Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT

A01W0255

POWER LOSS - FUEL STARVATION

DELTA HELICOPTERS LTD.

MCDONNELL DOUGLAS 369HS (HELICOPTER) C-FCVV

FORT SIMPSON, 2 NM SOUTH, NORTHWEST TERRITORIES

05 OCTOBER 2001

Canada

Aviation Investigation Report

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Delta Helicopters Ltd.
McDonnell Douglas 369HS (Helicopter) C-FCVV
Fort Simpson, 2 nm South, Northwest Territories
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Summary

A McDonnell Douglas 369HS helicopter, C-FCVV, serial number 440584S, with a pilot and a passenger on board, was on a visual flight rules flight from a hunting camp on the South Nahanni River to Fort Simpson, Northwest Territories. Approximately 25 nautical miles from Fort Simpson, the pilot observed that the fuel quantity gauge was indicating a much higher value than it should, considering the time the helicopter had been airborne. As a precautionary measure, he began to follow a cut line, and later a road, in order to remain over a suitable forced landing area. At approximately 1900 local time, as the helicopter neared the landing pad at Fort Simpson, the pilot initiated a left turn for the final approach. During the turn, at an altitude of 100 to 200 feet above ground, the engine (Allison 250-C20) flamed out. The pilot entered autorotation and attempted to force land on a secondary road; however, the helicopter struck trees prior to reaching the road and descended rapidly to the ground. The pilot was fatally injured and the passenger sustained serious injuries. The helicopter was substantially damaged.

Other Factual Information

The 1900 mountain daylight time (MDT)[1] hourly weather report for Fort Simpson, Northwest Territories, was as follows: high, thin, broken cloud; unrestricted visibility; winds from the southeast at 8 knots; and temperature 8˚ Celsius.

The pilot was licensed in accordance with existing regulations. He held a valid Canadian commercial pilot licence, endorsed for three helicopter types, including the McDonnell Douglas 369. His flying experience was estimated to be in excess of 5000 hours, including approximately 2000 hours in helicopters. He had approximately 600 hours in the McDonnell Douglas 369 helicopter. The pilot owned the helicopter, which was leased to Delta Helicopters at the time of the occurrence.

Both occupants were wearing available inertia reel shoulder harnesses and lap belts. The pilot was fatally injured and the passenger sustained serious injuries.

Field examination of the wreckage determined that the engine had flamed out due to fuel starvation. The helicopter was fitted with a main and an auxiliary fuel system, and both systems were examined following the recovery of the wreckage. Approximately three cups of fuel were drained from the main cells, and an additional 132.5 pounds of fuel were recovered from the auxiliary cell. The open/close control for the auxiliary fuel valve was found trapped, because of impact damage, in the closed position.

The McDonnell Douglas 369HS main airframe fuel system embodies two flexible, rubberized, bladder-type, interconnected fuel cells, located in separate fuel bays beneath the passenger compartment floor. Fuel is delivered to the engine from the left fuel cell. The main fuel system holds 62.1 US gallons, or approximately 416 pounds, of usable fuel. The upper panel of each fuel cell is laced to the underside of the cabin floor. The sides and bottoms of the fuel cells are left unsecured in the tank bays so as to reduce the probability of tearing and fuel spillage during an accident. The fuel cell bays were not structurally distorted from the impact. Visual examination of the main fuel cells showed that they were wrinkled and partially collapsed in several areas of the cell bays.

The helicopter was equipped with a float-type fuel quantity indication system and a FUEL LOW caution light that would normally illuminate when the fuel quantity in the main fuel cells decreased to approximately 35 pounds. During the last 15 minutes of flight to Fort Simpson, the pilot twice tested the annunciator panel lights to verify that the FUEL LOW caution light was functioning. The FUEL LOW caution light did not illuminate prior to the engine flame-out. The fuel quantity sensor, part number 369D296303-5, was mounted in the left fuel cell. Fuel quantity indications and the illumination of the FUEL LOW caution light are predicated on the position of the fuel quantity sensor arm; if the motion of the fuel quantity sensor arm is restricted, neither

[1]All times are mountain daylight time (Coordinated Universal Time [UTC] minus six hours)

system will function as designed. The fuel quantity indication system and the FUEL LOW caution light were field-tested in situ, and no discrepancies were noted.

The auxiliary fuel cell was mounted in the cabin, behind the rear cabin seat back, in accordance with Fargo Manufacturing Company Supplemental Type Certificate No. SH656GL. This system transfers auxiliary fuel by gravity into the main fuel cells when the auxiliary fuel valve is selected to the OPEN position. The system is pilot activated by a control knob on the floor adjacent to the left cockpit door. The normal procedure for fuel transfer, as stated in the Federal Aviation Administration (FAA) approved *3969HS Rotorcraft Flight Manual Supplement* for the Fargo auxiliary fuel system, is to use the aircraft main fuel down to 200 pounds and then transfer the auxiliary fuel.

The auxiliary fuel cell was not fitted with a fuel quantity indicator. The fuel quantity gauge indication would normally stabilize for the duration of the fuel transfer, as the rate of fuel transfer approximates the rate of fuel burn. The auxiliary fuel cell had a capacity of 21 US gallons, or approximately 138 pounds, of usable fuel. The auxiliary system had been installed in the helicopter in July 2000, and a review of the pilot's journey log entries indicated that there were few flights where he would have used the system. During a field examination, no mechanical discrepancies of the auxiliary fuel system were identified.

The helicopter had departed the hunting camp at approximately 1600 and the accident occurred at about 1900, during daylight hours. The flight included two intermediate stops, and total air time for the three legs was estimated to be two hours and forty minutes. The MD 369HS normally burns approximately 24 US gallons or 168 pounds of fuel per hour at a cruise power setting. The auxiliary fuel cell was full, and the main fuel cells were full or near full prior to departure. This would have been sufficient fuel for approximately three hours and twenty minutes of flight.

Helicopter 440584S was manufactured in 1974. At the time of manufacture, it was fitted with a single fuel vent tube that exited the bottom of the fuselage. Hughes *Service Information Notice HN-81*, issued 02 January 1975, provided for the installation of an additional vent tube and fairing assembly, modification kit number M50042, to provide alternative venting on MD 369HS helicopters, serial numbers 0101S through 0671S. The alternate vent was optional, at the discretion of owners and operators of applicable helicopters, and was installed at the manufacturer's facility on MD 369 helicopters assembled after 1975.

Modifications to install an external cargo pod in accordance with Gajon Associates Limited Supplemental Type Approval (STA) No. SH78-1 had been partially completed on the helicopter in April 2001, 45 flight hours prior to the occurrence. The original single fuel vent fairing was removed and a vent drain, consisting of a mounting bracket and a drain spigot, was permanently installed over the external end of the single vent tube, in accordance with the STA. The drain spigot was oriented approximately 80˚ to the right of the longitudinal axis of the fuselage, at approximately right angles to the relative air flow in forward flight, and the inside diameter of the external end of the vent tube was reduced from 9/16 inch to 5/32 inch. The cargo pod was then fitted to the airframe.

The pilot reconsidered his decision, and requested that the cargo pod be removed. The modification was incomplete at this stage because an alternate fuel vent had not been installed in accordance with Service Information Notice HN-81 and as required by the STA. The cargo pod was removed and the helicopter was returned to service in a partially modified condition, without the alternate vent and with the fuel vent drain spigot still in place.

While it is common practice in the industry to remove and install the cargo pod as required, and to leave the drain spigot in place, the STA is silent on operating a helicopter with the cargo pod removed and the drain spigot installed.

The helicopter was fitted with a wire cargo rack that was mounted on the left side of the fuselage. The weight and balance report had not been amended to include the cargo rack, which weighed approximately 30 pounds.

Emergency response personnel were apprised of the accident quickly and responded without delay, due to the proximity of the accident site to a well-travelled road. The accident occurred about 7 miles from the Fort Simpson airport, near a height of land between the town site and the Fort Simpson airport, and within the 15 nautical mile mandatory frequency area (MF area). The helicopter was fitted with a Narco emergency locator transmitter (ELT). The ELT transmitted on 121.5 MHz at impact, and the signal was received by the search and rescue satellite (SARSAT) system. While not considered a factor in the occurrence, the signal was not received by the community aerodrome radio station (CARS) at the Fort Simpson airport. Post-accident testing confirmed that the signal from a serviceable ELT transmitting at the accident site could not be received by the CARS. Airport antennas are located to maximize air-ground coverage in the area, and ground-ground coverage on the airport. Because 121.5 MHz is considered an air-ground frequency, and not a ground-ground frequency, there is no specification for 121.5 MHz ground-ground reception coverage within the 15 nautical mile MF area.

A similar accident involving a MD 369 helicopter occurred in Lethbridge, Alberta, in 1989 (TSB Report No. A89W0272). This helicopter was also fitted with a single fuel vent; however, the vent fairing, which is necessary to provide positive pressure within the fuel cells during forward flight, was missing from the fuselage. It was determined that the missing fuel vent fairing had induced negative pressure inside the fuel cell, which caused the fuel cell to partially collapse and impinge on the float arm of the fuel quantity sensor. This led to erroneous fuel quantity readings, resulting in the engine flaming out due to fuel exhaustion.

Analysis

Several factors were at play in this occurrence. The fuel quantity indication system and the FUEL LOW caution light are not independent, and anything that would restrict the motion of the fuel quantity sensor arm, such as a wrinkle in the fuel cell, would have induced an erroneous fuel quantity indication and disabled the caution light. The original single fuel vent had been modified with the installation of a drain spigot, which significantly reduced the inside diameter of the external end of the vent tube. However, the alternate vent system had not been installed, as required by the cargo pod STA. It is probable that this, combined with the low fuel state in the

main cells and a possible venturi effect due to the sideward orientation of the drain spigot in forward flight, induced a negative pressure within the main fuel cells, sufficient to partially collapse the cells, thus restricting the movement of the fuel quantity sensor arm.

The pilot had not opened the auxiliary fuel valve earlier in the flight, as recommended, when the main fuel quantity had depleted to 200 pounds. His actions near the end of the flight demonstrate that he was closely monitoring his flight time, but that he was uncertain of the main and auxiliary fuel states because of the conflicting 150-pound fuel quantity indication. The auxiliary fuel tank was not fitted with a fuel quantity indicator, and the pilot therefore could not visually corroborate the level of fuel in the auxiliary cell in flight. Because the fuel quantity gauge indication was stable during the final segment of the flight, he may have believed that the auxiliary fuel was transferring into the main cells due to a malfunction, with the auxiliary valve in the closed position.

It is probable that he expected the FUEL LOW caution light to illuminate if the fuel was not transferring. Given the choice of leaving the auxiliary fuel valve closed, or opening it, and despite being aware that the fuel quantity indication may have been erroneously high, the pilot elected to continue the final 15 minutes of the flight with the auxiliary fuel valve closed. The fuel in the auxiliary system was not available to the engine, and the engine flamed out due to fuel starvation during the approach to the landing pad. At the time the engine flamed out, the altitude of the helicopter precluded an autorotation to a safe landing.

Findings as to Causes and Contributing Factors

1. The helicopter engine flamed out due to fuel starvation; the pilot did not open the auxiliary fuel valve earlier in the flight, as recommended, in order to transfer the auxiliary fuel into the main fuel cells.

2. The fuel cell vent system had been partially modified, and an alternate vent had not been installed as required by the Supplemental Type Approval. As a result, it is probable that negative pressure within the fuel cells resulted in partial collapse of the left cell, preventing full motion of the fuel sensor arm, which induced an erroneously high fuel quantity reading and disabled the FUEL LOW caution light.

Other Findings

1. The weight and balance report had not been amended to include an external cargo rack that had been fitted to the helicopter.

2. The auxiliary fuel cell was not fitted with a fuel quantity indicator.

3. The fuel quantity indication system and the FUEL LOW caution light do not operate independently, as both require signals from the fuel quantity sensor.

4. The Fort Simpson CARS did not receive the ELT transmission. The accident occurred within the 15 nautical mile MF area; however, because 121.5 MHz is considered an air-ground frequency, there is no specification for 121.5 MHz ground-ground reception coverage within an MF area.

Safety Action Taken

Although Supplemental Type Approval SH78-1 contains clear installation instructions, a deviation from these instructions, such as excluding the alternate vent on applicable helicopters, could result in partial collapse of the fuel cells, erroneous fuel quantity indications, and engine flame out due to fuel starvation. It is also evident that discrepancies such as a damaged or missing fuel vent fairing could induce similar risks. This information was communicated to Transport Canada in Aviation Safety Information Letter A010051 (A01W0255) *Non-Compliance With STA - McDonnell Douglas 369HS*.

The operator no longer uses a McDonnell Douglas 369HS in its flight operations. However, the operator will be using a Hiller 12E which has external fuel tanks, and the intention is to install a placard below the fuel gauge that will read "Aux Fuel Switch **ON** at 100 Lbs" in order to eliminate any confusion as to when the auxiliary fuel switch should be on.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 06 December 2002.