AVIATION INVESTIGATION REPORT

A99C0245

FUEL CONTAMINATION — LOSS OF ENGINE POWER

NORTH STAR AIR LTD.

DE HAVILLAND DHC-2 BEAVER (SEAPLANE) C-GZBQ

PICKLE LAKE, ONTARIO 6 NM N

2 OCTOBER 1999

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.

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Summary

The de Havilland DHC-2 Beaver seaplane departed from Big Trout Lake, Ontario, on a visual flight rules flight for Geraldton, Ontario, with a pilot and an aircraft maintenance engineer on board. After encountering adverse weather conditions en route to Geraldton, the pilot decided to divert to Pickle Lake, Ontario. At about 1430 central daylight time, the engine lost power at an altitude of about 300 feet above ground level while in the descent for Pickle Lake. The pilot turned the aircraft toward a nearby narrow river. In an attempt to restart the engine, the pilot confirmed that the fuel pressure was normal, the fuel selector was on the fullest tank (front), the throttle was at idle, the mixture was rich, and the ignition switch was on both, then he operated the wobble pump. When the engine did not restart, he switched to the centre fuel tank and operated the wobble pump again, but the engine still did not restart. He then switched back to the front tank and tried another restart, without success.

He then landed the aircraft on the river at an estimated landing speed of about 40 to 45 mph. After the forced landing, the left wingtip collided with trees on the river bank, and the aircraft yawed to the left about 180 degrees and struck the river bank, breaking off the floats and the float struts. Impact with more trees on the river bank damaged the right wing and elevator. Both occupants were wearing lap belts with shoulder harnesses and were uninjured. The aircraft was substantially damaged. The pilot advised Thunder Bay flight service station by radio of the engine failure and crash and the crew were rescued two hours later.

Ce rapport est également disponible en français.

Other Factual Information

The de Havilland DHC-2 MK I, C-GZBQ serial number 919, was equipped with EDO 679-4930 floats. The aircraft had accumulated 13 372 hours since manufacture in 1958, and the engine had accumulated 952 hours since overhaul. The aircraft's records indicated that the aircraft had been certified and maintained in accordance with existing regulations. On 25 September 1999, the aircraft's left float was damaged during take-off at Perch Lake; on 30 September 1999 the float was temporarily repaired at Perch Lake, and the aircraft was certified as serviceable for flight to Geraldton for permanent repair. Using the front tank, the occurrence pilot flew the aircraft from Perch Lake to Big Trout Lake to refuel, and no unserviceabilities were noted. The subsequent departure for Geraldton was delayed for two days because of poor weather.

The aircraft's structure and flight controls were examined after the accident, and no pre-existing defects affecting the structural integrity or controllability of the aircraft were noted. The engine and propeller were examined at the accident location. There was no evidence of oil leakage in the engine compartment. The magneto switch and leads were found to operate normally. Movement of the propeller resulted in movement of the magneto drive mechanism at the accessory section. Engine and propeller controls were confirmed to have maintained their integrity. The propeller was in fine pitch and free turning within the limited movement available. No significant bends were evident in the propeller blades, which had stopped horizontally.

A sample of fuel was taken from the fuel line between the firewall and the engine-driven fuel pump; it contained mostly rusty brown water with a slight skim of fuel. After this sample was taken, water continued draining from the carburetor side of the line. Investigators found the fuel selector in the "FRONT TANK" position. A second large sample was taken from the drain valve on the delivery line fuel strainer downstream from the fuel tank selector. This sample was rusty brown water, with no evident fuel. Samples were not taken from the centre or rear fuel tanks. Rusty brown water is indicative of fuel drum contamination.

The aircraft's fuel tanks were filled in Big Trout Lake at a floating dock by the occurrence pilot and another pilot. Immediately before the refuelling, two drums that had been stored on their sides on the dock were filled with fuel from jerry cans flown into Big Trout Lake by the operator. About 70 imperial gallons of fuel was then pumped from the two drums into the aircraft's front, centre, and rear tanks with a hand-operated wobble pump.

The wobble pump was equipped with a particulate filter; however, the filter was not designed to prevent water contamination. An electric pump with a no-go filter was available, but it was not used because the dock was 350 feet from the nearest power source and only 300 feet of power cord was available. The company reported that they have not experienced any other recent fuel contamination problems with their fleet.

The Transport Canada *Aeronautical Information Publication* (AIP), section AIR 1.3.2, states that:

> A fuel dispensing system must have an approved filter, water separator or monitor to prevent water or sediment from entering aircraft fuel tanks. The use of temporary fuelling facilities such as drums or cans are discouraged. However, if such facilities are necessary, always filter aviation fuel using a proper filter and water separator with a portable pump bonded to the drum before bungs are removed. A clean chamois or felt lined filter funnel may only be used under dire emergency conditions, recognizing that filter fibres may clog fuel system filters and nozzles.

After refuelling the aircraft, the pilot reportedly drained the tank sumps and the fuel strainer into a container and did not observe any water. The aircraft was then moved from the dock to the beach because of concern about the temporary float repair. To ensure that the aircraft did not sink if water leaked into the floats, the aircraft was beached with the rear of the floats on the beach. This resulted in a nose-level aircraft attitude. The normal attitude on floats is slightly nose-up.

The aircraft was equipped with three fuselage fuel tanks and two wingtip fuel tanks; the wingtip tanks were not in use during the occurrence flight. Each fuselage tank consists of one aluminum cell with a sump at the rear of the tank to catch water contamination by gravity. Each sump has a drain which can be used to drain water from the sump. There is also a drain on the delivery line fuel strainer behind the rear tank. The drains are all located on the bottom of the aircraft under the cockpit and between the floats. On the morning of departure, the pilot drained the sumps and the strainer into a container and again did not find any water. The floats were inspected and no water was found in them.

The engine operated normally en route, with fuel being used first from the rear tank and then from the centre tank when the rear tank was empty. After about 2.5 hours of flight, the pilot decided to divert to Pickle Lake because of reports from other pilots of poor weather at Geraldton. Approaching Pickle Lake, the pilot set the fuel selector to the full front tank and noted that the centre tank had about five imperial gallons of fuel remaining. About five minutes later, the engine abruptly lost power without any rough running or other indication of any malfunction.

The aircraft flight manual (AFM) procedure for restart after engine failure during flight is as follows:

a. Airspeed - 95 mph
b. Fuel selectors - fullest tank
c. Check fuel pressure normal
d. Check oil pressure indication
e. Throttle - 1/3 open
f. Ignition switch - both
g. Wobble pump - operate to build up fuel pressure

The aircraft departed Big Trout Lake at 1155 central daylight time.[1] The observed weather at 1200 at Big Trout

Lake was as follows: winds 340 degrees at eight knots, visibility nine statute miles, a few clouds at 3000 feet, a scattered cloud layer at 4600 feet, a broken cloud layer at 8200 feet, temperature minus one degree Celsius, dewpoint minus eight degrees Celsius, altimeter setting 30.12 inches. At 1400, 30 minutes before the accident, the observed weather at Pickle Lake, about six nautical miles south of the accident site, was as follows: winds 320 degrees at 10 knots, visibility 15 statute miles, a broken cloud layer at 1500 feet, temperature minus two degrees Celsius, dewpoint minus four degrees Celsius, altimeter setting 30.06 inches.

Carburetor ice is a phenomenon by which ice forms in a carburetor's venturi area. As the ice develops, it results in a gradual reduction in engine power; the reported temperature and dewpoint at Pickle Lake were conducive to serious carburetor icing at any power setting. However, the carburetor heat control, a system which preheats the air entering the carburetor to prevent the formation of carburetor icing, was found in the "HOT" position and the carburetor heat indicator was in the green range just above zero degrees Celsius.

The 23-year-old pilot held a Canadian Commercial Pilot Licence issued 19 June 1998 with a seaplane endorsement. His licence was validated by a Category One medical certificate issued on 21 April 1999 with no restrictions. He had accumulated 1420 hours total flying time with 725 hours on floats and had flown 98 hours during the previous 30 days and 248 hours during the previous 90 days.

The aircraft's load at the time of the occurrence, in addition to the crew, consisted of tools and equipment. The load was stowed and secured in the rear of the aircraft, and the load restraints were still secure following the crash. Based on the recorded load, the aircraft's gross weight at take-off was 5415 pounds, and the centre of gravity was within approved limits. The maximum allowable gross weight is 5500 pounds.

Analysis

Since the tank selector was in the "FRONT TANK" position, the contamination in the sample drained from the delivery line strainer after the occurrence would have come from the front tank. The engine operated normally during the flight, using fuel from the rear and centre tanks, and the power loss occurred after the front tank had been selected; therefore, the water contamination was likely confined to the front tank. The fact that the engine operated normally with fuel being fed from the front tank during the previous flight indicates that the front tank fuel was probably uncontaminated at that time. Therefore, the contamination was likely introduced into the front tank while the aircraft was at Big Trout Lake.

The company reported that it has not experienced any other contamination problems using fuel transported in jerry cans; therefore, it is likely the water contamination came from the drums into which the fuel was poured just before the aircraft was refuelled. Since only the front tank was contaminated, it is probable that only one of the two drums was contaminated. The filter on the hand-operated wobble pump was not designed to prevent water contamination; therefore, water from the drum would have been transferred into the aircraft's fuel system.

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[1] All times are central daylight time (Coordinated Universal Time [UTC] minus five hours) unless otherwise stated.

The aircraft fuel tank sumps were drained into a sample glass both after the refuelling and before the departure from Big Trout Lake, but no contamination was detected. It is possible that after the refuelling, the sample was taken before the water had time to settle into the sump. Once the aircraft was beached, its attitude was nose-level rather than the normal slightly nose-up. Because the tank sumps are at the rear of the tank, it is possible that the nose-level attitude prevented the water from reaching the sump for the pre-flight fuel sample. The temperature was below freezing, so it is also possible that the water froze and could not be drained.

If the tank sump was drained during the pre-flight check, it is probable that contamination remained undetected in the front tank. Any ice in the tank could have melted as a result of heat from the engine, exhaust system, and cabin heating system. When the pilot selected the front tank en route, the water entered the fuel lines and migrated to the carburetor and into the engine, resulting in a loss of power.

The low altitude at the time of the power loss limited the time available to restart the engine. The pilot's actions after the power loss correspond to the actions mentioned in the AFM for restart after engine failure during flight, except for the throttle position and the change in the fuel tank selection. However, regardless of throttle position or tank selection, it is unlikely that the contamination would have been eliminated or the engine would have restarted, given the extent of the water contamination and the limited time available.

Both the pilot and the engineer were wearing lap belts and shoulder harnesses at the time of the crash. It is likely that the use of the shoulder harnesses helped to prevent injuries.

Findings as to Causes and Contributing Factors

1. The engine quit operating because the aircraft fuel system was contaminated with a large amount of water.

2. The most likely source of the water contamination was the drums from which the aircraft was refuelled.

3. A proper filter to prevent water contamination was not used when the aircraft was refuelled.

4. The nose-level aircraft attitude when beached and the freezing of water probably prevented the water contamination from being drained from the front tank during the pilot's pre-flight checks.

Other Findings

1. The aircraft's maintenance records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

2. The use of the available shoulder harnesses probably prevented serious injury to the pilot and engineer.

Safety Action

The operator has equipped the main fuel supply tank and all fuel pumps with no-go filters.

The operator has implemented a pilot training program on fuel system supply and fuel drum handling to prevent fuel contamination before the fuel reaches a no-go filter. This program includes written policies and a written test.

The operator has also implemented a training program for its pilots to mitigate the inherent risks of operating in the remote wilderness environment. The program includes a written test of the pilots' knowledge of action required for "extraordinary situations." The exam is reviewed by supervisors and discussed with the pilots.

Transport Canada plans to publish an article in the November 2000 edition of the *Feedback* newsletter for all aircraft maintenance engineers. The article is intended to alert the industry to the possibility that water may remain in aircraft fuel tanks if the aircraft are not positioned in such an attitude as to allow the sumps to collect water and other contaminants.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 1 November 2000.