AVIATION INVESTIGATION REPORT
A98P0194

LOSS OF CONTROL – COLLISION WITH WATER

AIR RAINBOW MIDCOAST (444316 B.C. LTD.)
DE HAVILLAND DHC-2 MKI C-GCZA
SATURNA ISLAND, BRITISH COLUMBIA
15 JULY 1998

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Summary

The float-equipped de Havilland DHC-2 Beaver (C-GCZA), serial number 1667, was en route under visual flight rules from Campbell River, British Columbia, to Renton, Washington, with the pilot and four passengers on board. It was following another Air Rainbow DHC-2 Beaver C-GCYX) that was also proceeding to Renton on an identical flight planned route. While en route, the pilot of C-GCZA closed in on C-GCYX and positioned his aircraft about 45 degrees off the leading aircraft's wing and about 500 feet astern of the lead aircraft. When the two aircraft approached Samuel Island, the weather deteriorated to such an extent that the pilots decided to land on the water and wait for conditions to improve. The leading aircraft landed first and, almost immediately, its pilot reported that he could see that the weather was clear ahead and that they should overshoot and continue.

At 1007 Pacific daylight saving time, the pilot of C-GCZA lost control of his aircraft during that overshoot procedure. It stalled and crashed in a steep, nose-down, left-wing-low attitude. The aircraft remained upright after impact, and the pilot opened the exits, distributed life jackets, and evacuated the passengers; the aircraft capsized a short time later. When the pilot of C-GCYX lost radio contact with C-GCZA, he backtracked to locate and report the accident position. He then recovered the occupants of the accident aircraft and transported them to the nearby shore of Mayne Island (Bennet Bay). The aircraft suffered substantial damage during the crash, but no injuries were reported.

Ce rapport est également disponible en français.

Other Factual Information

The accident aircraft was owned and operated by Air Rainbow Midcoast Inc., a privately-owned company which conducts single-engine, day-visual flight rules (VFR) float operations from its main base at Campbell River and from a sub-base at Port McNeill. At the time of the accident, the company provided year-round general charter services and scheduled services to coastal and interior destinations. The focus of the company's operations were the coastal regions' forestry, fishing, and tourism industries. These services were being performed under the provisions of Part 703 ("Air Taxi") of *Canadian Aviation Regulations* (CARs).

On the day of the accident, the two company aircraft were transporting a group of nine passengers from Port McNeill to Renton through an intermediate stop in Campbell River. The passengers and their cargo were divided between two aircraft, and the pilots decided to proceed together on the final leg from Campbell River to Renton. The pilot of C-GCYX planned to lead the group because he was more familiar with the route. This was not briefed as a formation flight and the two aircraft were to operate independently.

Both pilots checked the local and en route weather conditions with the Campbell River flight service station (FSS) at about 0700;[1] they received separate weather briefings and filed separate flight plans. Their departures were initially delayed because the weather conditions in the Nanaimo–Victoria area were unsuitable for VFR flight. However, based on the weather forecast, they determined that conditions should improve by about 1000; they planned their departure from Campbell River to arrive after the forecast improvements.

C-GCYX took off from Campbell River at about 0833, and C-GCZA took off about three minutes later; the flight was planned to take two and a half hours. The two aircraft proceeded southward through the Comox terminal area at about 1500 feet above sea level (asl). After clearing the Comox terminal area, the aircraft descended to about 800 feet asl and skirted the eastern sides of Hornby, Gabriola, Valdes, and Galiano Islands. As the flights progressed, both aircraft descended further to remain clear of cloud. Once below 700 feet asl, they entered uncontrolled airspace. During this period, the pilot of the accident aircraft closed in on the leading aircraft and positioned his aircraft about 500 feet from the leading aircraft.

The flights were uneventful until the two aircraft neared Samuel Island, where both pilots noted that the weather conditions ahead were unsuitable for VFR flight. They decided to make precautionary landings and wait for the weather to improve. The leading aircraft landed first and decelerated; however, almost immediately after landing, the pilot of the leading aircraft added power, accelerated, and lifted off again.

As the leading aircraft took off, C-GCZA was about 20 feet above the water and was offset about 300 to 400 feet to the left and slightly behind the lead. The pilot of C-GCZA discontinued his landing procedure and initiated an overshoot. He applied power, about 27 inches of manifold pressure, and established an initial climbing attitude at about 80 miles per hour. The aircraft was configured with 15 to 20 degrees of flap at the time of the overshoot. During the climb, the aircraft commenced an uncommanded left yaw of 10 to 15 degrees

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[1] All times are PDT (Coordinated Universal Time minus seven hours) unless otherwise noted.

which the pilot countered with rudder. With the rudder application, the aircraft yawed violently to the right, the nose dropped, and the aircraft descended steeply, entering the water in a left-wing-low attitude.

Before commencing a VFR flight, pilots must ensure that the current weather reports and forecasts, if obtainable, indicate that the weather conditions along the route to be flown and at the destination aerodrome will be such that the flight can be conducted in compliance with the rules for visual flight and in visual meteorological conditions. In the area of the accident site, the flights were being conducted in uncontrolled airspace, less than 1000 feet above ground level (agl). Weather requirements listed in CAR 602.115 state that, under those conditions, the aircraft must be operated with visual reference to the surface, the flight visibility must not be less than two statute miles (sm), and the aircraft must be operated clear of cloud.

The terminal forecast for Nanaimo for the day of the accident showed scattered cloud at 500 feet, a broken layer at 1500 feet with 6 sm visibility in light rain and mist. A temporary condition was forecast between 0800 and 1100 as follows: a 500-foot broken ceiling and 3 sm visibility in light rain and mist. The terminal forecast for Victoria showed scattered cloud at 1000 feet agl, a broken ceiling at 3000 feet, and visibility of 6 sm. The forecast also indicated a temporary condition of a broken layer at 600 feet between 0600 and 0900 and a visibility of 2 sm in light rain showers and mist.

As the two Air Rainbow aircraft approached Nanaimo, a westbound helicopter reported by radio that the ceilings in the Ladysmith region (south of Nanaimo and west of the Gulf Islands) were between 400 and 500 feet asl. In the vicinity of Samuel Island, on the east side of the Gulf Islands and in the area where the pilots decided to land and wait for improved conditions, the pilots reported that the low cloud base had dropped to about 200 feet asl and that the visibility was between 0.5 and 1 sm in fog and mist.

CARs state that, except when taking off or landing, aircraft operating under daylight VFR conditions in uncontrolled airspace are required to maintain a minimum of 300 feet above the highest obstacle within 300 feet of track.

The pilots of aircraft travelling to the same destination may occasionally decide to travel together, with one aircraft leading the group and providing advance en route weather information to the aircraft that are following. The coordination between the aircraft is normally accomplished by radio on a discrete frequency. Typically, the spacing between the aircraft will be about five miles; otherwise, the advantage of receiving weather reports from the lead aircraft is lost to the aircraft that are following. In this occurrence, the pilot of the accident aircraft began his flight with a spacing in trail of about four miles, but subsequently closed in on the lead aircraft to the point where the actions of the lead aircraft could affect his own actions. Neither the CARs nor the *Aeronautical Information Publication* (AIP) provide any guidance related to the minimum spacing that is permitted between VFR aircraft operating independently. Transport Canada (TC) expects aircraft operators to develop a structured plan for all company-approved procedures. These plans are then approved by TC and enabled in the Company Operations Manual (COM). At the time of the accident the COM did not contain any guidance for this type of operation. The company has subsequently developed relevant guidance for its pilots.

The accident aircraft had been modified to increase the maximum allowable gross weight from 5090 pounds to 5370 pounds as specified in Supplemental Type Certificate Number SA4025NM. In general terms, that

modification involved the reinforcement of the upper and lower surfaces of the horizontal stabilizer's rear spar, as well as the reinforcement of its front spar fittings. At the aircraft's higher take-off weight of 5370 pounds, the best rate of climb is reduced by 80 feet per minute at sea level; otherwise the modification caused no changes to the performance of the aircraft. With that modification, the aft centre-of-gravity limit is 6.1 inches aft of datum. The weight of the accident aircraft at take-off from Campbell River was recorded as 4824 pounds, which included 300 pounds of baggage that was loaded in the rear row of seats of the aircraft and 480 pounds of fuel distributed between the front, centre, and rear tanks. Weight and balance calculations completed by the company, for the time of the accident, show a weight of 4687.8 pounds and a centre of gravity of 5.64 inches aft of datum. Based on these calculations, the aircraft weight and load distribution at the time of the accident were within the certificated limits, and the centre of gravity was in the aft-portion of the approved envelope.

According to the aircraft flight manual, full take-off power (36.5 inches of manifold pressure) should be selected for an overshoot. In this occurrence, the pilot of the accident aircraft selected the power to about 27 inches of manifold pressure during the overshoot attempt.

The DHC-2 aircraft was designed and certified to meet *British Civil Airworthiness Requirements*, published in 1945. At that time, the British Air Registration Board's policy was that "tests to prove compliance...need only be made at such points in each range as are necessary for reliable inferences to be made of the behaviour of the aeroplane over the remainder of that range".

In part, the specific certification requirements regarding aircraft stall characteristics state that "as the stall is approached from straight flight, there shall be no violent wing dropping and no tendency to spin" and "the aeroplane should give, by juddering or other means, clear warning of the approach to the stall from straight or turning flight".

In the case of the DHC-2, the aircraft is not equipped with any aural or visual stall warning system, and warning of an impending stall is dependant on "juddering" or on some other aerodynamic indication.

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. According to company literature, ATS was created to help increase the safety and performance of general aviation aircraft by designing and building vortex generator kits for use on a variety of general aviation and agricultural aircraft. ATS completed flight tests on an un-modified DHC-2 MKI 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 a variety of weight and balance configurations that were not specifically required by the original *British Civil Airworthiness Requirements*.

The flight test report of that activity indicates that with a forward centre of gravity, the stall characteristics of the aircraft were acceptable. However, with an aft centre of gravity and with power on, departures of 60 degrees of roll, 30 to 40 degrees of yaw, and 30 degrees of pitch were reported as being common during these flight tests. With the flaps selected to the "climb", "take-off", and "landing" positions, the ATS flight test report indicates that the ailerons and rudder were effective up to the point of the stall but were not adequate to control

the violent roll and yaw once the stall occurred. A positive elevator movement was required to recover from the stalled condition before the aircraft began to spin. Test pilots with the TC Flight Certification Branch and with de Havilland have not experienced such violent stall characteristics as described by both ATS and by the accident pilot involved. The TC Aircraft Certification Branch has subsequently indicated that it will examine the DHC-2 service history and stall characteristics to determine whether any mandatory changes are warranted.

The accident pilot held a valid Canadian commercial licence and was qualified to fly all non-high performance, single- or multi-engine land or sea airplanes. He held a valid instrument rating and a valid medical certificate, and had acquired a total of about 800 flight hours. After being hired by Air Rainbow, the pilot completed the company's initial ground training program by 21 May 1998. This was followed by about four hours of flight training on the DHC-2 in late May and an additional nine hours of route familiarization training in June 1998. His DHC-2 training was conducted in aircraft that were not equipped with dual controls, nor were such control systems required by regulation. The company training program did not expose him to the unique and potentially aggressive stall characteristics encountered with an aft centre of gravity and the application of engine power; this type of training is not required by TC. At the time of the accident, the pilot's total experience as pilot-in-command of a DHC-2 was about 38 hours.

In 1999, TC conducted "*An Evaluation of Stall / Spin Accidents in Canada*" and, based on that study, has made a number of changes to its pilot training plans. These changes were aimed at emphasizing pilots' ability to recognize a stall situation and their knowledge and skills required to prevent the stall from occurring. Part of that study recognizes that, in a pilot training environment, the student pilot learns about weight and balance but may not experience flying and manoeuvring an aircraft at or near its maximum gross weight in controlled conditions. TC notes that, "having had the experience, a pilot may be more able to recognize the change in handling characteristics and avoid stall conditions". This type of training is expected to improve a pilot's awareness of an impending stall and should aid in reducing the accident rate through stall prevention, rather than through stall recovery skills.

Analysis

The risks of conducting VFR flight under conditions of low ceilings and low visibilities are known and are mitigated, to a degree, by the establishment of minimum obstacle clearance altitudes and minimum visibility requirements. Under minimum conditions, CARs allow pilots to conduct VFR flight in uncontrolled airspace and in weather conditions as low as 300 feet agl (the obstacle clearance limit) and 2 sm visibility; Environment Canada categorized these same weather conditions as "IFR". Stated another way, CARs allow VFR flights to be conducted in IFR weather conditions provided the aircraft is in uncontrolled airspace. The degree to which these regulations mitigate risk is questionable.

In this occurrence, the flight was conducted under the minimum conditions that are permissible for VFR flight. When the weather and operational conditions deteriorated below these minimum levels, the pilots decided to land and wait for the conditions to improve.

No clear rules or guidelines govern the coordinated operation of two independent flights. The pilots of the two aircraft involved coordinated their activities in advance of the flight and filed separate flight plans. They took off separately, with an initial spacing between the aircraft of about four miles. As the flights passed through the Comox control zone, they were treated as independent flights by the air traffic control system. However, as the trip progressed, the pilot of the second aircraft in the group closed in on the leading aircraft and stabilized in a position that was much closer than that described as being typical for this type of flight. By closing in on the leading aircraft, the accident pilot reduced any advantage he may have had of receiving en route weather reports from the leading aircraft.

On encountering unsuitable weather, the lead aircraft landed. It decelerated rapidly on touchdown and the spacing between the two aircraft was reduced even further. Immediately after landing, the pilot of the lead aircraft took off again and began a full-power climb. In response, the pilot of the accident aircraft began a missed-approach procedure with less than full power. This procedure was not in accordance with the aircraft flight manual and was only done in an attempt to stop any further overtake of the lead aircraft. By following too closely, the pilot of the accident aircraft reduced his own ability to operate as an independent aircraft and placed the passengers of both aircraft at increased risk. Following this accident, the company developed and promulgated a directive to provide specific procedures for its pilots to follow when two or more aircraft are flying together on the same route.

During the reduced-power overshoot, it is likely the airspeed was allowed to decrease to the point where the accident aircraft departed from controlled flight and stalled. The airplane did not give, "by juddering or other means", clear warning of the approach to the stall as required by its certification standards. The aircraft's response as was described by the accident pilot involved was consistent with the stall characteristics reported by ATS in their flight test report.

The pilot involved in this accident had received the training required by the TC-approved training plan. However, he had not been exposed to the aircraft's power-on stall characteristics with an aft centre-of-gravity loading. When the aircraft initially yawed to the left, the pilot responded by applying rudder to correct an uncommanded yaw; this response was not effective. When the aircraft stalled, it yawed violently and entered a steep, nose-low attitude.

The Air Rainbow DHC-2 aircraft were not equipped with dual flight controls, nor were such control systems required by regulation. Dual controls allow for the training and testing of new pilots throughout the entire range of the flight envelope. In the absence of dual controls, the risk is elevated when training includes areas of flight envelope where violent stall conditions may be encountered. TC recently changed the pilot training programs to provide pilots with increased exposure to stall characteristics in varying weight and balance configurations. This should improve a pilot's ability to recognize and prevent a stall.

Findings as to Causes and Contributing Factors

1. As visibility decreased, the pilot of the accident aircraft closed in on the leading aircraft to maintain visual contact and as a result, when the aircraft took off, the spacing between the two aircraft had been reduced to the point where the actions of the leading aircraft adversely affected the actions of the trailing aircraft.

2. The trailing aircraft stalled while the pilot was attempting an overshoot procedure with less than the required engine power.

3. The pilot had no warning of the impending stall by either juddering or other means as required by the certification standards.

4. The accident pilot's training did not include exposure to the stall characteristics of the DHC-2 aircraft in a rear centre-of-gravity condition.

Other Findings

1. The pilot was certified and qualified for the flight in accordance with existing regulations.

2. Portions of the flight were conducted at low altitudes and in marginal VFR or IFR weather conditions.

3. The lowering cloud ceiling and decreased forward visibility prompted the pilots of both aircraft to plan to land.

4. TC has recognized the need for improved training in the recognition and prevention of stalls and has modified its pilot training programs accordingly.

Safety Action Taken

Following this accident, the company promulgated a directive to provide its pilots with specific procedures regarding two or more aircraft flying together on the same route. In essence, this directive recognizes each aircraft pilot's responsibility for his or her own navigation, radio work, and all decisions pertaining to the safe conduct of the flight.

In consultation with industry, Transport Canada is in the process of developing two new integrated pilot training programs including flight training and flight test standards.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 06 July 2000.