AVIATION INVESTIGATION REPORT
A99C0137

LOSS OF ENGINE POWER / COLLISION WITH TERRAIN

BLUE WATER AVIATION SERVICES LTD.
DE HAVILLAND DHC-3 OTTER C-FIFP
LONG HAUL LAKE, MANITOBA
25 JUNE 1999

Aviation Investigation Report

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Summary

The Blue Water Aviation Services seaplane departed from Long Haul Lake, Manitoba, with a pilot and an aviation maintenance engineer on board. Shortly after take-off, at 1320 central daylight savings time, the aircraft's engine abruptly lost power. The pilot's attempts to restart the engine were unsuccessful, and the aircraft descended into a stand of trees and struck the ground. The engineer suffered fatal injuries, and the pilot was seriously injured. The aircraft was destroyed by impact forces.

Ce rapport est également disponible en français.

Other Factual Information

On the morning of the occurrence, the aircraft was loaded with six passengers, their luggage, and their equipment for a flight from Silver Falls, Manitoba (Man.), to Sasaginnigak Lake, Man. Before departure, the pilot drained the fuel-tank sumps. He did not use a cup to examine the fuel but assumed from its feel that the liquid was fuel. He completed a run-up and noted no anomalies. The flight to Sasaginnigak Lake was unremarkable and, after the passengers disembarked, the aircraft continued on to Long Haul Lake. For the flight to Sasaginnigak Lake and for most of the flight to Long Haul Lake, the fuel used was from the front tank. Shortly before landing at Long Haul Lake, the pilot set the fuel selector to the centre tank. At Long Haul Lake, the aircraft was loaded with eight passengers and their luggage and equipment for a flight to Matheson Island, Man.

Just before lift-off during the take-off from Long Haul Lake, the aircraft's engine abruptly lost power. The propeller reportedly continued to turn, but at idle power or less than idle power. The aircraft slowed, and the pilot pulled out the engine shut-off control and beached the aircraft on an island. It was not determined whether the engine had lost power completely, or whether it had continued to operate at idle power. The pilot relayed a message as to his situation to the operator's base using the aircraft's very high frequency radio, via an overflying aircraft.

Upon receipt of the message from Long Haul Lake, the company maintenance coordinator and a company aviation maintenance engineer conferred. Together they loaded some spare parts, tools, and equipment onto a second aircraft and flew it to Long Haul Lake. The company maintenance coordinator was also a licensed pilot and operated company aircraft. On arrival, this pilot and the engineer took over C-FIFP and relinquished their aircraft to the other pilot. The relief aircraft was then loaded with the passengers, equipment, and baggage and departed from Long Haul Lake.

The pilot and the engineer examined C-FIFP to determine the reason for power loss during the previous take-off. The pilot turned the engine over with the starter and determined that the engine generated fuel pressure. He then started the engine, ran it at idle speed, and conducted a run-up with power checks. He found that the engine ran rough at the increased power setting required for the magneto check and backfired once. The pilot then taxied C-FIFP to the camp dock. He checked the main fuel-filter sump and the carburettor sumps, and the engineer checked the fuel-tank sumps. Approximately a cup of water was drained from the main fuel-filter sump and a small quantity of water was drained from the carburettor sumps. The engineer advised the pilot that a small quantity of water had been drained from one of the sumps in the centre fuel tank . The pilot and engineer then flushed the fuel system with the electric boost pump, checked the fuel at the main fuel filter, and found it to be clean.

The pilot then taxied out onto the lake and conducted two run-ups. The pilot and the engineer were satisfied with the engine's performance and believed the engine's earlier rough running resulted from water contamination in the fuel. The pilot selected a take-off run which afforded a curving take-off distance of about 4 000 feet in a north-westerly direction, among several islands. The pilot then taxied into take-off position and applied power for departure. The fuel selector was still set to the centre tank. The engine reportedly ran smoothly and produced full power during the take-off and initial climb, to an altitude of about 100 to 150 feet above ground level. The engine then lost power suddenly, without any rough running or other indication of unserviceability.

The engine lost power at a point from which the aircraft could not be landed on the remaining portion of the lake. The pilot turned toward the next nearest water area, set the fuel selector to the rear tank, turned on the fuel boost pump, and worked the throttle. The pilot suspected that water contamination in the fuel might have led to the loss of engine power and concentrated on measures to clear any such contamination in order to restart the engine. Working the throttle operates the carburettor's accelerator pump, which is designed to spray raw fuel into the engine's intake manifold to overcome a temporarily lean mixture and support combustion during engine acceleration. The engine did not restart, and the aircraft descended into a stand of trees about one nautical mile (nm) north of the main body of Long Haul Lake, on a heading of 290 degrees magnetic. The aircraft descended through the tops of the trees, and then, at the edge of the stand of trees, the aircraft fell and struck the ground at a steep angle. A small, post-impact fire broke out in the engine's carburettor. This fire damaged the carburettor and the intake air scoop, then self-extinguished.

The impact with the trees and ground broke the float attachment struts and the wing attachment points. The roof and floor of the cockpit were twisted, and the engine mounts were broken from the fuselage. The pilot's injuries were consistent with impact-related acceleration forces. The engineer suffered multiple traumatic injuries, primarily involving the head and chest, which were consistent with unrestrained upper-body contact with aircraft components during the impact sequence. Both occupants received injuries from contact with trees when the front part of the cockpit broke away during the impact with the ground. The pilot was wearing his lap belt and shoulder harness during the accident flight. The engineer was wearing his lap belt but not the available shoulder harness. The emergency locator transmitter in the aircraft was activated by impact forces. Search and rescue aircraft were dispatched from Winnipeg, and the occupants were removed from the scene.

The aircraft's load at the time of the occurrence consisted of the two crew members, tools, equipment, and spare parts. The load was reportedly stowed and secured in the rear of the aircraft. A post-accident examination of the aircraft found the cargo restraints to be damaged and the aircraft's load scattered throughout the cabin. Based on the reported load, the aircraft's gross weight at take-off was 7 160 pounds, and the centre of gravity was within approved limits. The maximum allowable gross weight is 7 967 pounds.

The aircraft flight manual (AFM) procedures for restart after engine failure are as follows:

a. airspeed—85 miles per hour
b. fuel selector—fullest tank
c. mixture control—full rich
d. propeller control—full increase revolutions per minute
e. throttle—one-third open
f. ignition switch—both
g. boost pump switch—boost pump

The pilot held a Canadian commercial pilot's licence with multi-engine and seaplane endorsements. He had a current medical certificate, restricted to daytime operation only, and was required to wear glasses while flying. He was reportedly complying with the requirement to wear glasses at the time of the occurrence. The pilot had flown 80 hours during the previous 30 days and 200 hours during the previous 90 days. The flight to Long Haul Lake was his first flight of the day, and he reported being well rested at the time of the accident flight.

The observed weather at 1300[1] at Berens River, about 40 nm west of the accident site, was as follows: winds 290 degrees at 7 knots, visibility 15 statute miles, a few clouds at 2 200 feet, a few clouds at 4 000 feet, a

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1 All times are central daylight savings time (CDT) (Coordinated Universal Time [UTC] minus five hours).

broken cloud layer at 11 000 feet, a broken cloud layer at 20 000 feet, temperature 13 degrees Celsius, dewpoint 7 degrees Celsius, and altimeter setting 29.90 inches. The observed weather at 1300 at Little Grand Rapids was as follows: winds 270 degrees at 6 knots, visibility 15 statute miles, high thin overcast, temperature 17 degrees Celsius, altimeter setting 29.88 inches.

Carburettor ice is a phenomenon by which ice forms in a carburettor's venturi area. As the ice develops, there is a gradual reduction in engine power. According to section AIR 2.3 of Transport Canada's *A.I.P. Canada* (aeronautical information publication), the reported temperature and dewpoint at Berens River were conducive to moderate carburettor icing at cruise power and serious icing at descent power. The pilot had reportedly checked carburettor heat during the run-ups and noted no carburettor ice. He did not use carburettor heat for the take-off. The AFM directs that carburettor heat be set on "cold" for take-off, except in conditions of extreme carburettor icing. The operator's experience with the accident aircraft type was that little or no carburettor icing accumulated during the take-off phase of flight.

The de Havilland DHC-3, serial number 73, was equipped with EDO 7850 floats. It was modified by the installation of a Pezetel Asz-621R-M18 piston radial engine and AW-2-30 propeller in September 1981 and had accumulated 5 314 hours of air time since the date of its modification. It was equipped with lap belts and shoulder harnesses for the cockpit seats and lap belts only for the passenger seats.

The aircraft was equipped with three bladder-type fuselage fuel tanks and with fuel sumps designed to catch water contamination by gravity. The front and rear tanks comprise one fuel cell and one sump each. The centre tank comprises two connected fuel cells, with one sump for each cell. The aircraft had a reported fuel load of about 950 pounds at the time of the accident. The fuel from the centre tank had leaked out as a result of impact damage. A small sample of residual fuel, which was drained from the centre tank's forward sump drain, showed there was water contamination. The front tank was found to contain less than five gallons of fuel, with no indication of water. More than ten gallons of fuel were drained from the rear tank, with no indication of water. All the fuel which was sampled was 100 octane low lead (100LL) aviation gasoline, which was the recommended grade of fuel for the accident aircraft. The fuel system was examined to the extent possible at the scene of the accident. A rusty substance, consistent with water contamination, was found in the main fuel strainer bowl. After the aircraft was removed from the site, the remainder of the fuel system was examined. Traces of water and rusty deposits were found in the carburettor screens, the fuel lines, and the main fuel filter. No blockages, degraded fasteners, or bladder ripples were noted.

The accident aircraft had been fuelled from the operator's fuel supply during the several days before the accident. The fuel supply is equipped with a filter designed to prevent the passage of water. The operator reported that the filter was checked periodically and that very little water had been found during the 1999 operating season. The operator's fuel supply was sampled after the accident and no contamination was found. The aircraft had operated in the Silver Falls, Man., and Bissett, Man., areas on the day before the accident. While in Bissett, about 70 litres of 100LL fuel were purchased from an aircraft operator located there. That operator reported that its fuel supply had been in use by other aircraft before and after the accident, without incident. The purchased fuel was added to the rear fuel tank. After this fuel was added, the rear tank was reportedly not selected for use until the pilot reset the fuel selector after the engine lost power. After fuelling at Bissett, the aircraft proceeded to Silver Falls with the front tank selected. All three of the aircraft's fuselage fuel tanks were reportedly filled the night before the occurrence from the fuel supply tank at the operator's base at Silver Falls. Water can enter an aircraft's fuel system by condensation, spray from seaplane operations, or as contamination in uploaded fuel. The time at which the water contamination had entered the aircraft's fuel system and the source of the water were not determined.

The aircraft's structure and flight controls were examined after the accident, and no pre-existing defects affecting the aircraft's controllability or structural integrity were noted. The aircraft had accumulated 23 960 hours since manufacture in 1955, and the engine had accumulated 1 260 hours since its installation in 1996. The aircraft's records indicated that the aircraft had been certified and maintained in accordance with existing regulations.

The engine was damaged to an extent that precluded a test run. The engine was disassembled and examined at an overhaul facility. The spark plugs appeared to be serviceable and exhibited operational wear consistent with low-time operation. The magnetos and fuel pump were tested and found to be serviceable. The magneto timing and point clearance settings were found to be outside the required limits, but the settings were considered to be capable of supporting continued engine operation. Adequate cylinder compression was found, and no indication of valve, bearing, or rotating-component malfunction was noted. No mechanical or system defects that would have resulted in a sudden or significant engine power loss were noted in the engine, propeller, or accessories.

The carburettor had sustained fire damage after impact with the ground and could not be tested without the overhaul of some component parts. However, disassembly and examination of the carburettor revealed no pre-existing mechanical defects. During flow testing, the carburettor accelerator pump and floats exhibited normal operation and no leaks. The mixture settings were as set at the factory and the automatic mixture control was fixed at the full-rich position. The carburettor's pneumatic idle shut-off is designed to introduce air into the carburettor and lean the fuel-air mixture at idle, sufficient to stop the engine. This depends on correct rigging for proper operation; rigging was disturbed by impact forces and could not be evaluated. However, the idle shut-off valves and their seals exhibited normal operation.

The ignition harness cannon plug was examined at the accident site and was found to be secure and lockwired. The cannon plug contains an electrical bridging mechanism that was designed to short the magnetos to ground when the cannon plug is disconnected. During examination at the TSB regional wreckage examination facility, the cannon plug exhibited correct electrical continuity and proper operation of the bridging mechanism. The ignition harness cannon plug and the magneto switch were sent for testing to the TSB Engineering Laboratory. The magneto switch was tested, and its operation was found to be normal in all switch positions. The cannon plug was tested at various temperatures to replicate service conditions. It exhibited correct continuity at all temperatures. The cannon plug was then sectioned to further examine the bridging mechanism components. The mechanism was found to be intact and functioning as designed. During examination, a cannon plug intermittent malfunction or malfunction that would have compromised the operation of the magneto ignition system was not observed.

Analysis

No mechanical reason was found for the first engine power loss on the day of the accident. However, the fact that water was found in several fuel sumps after the engine power loss during the first attempted departure indicates that the aircraft's fuel system was contaminated to some extent at that time. Because the aircraft's engine ran smoothly after water was drained from its fuel system, it is likely that the engine power loss during the first attempted take-off resulted from fuel contamination. It is unlikely that any significant amount of carburettor ice accumulated in the carburettor due to the low ice accretion rate during the take-off phase and the short duration of the flight.

Traces of water were found in the carburettor filter and in the main fuel-line filter. Although the water's time of entry could not be definitely established, the finding of a rusty substance, which is consistent with water contamination, in various parts of the fuel system indicates that the fuel system had become contaminated after the system had last been cleaned or replaced. Impact damage resulted in the loss of all but a very small amount of fuel from the centre tank; however, the amount that was obtained from the centre tank's forward sump drain contained water contamination. Because most of the fuel had escaped, the amount of water contamination in the fuel system before impact could not be accurately assessed. Water contamination in the fuel tanks would have migrated by gravity to the fuel sumps. Damage to the tanks and sumps during the impact would have allowed water contamination in the area to escape. Although the fuel system had been drained after the first power loss incident, some contamination probably remained in the system.

The most likely accident scenario is that water contamination remained in the fuel system after it was flushed. The water would then have shifted its position during take-off, entered fuel lines and migrated to the carburettor and into the engine, resulting in a loss of power. After the power loss, the pilot changed fuel tanks, activated the fuel boost pump, and worked the throttle, which began to clear the contamination and moved fresh fuel into the carburettor. In this scenario, enough fresh fuel would have been moved to the carburettor area to facilitate the post-crash carburettor fire, but the impact with the trees and ground would have intervened before the fuel entered the engine and allowed it to regain power.

The pilot's actions after the power loss correspond to the actions specified in the AFM for restart after engine failure during flight, with the exception of the throttle position. The pilot's action in working the throttle differs from the stated procedure of positioning the throttle to one-third open. However, in the most likely accident scenario—fuel contamination—working the throttle operated the accelerator pump in the carburettor and increased the movement of fuel through the system. The pilot's action therefore hastened the time at which clean fuel would have been supplied to the engine. It was not determined whether the pilot's action would have affected the engine restart once clean fuel was available.

Although the pilot and the engineer were subjected to similar deceleration forces during the crash sequence, the types of injuries suffered by the engineer were more serious than those of the pilot. Differences in physiology between the two individuals and differences in impact forces at the two seat positions make it difficult to draw comparisons between the origin of the injuries suffered by the two crew members. However, the pilot's use of the available shoulder harness likely prevented more serious injuries during the impact sequence. Based on the general knowledge that seat belts and shoulder harnesses more often than not prevent injuries, the engineer's injuries would have likely been less severe had he been using both his seat belt and shoulder harness.

The following TSB Engineering Laboratory Report was prepared:

LP107/99—*Magneto Harness Cannon Plug.*

Findings as to Causes and Contributing Factors

1. The most likely accident scenario during the second take-off is that water contamination migrated from the centre fuel tank to the engine, resulting in a loss of engine power.

2. The engine stopped at a point from which there was insufficient time for the engine to restart, nor from which a safe landing could be made.

~~3.~~ Indications of water contamination were found in the fuel system after the occurrence; however, the source(s) of the water contamination could not be identified.

Other Findings

1. Examination of the aircraft and testing of the engine and components did not identify any pre-occurrence structural, mechanical, or electrical defects or malfunctions that would have contributed to this occurrence.

2. The post-crash fire in the carburettor most likely resulted from uncontaminated fuel brought forward by the windmilling engine and the pilot's efforts to clear contamination from the fuel system.

3. The pilot's use of his shoulder harness likely prevented more serious injuries during the impact sequence.

4. The engineer's injuries likely would have been less severe had he been using both his seat belt and shoulder harness.

5. The pilot was certified and qualified for the flight.

6. The aircraft's weight and centre of gravity were within approved limits.

7. The aircraft's records indicated that the aircraft had been certified and maintained in accordance with existing regulations.

8. The aircraft's engine power loss during the first attempted take-off was likely due to water contamination in the fuel.

Safety Action Taken by the Operator

The operator has reportedly taken steps to ensure that fuel sumps are regularly checked for contamination.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 13 July 2000.