AVIATION INVESTIGATION REPORT
A99C0127

POWER LOSS / FORCED LANDING

ATHABASCA AIRWAYS LTD.
SIKORSKY S55B/T (HELICOPTER) C-FUNT
PELICAN NARROWS, SASKATCHEWAN 16 NM NW
09 JUNE 1999

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Summary

The helicopter was on the second flight of the day, flying contract missions for the Fire Management and Forest Protection Branch of the Province of Saskatchewan. The pilot was bucketing hot spots on a fire that was almost out. The pace was leisurely and pilots in the area were picking their own targets. The pilot of the S55B/T was making right-hand circuits from the fire line to a nearby lake. He estimated that he had dumped 10 to 15 buckets on the fire when he returned to a bay in the lake to charge the bucket for the next drop. The bucket was in the water, suspended on a 20-foot line below the helicopter. The pilot had moved the helicopter off to the side and had his head out the side window to watch the progress of the fill, and he was not in a position to monitor the engine gauges.

While hovering 10 to 15 feet above the water's surface, with the throttle in the full-open position, the pilot heard the engine begin to spool down. He did not have time to tell if the engine had stopped completely or if it had decelerated to flight idle, but it was apparent that the helicopter would not maintain its altitude. The pilot pulled the collective to arrest the descent, and then rolled the throttle off in an attempt to reduce the main rotor revolutions per minute (rpm). He did not have time to pull the fuel shut-off or to pull the rotor brake before the helicopter struck the water. The helicopter settled onto its left side, and the main rotor blades were substantially damaged. When it was apparent that the helicopter was sinking, the pilot departed the helicopter and swam to the nearest shoreline. He did not think to reach for his life jacket that was stored overhead in the cockpit of the helicopter. The pilot, who was wearing his helmet, suffered a blow to the head during the occurrence and experienced some soreness in his neck afterwards.

Ce rapport est également disponible en français.

Other Factual Information

The 1000 central standard time (CST) weather, as observed by the Fire Management Branch at Pelican Narrows, 16 nautical miles (nm) from the occurrence site, was as follows: temperature of 16 degrees Celsius, relative humidity of 78 per cent, wind from 180 degrees magnetic, and wind speed of 5 kilometres per hour. It was indicated that the conditions were similar at the occurrence site.

Persons on the shoreline observed that the helicopter was in a stable hover, and the bucket was resting in the water when the engine noise decreased and the helicopter settled in the water.

The helicopter was recovered from the water after being submerged for two days. A fuel sample taken from between the engine fuel shut-off and the engine-driven pump showed the fuel to be clean and free from water contamination. While the helicopter was submerged, water displaced the fuel from the main fuel tanks, and the quantity of fuel on board at the time of the occurrence could not be accurately determined. The fuelling records for the aircraft indicated that there would have been ample fuel to complete the assigned flights. Samples taken from the fuel dispensing pump and tank system were clean and free from contamination. No problems were reported by operators of other aircraft that were fuelled from the same source.

Although the main rotor blades had suffered significant damage, the main rotor and tail rotor controls maintained their integrity and were found to function normally. Inspection of the cockpit indicated that the ground/flight switch was in the flight position. The helicopter engine did not incur a catastrophic internal failure; the engine compressor and turbine sections turned freely without grinding or restriction; and there was continuity between the main engine components and the accessories of the accessory drive section. All engine linkages and controls were found to be secure and to function normally.

Records indicated that the helicopter was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The helicopter was operating within its maximum gross weight limit, and the centre of gravity was within the prescribed limits.

The pilot held a valid commercial pilot licence appropriately endorsed for the S55B/T helicopter and a valid Category 1 medical certificate. His recurrent training was up-to-date, and he had accumulated more than 3 000 hours as pilot-in-command for the helicopter type and a total flight time of approximately 5 500 hours. The pilot and helicopter had been on contract for about three weeks prior to the occurrence. During that time, the pilot had accumulated approximately 80 hours of flight time. The day before the occurrence, the pilot had flown eleven hours. Information provided indicated that he had slept for more than eight hours prior to the day of the accident and he felt that he was well rested. The pilot reported that he had been accomplishing under-speed governor (USG) checks before the first flight of the day, in accordance with company policy and the requirements of the helicopter operating manual. He reported that the helicopter had operated within allowable limits when this test was conducted on the day of the occurrence. The helicopter was being operated in a low-load role at the time of the occurrence. The pilot was aware of the tendency for this engine to decelerate if additional power was required when the engine rpm was at 99%, and he believed that the helicopter was operating above this critical 99% engine rpm at the time of the occurrence.

In an information letter dated 28 July 1975, Helitec Corporation identified a possibility whereby S55T helicopters, equipped with AiResearch TSE331-3U-303 turbo shaft engines, may encounter power loss at lowered engine speed. Under normal operating conditions, the USG regulates the fuel delivered to the engine to maintain a nearly-constant engine speed under various engine power conditions. As the power requirement of the engine is increased, the USG increases the fuel flow. The engine speed typically decreases about three per cent in going from no-load to 650 shaft-horsepower. To facilitate engine starting and to prevent surges or serious over-temperatures, a limit, described as the acceleration schedule, was provided beyond which the fuel flow will not be increased. If the engine is operating near this acceleration schedule limit, any additional load will cause the engine speed (rpm) to decrease. Unless the load on the engine is reduced, the engine will experience a rapid loss of engine power and rpm but will not flame out.

The letter further suggested the following: the engine tachometer must be verified for accuracy; pilots must be aware of the possibility of deceleration if the engine is operated below 99 per cent engine speed in flight; the USG setting and throttle linkage must be confirmed to provide full-travel operation; and the specific gravity setting for the fuel control must be appropriate for the fuel being used. Airworthiness Directive (AD) 75-22-12 was subsequently issued. It mandated accomplishment of these preventative measures and further required that a fuel enrichment valve system be installed. Records indicate that company maintenance personnel had completed calibration tests for the engine tachometer and the engine tachometer generator, in accordance with the requirements of AD 75-22-12, and the required fuel enrichment valve system was installed on the engine.

Athabaska Airways Ltd. owned several S55T helicopters. At the time of the occurrence, C-FUNT was the only one of these helicopters that was operational. After this accident, the operator sold all of its S55T helicopters and shipped them to the United States. There were no other S55T helicopters operating in Canada.

The engine was in the process of spooling down at the time of the submersion and was exposed to the thermal shock of sudden cooling in the cold water of the lake. As a result of the detrimental effects of this cooling exposure, it was not deemed feasible to test run the engine. Despite this shock loading, there was no evidence of internal failure, and it was deemed to be unnecessary to tear the engine down. The electrical system was on-line and powered when the helicopter sank and would have been subjected to arcing of the electrical components due to moisture-related conductivity. It would be difficult to differentiate between pre-submergence arcing and arcing caused by submersion, and any arcing damage would be inconclusive. With the exception of a non-water contaminated sample of fuel, which was trapped between the engine-driven fuel pump and the firewall shut-off, all of the fuel in the helicopter and the engine was displaced by lake water when the helicopter was submerged.

As a result of the foregoing, the scope of the investigation was limited to testing those items which had previously been suspected to cause problems with TSE331-3U-303-equipped S55T helicopters, in particular those components that provide fuel delivery control to the engine.

During disassembly of the fuel system and removal of the primary components, all lines and orifice fittings were found to be secure. After removal, they were examined for blockages or contaminants. Other than water that had entered the system while submerged in the lake, there were no contaminants or blockages. The fuel control Ps3 rolling diaphragm was checked for leaks and found to be secure. The fuel system components were sent to their respective manufacturer facilities, where they were tested in the presence of Federal Aviation Administration (FAA) inspectors. Despite the effects of submersion and the time between the accident and the testing, each component was deemed to function in a manner which would not have caused an engine deceleration. The following minor anomalies were noted during testing: during initial testing of the engine-driven fuel pump (Garrett P/N 89370-2) the vanes were stuck in a retracted position and the pump did not immediately produce flow; and, when the pump vanes released, the pump discharge rate was 115 pounds per hour (pph) instead of the standard 120 pph. This difference in flow rates was deemed to be insufficient to cause an engine deceleration.

The flow divider and drain assembly (Garrett P/N 394300-3-1) functioned at 85 pounds per square inch differential pressure (psid) rather than the standard pressure of 75 psid. The safety wire crimp seal for the bellows assembly was reported to be other than that of the manufacturer, and a thin, white, oxidation substance was noted in the vicinity of the bellows adjustment screw assembly. The presence of the oxidization substance and the difference in psid were assessed as not contributory to an engine deceleration.

The manufacturer of the fuel control (Woodward part number (P/N) 8070-113, Garrett P/N 89309-4) found that the lockwire on the speed setting shaft was not the same as that installed by the manufacturer, indicating that a field adjustment had probably been made. According to the manufacturer, the "USG max stop was high out of limits, 4700 rpm required to meet 220 pph requirement when 4627 rpm should achieve. This shows a change in the USG max. setting of approximately 1.5%." In a follow-up discussion, the manufacturer indicated that this would have resulted in the engine being less likely to reach its acceleration schedule. When tested with the Tt2 sensor (Woodward P/N 8901-013) installed, all test parameters for the assembly were satisfactory. Nothing was found to indicate that the fuel control or the Tt2 sensor could have contributed to the reported problem.

Analysis

The pilot was aware that the engine could decelerate if flight loads reduced the engine rpm to below 99% and the engine began operating on the acceleration schedule. Because the pilot had his head out of the side window, he did not see the engine rpm indicated on the gauge. The helicopter engine should have been operating at greater that 99% rpm and should not have been operating on the acceleration schedule because the helicopter was in a stable hover and it was not lifting a heavy load.

Because the fuel supply for the helicopter and the fuel in the fuel line to the engine-driven pump were found to be uncontaminated, it is unlikely that the engine power loss resulted from fuel contamination. The fact that other aircraft fuelled from the same source operated without fuel-related problems indicates that it is unlikely that fuel quality was a factor in the occurrence. The information as to the fuel quantity in the helicopter makes it unlikely that the power loss resulted from fuel starvation.

As the electrical system was active and running when the helicopter became submerged, the electrical system was not analyzed. While it is possible that arcing in the electrical control system could cause a loss of engine rpm, it would be extremely difficult to differentiate between pre-impact and submersion-related arcing. Therefore, the electrical system was not investigated further.

There was no evidence of catastrophic engine failure. Despite being subjected to thermal shock and submersion, the engine was free-turning without grinding or binding and the accessory drives were intact. The shock loading precluded ground running or engine-stand running of the engine. The engine's free-turning condition after recovery suggests that the engine did not suffer a pre-impact internal failure.

Testing of the fuel control, the Tt2 sensor, the fuel pump, and the flow divider valve at their respective manufacture facilities did not disclose conditions that would have caused a loss of engine power. Several minor anomalies were noted during testing, but it was not determined whether these anomalies were present prior to the occurrence or if they resulted from the effects of the immersion of the helicopter. Even if the abnormalities existed before immersion, none of these individual anomalies should have resulted in an uncommanded loss of engine power. In addition, it is unlikely that their combined effect would have resulted in a complete loss of engine power. However, because the engine could not be ground run or test run with the components in place, it was not feasible to assess the combined effect of these anomalies.

The following TSB Engineering Branch report was completed:

LP 90/99 - Engine Fuel Delivery Components.

Findings

1. The pilot was experienced on type and certified and qualified for the occurrence flight.

2. Records indicate that the aircraft was maintained and certified in accordance with existing standards and procedures.

3. The weather conditions were not a factor in the occurrence.

4. The operating parameters at the time of the occurrence did not contribute to the cause of the loss of engine power.

5. Neither the fuel quality nor the fuel quantity was a likely factor in the occurrence.

6. The effects of submersion of the helicopter precluded post-occurrence engine run testing.

7. Component testing did not identify a cause for the deceleration of the engine.

Causes and Contributing Factors

For undetermined reasons, the engine experienced an uncommanded power reduction when the helicopter was at a low height above water. While functional testing of the fuel control, fuel pump, and the USG indicated that none of these components should have caused the reduction of power, some slight test parameter deviations were noted. The combined effects of these slight deviations could not be assessed.

Action Taken by the Operator

The operator sold this machine and all others that it owned to a company in the USA, where the helicopters are scheduled to be converted to a more successful engine/airframe combination. There are no other S55B/T helicopters operating in Canada.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 23 March 2000.