Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A11W0144

LOSS OF CONTROL AND COLLISION WITH BUILDING

ARCTIC SUNWEST CHARTERS
DE HAVILLAND DHC-6-300 TWIN OTTER, C-GARW
YELLOWKNIFE, NORTHWEST TERRITORIES
22 SEPTEMBER 2011

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Investigation Report

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Synopsis

The float-equipped de Havilland DHC-6-300 Twin Otter (registration C-GARW, serial number 367) was landing at the float-plane base (CEN9) located in Yellowknife, Northwest Territories, along the western shore of Great Slave Lake, beside the area known as Old Town. There were 2 crew members and 7 passengers on board, and the first officer was the pilot flying. On touchdown, the aircraft bounced, porpoised and landed hard on the right float. The flight crew initiated a go-around; the aircraft lifted off at low speed in a nose-high, right-wing-low attitude, and it continued in a right turn towards the shore. As the turn continued, the aircraft's right wing contacted power lines and cables before the float bottoms impacted the side of an office building. The aircraft then dropped to the ground on its nose and cart-wheeled into an adjacent parking lot. Both crew members were fatally injured, 4 passengers were seriously injured, and 3 passengers sustained minor injuries. The aircraft was substantially damaged. The 406-megahertz emergency locator transmitter activated. There was no fire. The accident occurred at 1318 Mountain Daylight Time.

Ce rapport est également disponible en français.

Factual Information

History of the Flight

The crew members began their duty day departing the Yellowknife, Northwest Territories, float-plane base (CEN9) at 1058 [1] for a 45-minute cargo flight to a mining camp in Thor Lake, Northwest Territories. C-GARW departed Thor Lake at 1248 for the return flight to CEN9 with 7 passengers on board and climbed to an enroute altitude of 3500 feet above sea level (asl). On the return flight, the first officer (FO) was acting as the pilot flying (PF) in the right seat, and the captain was the pilot not flying (PNF) in the left seat. The crew obtained weather information from the Yellowknife Airport (CYZF) automatic terminal information service (ATIS) and briefed their planned approach to CEN9. When joining a left base for landing, C-GARW was advised by the CYZF control tower, located about 6 nautical miles (nm) west of CEN9, that the winds at the airport were variable from the southwest at 10 knots, gusting to 30 knots. CEN9 is not visible from CYZF.

Due to the 2- to 3-foot waves (rollers) on the lake, the crew planned their approach so as to land close to the shore and to avoid entering the passage between the shore and Jolliffe Island (Figure 1). The captain also advised that the airspeed should be kept above 80 knots indicated airspeed (KIAS), which is 10 KIAS above the normal approach speed of 70 KIAS, for the full-flap (37.5°) approach and landing. During the approach, the captain cautioned the FO twice about the airspeed getting too low. The aircraft touched down in the intended landing area and bounced, then contacted the water a second time with the right float first. The float dug in, and the aircraft yawed to the right, turning towards the shore. The stall warning sounded for about 0.3 seconds.

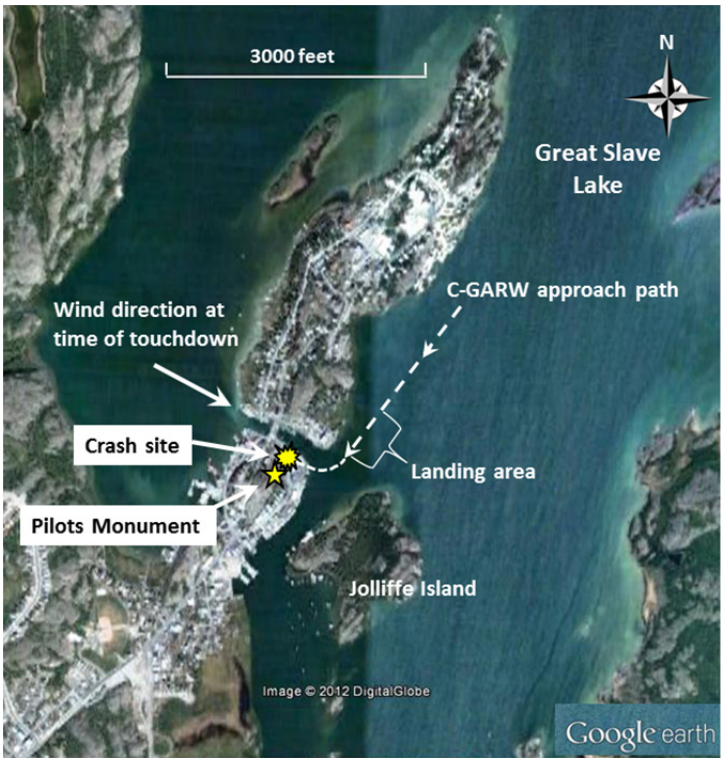

Figure 1. Yellowknife float-plane base

[1] All times are Mountain Daylight Time (Coordinated Universal Time minus 6 hours).

Without declaring that he was taking control, the captain placed his right hand on the power lever over the FO's left hand and initiated full power for a go-around. C-GARW lifted off in a nose-high, right-wing-low attitude, in a right turn that continued at a low altitude over the shore and toward the buildings in Old Town, Northwest Territories. At this time, the captain called for the flaps to be raised to 20°, to which the FO responded. However, the flaps were not moved before impact. The right wing contacted power lines, causing the aircraft to rotate to a nose-down attitude. The bottom of the floats then contacted the side of a 3-storey office building. C-GARW dropped to the ground on its nose section, then cart-wheeled to its left into an adjacent parking lot. The stall warning intermittently activated throughout the go-around until just prior to impact.

The total elapsed time from the initiation of the go-around to the command that flaps be set to 20° was about 4 seconds, and, from that command to the final impact, about 6 seconds. The maximum altitude gained was approximately 50 feet above ground.

Numerous witnesses to the accident were on scene immediately to assist in evacuating the passengers. There was no fire, although a considerable amount of fuel was spilled.

Photo Information

Southwest of the landing zone and the accident site in Old Town is a rock outcrop known as The Rock, rising about 70 feet above the lake level and about 60 feet above the street. Located on top of The Rock is a public viewpoint, a private weather station, and the Pilot's Monument. The aircraft was photographed from the public viewpoint throughout the approach, landing, overshoot (Photo 1), and impact with the building. Also visible in the photos taken before and after Photo 1 was a windsock on a building beside the touchdown area displaying the changes in wind speed and direction throughout the landing sequence. At initial touchdown, the wind was a crosswind from the west. The wind then changed to a southwest headwind at the start of the overshoot, and shifted back to west for the remainder of the flight.

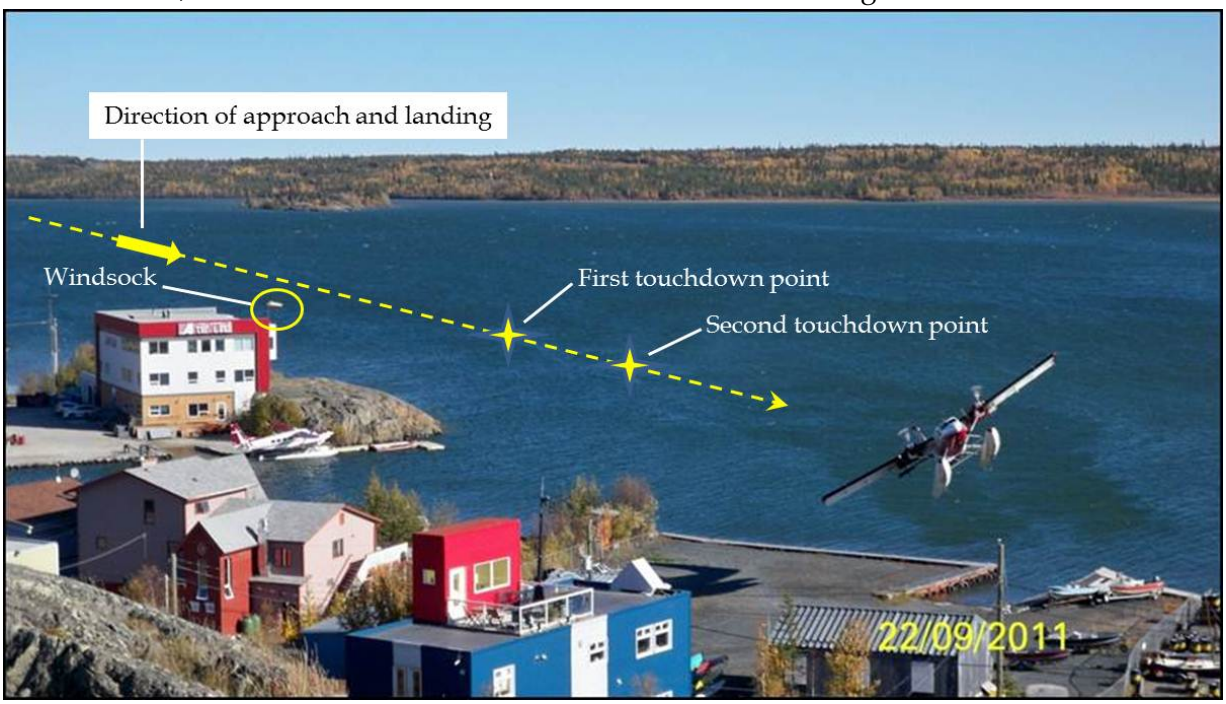

Photo 1. C-GARW over docks during overshoot (photo used with owner's permission)

Weather

NAV CANADA's CYZF aviation routine weather report (METAR) taken at 1300 was as follows: wind 230° true (T) at 10 knots, gusting to 17 knots, visibility 15 statute miles (sm), few clouds at 25 000 feet above ground level (agl), temperature 16°C, dew point 1°C, and altimeter setting 29.20 inches of mercury.

A graphic area forecast (GFA) was issued by NAV CANADA at 1142 and was valid at 1200 on the day of the accident. The GFA indicated a low-level jet stream in the area, as well as the possibility of moderate mechanical turbulence and low-level wind shear from the ground to 3000 feet agl.

The privately operated Pilots Monument Weather Station recorded the winds at approximately 1.5-minute intervals. At 1315:46, the winds were from 167° magnetic (M) at 19.1 knots, gusting to 31.3 knots; at 1317:08, the winds were from 159°M at 24.3 knots, gusting to 31.3 knots; and at 1318:16, the winds were from 195°M at 21.7 knots, gusting to 31.3 knots. Winds were not recorded at 1320, as well as for the subsequent hour and 38 minutes, because power had been disrupted by the aircraft impacting the power lines.

Crosswind Component

The approximate track of C-GARW through the approach and landing was 195°M. Wind direction was variable, but was from approximately 273°M at 24 knots, gusting to 31 knots at touchdown, resulting in a crosswind component of 20 to 30 knots. The wind direction at the time of landing can been verified by the deflection of the windsock (Photo 1).

Section 2.6.2 of the DHC-6-300 Airplane Flight Manual (AFM) states:

> With full flap (37.5°) crosswind landings have been demonstrated in a maximum crosswind component of 20 knots measured at 6 feet, which is equivalent to 27 knots at 50 feet. This was the maximum encountered during crosswind landing trials, and is not considered limiting. The preferred technique requires that the upwind wing be lowered during the approach with sufficient opposite rudder applied to align the aircraft with the runway. As airspeed decreases during the flare and rollout, both of these control applications must be increased. [2]

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[2] De Havilland Aircraft of Canada, *DHC-6 Twin Otter, Series 300: Flight Manual*, (De Havilland Aircraft of Canada, 1973), section 2.6.2.

Wind Shear

> Windshear is a sudden, drastic shift in wind speed and/or direction that may occur at any altitude in a vertical or horizontal plane. It can subject an aircraft to extreme horizontal wind components, causing loss of lift or violent changes in vertical speeds or altitudes. [3]
>
> If the airplane is approaching to land at an airspeed near the stall, the approach path could steepen or a stall could occur since any loss in airspeed means a reduction in lift. [4]

When wind shear is anticipated, a precaution would be to add an appropriate wind correction to the approach airspeed, in the same manner as wind gust correction.

Go-Around From a Rejected Landing

The DHC-6-300 AFM recommends that the decision to overshoot or to go around should be made, if possible, during approach with flaps at 10°. Power levers should be advanced to the take-off setting, and the minimum airspeed should be 1.3 times the stall speed with 10° flaps for the aircraft weight; in this case, 81 KIAS for an aircraft weight of 11 000 pounds. When the aircraft is clear of obstacles with a positive climb rate, the flaps should be retracted to 0°, and the airspeed should be increased to 87 KIAS. The AFM also states:

> AFM NOTE: With flap 37.5°, pitch attitude in the go-around will be approximately 0° (level flight attitude).
>
> AFM CAUTION: With flap 37.5°, pitch attitude in the go around greater than 0° (level flight attitude) may cause a rapid decrease in airspeed and possible stall. [5]

As listed in Section 10 (“Safety and Operational Tips”) of the Viking Air Ltd. DHC-6 Series 300 manual:

> If a high angle of attack has been inadvertently allowed to develop, recovery is accomplished by reducing pitch attitude and allowing airspeed to increase. Once the pitch attitude has been reduced and airspeed begins to increase, power may then be increased if necessary to avoid further descent. It is not acceptable to maintain a high

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3 Jeppesen Sanderson, Inc., *Private Pilot Manual, Jeppesen Sanderson Training Products*, (Colorado, US: Jeppesen Sanderson, Inc., 1997), pages 6-50.

4 A.F. MacDonald and Isabel L. Peppler, *From The Ground Up, Millennium Edition*, (Ottawa, ON: Aviation Publishers Co. Limited, 2004), page 288.

5 De Havilland Aircraft of Canada, *DHC-6 Twin Otter, Series 300: Flight Manual*, (De Havilland Aircraft of Canada, 1973).

> angle of attack, add power, and attempt to power out of the high angle of attack. It is essential that the nose be lowered in order to increase airspeed. [6]

National Transportation Safety Board Accident Report AAR-91/01

The following is stated in an investigation report (AAR-91/01) from the National Transportation Safety Board (NTSB) following a similar DHC-6-300 accident which occurred in 1989:

> Grand Canyon Airlines' Pilot Operating Manual (POM) for the DHC-6…contains a caution statement that; In a go-around with flaps extended, the nose will point below the actual flight path. Pilots reported that applying power at low airspeeds when the flaps were fully deployed would result in the airplane pitching up. The pilots further reported that positive pressure against the control yoke was needed to stop or prevent this pitching tendency. While some pilots reported that occasionally it was necessary to use both hands on the control yoke to prevent the airplane from pitching up, no one reported that the control forces exceeded the Federal Aviation Administration (FAA) maximum limitation of 50 pounds.
>
> The NTSB investigation sought to determine the factors that might have caused the pilots to lose control of the airplane during the go-around. During the dynamic situation while the airplane was right wing down and heading for the side of the runway, the pilot's reaction might have been to raise the nose and add power for an anticipated go-around. At airspeeds near stall, the downwash on the horizontal stabilizer tends to raise the nose of the airplane, requiring the control yoke to be pushed forward to maintain a normal pitch attitude for the same trim setting. If the pilot pulled back on the control yoke while adding power, this could have resulted in the airplane lifting off in a nose-high, power-on stall or near-stall condition. In addition, the visual reference may have been misleading. According to the operations manual for the DHC-6, with 40° (full flap is frequently referred to as 40°, but is actually 37.5°) of flaps, the airplane's deck angle is below the flight path angle during a go-around. Therefore, an increase in pitch to a typical nose-up reference attitude while the flaps were at 40° would increase the possibility of aerodynamic stall and subsequent loss of lift. [7]

Crew Information

Records indicate that the flight crew members were certified and qualified for the flight in accordance with existing regulations.

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6 Viking Air Ltd., *DHC-6 Series 300 PSM 1-63-POH*, (Sidney, BC: Viking Air Ltd., 1973), pages 10-45.

7 National Transportation Safety Board, *Grand Canyon Airlines flight Canyon 5, De Havilland Twin Otter, DHC-6-300, N75GC, Grand Canyon National Park Airport, Tusayan, Arizona, September 27, 1989*, (Washington, D.C.: National Transportation Safety Board, 1991), page 13.

The captain held a commercial pilot's licence (CPL) and was rated for single- and multi-engine land and sea operations. The captain's Group 1 instrument rating was valid until 01 June 2012, and Category 1 medical was valid until 01 November 2011. Total flight time was 5817 hours, 4893 hours of which were as pilot-in-command, with 1106 hours on multi-engine aircraft and 1562 hours on float-equipped aircraft. Total experience on a DHC-6 was 1037 hours, 285 hours of which were on floats. Initial training on the DHC-6 took place in May 2010, which resulted in a successful pilot proficiency check (PPC). During the course of the training, the pilot was able to successfully demonstrate stall entry, recognition, and recovery from the following configurations: clean, flap at approach and flap at approach while in a turn. The captain was also able to conduct a rejected landing with maximum landing flap.

The FO held a CPL and was rated for single- and multi-engine land and sea operations. The FO's Group 1 instrument rating was valid until 01 August 2012, and Category 1 medical was valid until 14 March 2012. Total flight time was 570 hours, 111 hours of which were as pilot-in-command, with 343 hours on multi-engine aircraft and 136 hours on float-equipped aircraft. Total experience on a DHC-6 was 323 hours, 135 hours of which were on floats. Initial PPC on the DHC-6 was completed in August 2010, and, in lieu of a flight test, recurrent training was completed in June and July 2011. Two training flights totaling 4.1 hours were conducted, covering stalls from the clean configurations, full flaps, and 20° flaps in a turn. These were assessed as satisfactory. Training for a rejected landing with maximum landing flap was not conducted.

Aircraft Information

Records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The weight and centre of gravity were within the prescribed limits.

C-GARW, a de Havilland DHC-6 Series 300 Twin Otter (serial number 367), was manufactured in 1973 and was being operated on CAP 12000 floats. Total time since new (TTSN) was 33 355 hours. The last Equal Maintenance for Maximum Availability (EMMA) number 16 inspection and 2000 hour airframe inspection were completed on 04 September 2011 at 33 282 hours.

There was no indication of any airframe/engine failure or system malfunction prior to or during the accident flight.

Wreckage Information

The forward fuselage and cockpit were destroyed, with the main fuselage, cabin, and empennage remaining intact. Both wings were attached, with the left-hand wing remaining intact. About 4 feet of the outboard section of the right-hand wing was missing, as well as one-half of the outboard aileron. The flaps were fully down, consistent with the cockpit indication. Both the elevator trim actuator and the flap interconnect trim actuator were in the full nose-down position. Continuity and travel of other controls could not be determined due to damage. Both engines and nacelles were detached from the wings, but remained connected by the hoses and cables. The exhaust sections of both engines indicated considerable distortion opposite the direction of propeller rotation, which shows that both engines were producing considerable

power at impact. All propeller blades were attached to their hubs, but were severely damaged. Floats and struts were detached from the fuselage.

The cockpit voice recorder (CVR) was recovered, and the information was successfully retrieved. The aircraft was not equipped with a flight data recorder (FDR), nor was it required to by regulation.

The following TSB Laboratory report was completed:

- LP 123-2011 - CVR Download Project Summary

Analysis

There was no indication that an aircraft system malfunction contributed to this occurrence. The analysis will focus on crew coordination and handling of the aircraft during the landing and attempted go-around.

When the crew briefed the approach, they were aware of the strong southerly winds and of the resulting rollers. To compensate for wind conditions, an approach speed above 80 knots was agreed upon, which is 10 knots above normal approach speed with full flaps. Airspeeds prior to touchdown were at or below 80 knots, as indicated by the captain's 2 warnings. Strong westerly winds just prior to touchdown created crosswind and wind shear conditions over the intended landing area, and these conditions were probably aggravated by the turbulence around The Rock immediately upwind of the touchdown zone. This combination would have resulted in airspeed fluctuations and caused the initial hard landing and bounce as the FO flared for the landing.

After the initial bounce, the aircraft would have been in a slow flight condition. The strong right crosswind and pilot aileron compensation likely caused the right float to contact the water before the left float during the second touchdown. The aircraft then yawed to the right, and the nose pitched down. Aft elevator control was used to counter the nose-down movement and to initiate the go-around. This, combined with the pitch-up effect of adding full power, resulted in the aircraft lifting off the water in a very nose-high, right-wing-low attitude. With full flaps selected and both wings in a stalled or semi stalled condition, the aircraft could not accelerate or climb for the remainder of the flight. Since the captain assumed control without declaring that he had control, it is possible that both pilots were manipulating the controls during the go-around.

By causing or allowing the nose to continue to pitch up when full power was added during the go-around,the airspeed could not increase. This resulted in the wings stalling and a loss of control.

Findings

Findings as to Causes and Contributing Factors

1. Airspeed fluctuations at touchdown, coupled with gusty wind conditions, caused a bounced landing.

2. Improper go-around techniques during the recovery from the bounced landing resulted in a loss of control.

3. It is possible that confused crew coordination during the attempted go-around contributed to the loss of control.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 12 December 2012. It was officially released on 09 January 2013.

Visit the Transportation Safety Board's website (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. You will also find the Watchlist, which identifies the transportation safety issues that pose the greatest risk to Canadians. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.