluded that the loss of control was due to an aerodynamic stall.

The increased g-loading in the turn, the reduction in power, the heavy weight of the aircraft, its aft C of G condition, and the retraction of the flaps would have contributed to reduced climb performance. Because of the wind conditions, the aircraft's airspeed may have been changing rapidly up and down. As well, the pilot's attempt to maintain a climb in the left turn out of wind would have caused the aircraft's airspeed to decrease. The airspeed likely decreased below the flaps-up stall speed during the left turn, and the left wing stalled. The aft C of G condition would have contributed to the adverse characteristics of roll, yaw, and pitch that followed the stall. The pilot's initial response, inputting right aileron, likely aggravated the stall. His attempt to reach the bay in the lake by turning into the left bank and pushing the flight control forward may have allowed the aircraft to start flying again; however, the aircraft's height above the lake was too low to allow the aircraft to reach level flight before striking the surface.

It is not known why the two passengers could not exit the aircraft. The centre seat, once it broke loose, may have injured and incapacitated the passengers or impeded their escape.

Findings as to Causes and Contributing Factors

1. When the pilot entered a turn, the combined effects of the increased g-forces, power reduction, the aircraft's heavy weight, the aft C of G, retraction of the flaps, and the wind conditions resulted in the aircraft stalling. The aircraft struck the lake surface before the pilot was able to re-establish a level-flight attitude.

2. The aircraft was operating in excess of 385 pounds above the maximum gross take-off weight, and the C of G was about 2.7 inches aft of the aft limit. This loading configuration aggravated the stall characteristics of the aircraft.

3. The pilot reduced power and raised the flaps before the climb was complete, contrary to the Pilot Operating Handbook, thereby increasing the aircraft's stall speed.

Other Findings

1. The shoulder harnesses worn by the pilot and the front passenger likely prevented serious head injuries.

2. The centre seat broke from its footings. This may have incapacitated the two passengers inside the aircraft or impeded their escape.

3. One passenger drowned while trying to reach shore.

4. Life jackets were available in the aircraft but were not used by the pilot or passengers.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 09 May 2001.