AVIATION OCCURRENCE REPORT

ENGINE FAILURE/FORCED LANDING

TRANS NORTH TURBO AIR LTD.
MCDONNELL-DOUGLAS 369D (HELICOPTER) C-GDMP
FIRE LAKE, YUKON
23 SEPTEMBER 1996

REPORT NUMBER A96W0185

Aviation Occurrence Report

Engine Failure/Forced Landing

Trans North Turbo Air Ltd.
McDonnell-Douglas 369D (Helicopter)
C-GDMP
Fire Lake, Yukon
23 September 1996

Report Number A96W0185

Summary

The helicopter, serial number 610993D, had completed moving a diamond drill, and the pilot was transporting a driller's helper to connect sections of water hose on the steep mountainside. At about 1630 mountain daylight time (MDT), during the climb-out after the first hose connection was completed, the pilot felt that the cyclic control was not responding correctly. He yelled to the helper to "hang on," then descended rapidly and attempted to toe in on the steep talus slope of the mountain. The main rotor blades struck the hillside, cut off the tail boom, and broke away. The helicopter rolled onto its right side and began sliding down the slope, tearing off the cabin roof and the front of the "doghouse," or transmission cowl. The helper, who was not wearing his lap belt, was thrown out of the helicopter onto the rocky slope. The helicopter then rolled over onto its left side, and continued to slide backward down the slope. The pilot, who was wearing a helmet, was hanging inverted and his head was being dragged against the rocks as the helicopter slid backward. The helicopter finally came to rest on its side. The injured helper tried to assist the seriously injured pilot out of the front seat but was only able to unfasten the pilot's lap-belt. The helper crawled up the slope and yelled to the driller for help. When the helper returned to the helicopter, the pilot had crawled out of the cabin. Moments later, first-aid assistance arrived. The driller reportedly turned off the helicopter's electric start (fuel) pump. The two occupants of the helicopter were evacuated by aircraft to hospitals for treatment.

Ce rapport est également disponible en francais.

---

[1] All times are MDT (Coordinated Universal Time minus six hours) unless otherwise noted.

Other Factual Information

The driller's helper indicated that at the time the pilot yelled "hang on," the helicopter was jumping around as if in turbulence and was yawing from side to side. He also observed that the engine out warning light was illuminated. The helper had not fastened his lap belt because he planned to be in and out of the helicopter frequently while hooking up water hose connections.

The helicopter came to rest at about 5,000 feet above sea level (asl) on the mountainside. The weather conditions at the site were reported as overcast with light snow falling, visibility ½ mile, temperature of minus three to minus four degrees Celsius, and wind from the south at five mph. It had been snowing throughout the day.

Examination of the helicopter did not reveal any mechanical discrepancies or evidence of fuel contamination. The pilot reported that the helicopter contained between 100 and 150 pounds of Jet B fuel at the time of the occurrence.

The engine (Allison 250 C20B) compressor had been damaged by debris, and was found to be contaminated with a fine, grey powder that, after further analysis, was determined to be bentonite, a drilling mud product. The bentonite was found in the particle separator and around the bleed valve outlet in a manner that suggested it had been deposited while wet. The engine was internally examined at the manufacturer's facility and bentonite was found throughout the axial and centrifugal compressor sections as well as in the combustion chamber, where it formed several hard, baked lumps. Literature on bentonite describes it as a colloidal clay which has the property of being hydrophilic (water-swelling), with some varieties absorbing as much as five times their own weight in water. It is characterized by a sticky nature and soapy feel, and is highly absorbent. Discussions with the engine manufacturer regarding the effect of this unusual contamination indicated that, although they had not encountered this specific material previously, they had observed worse cases of deposits from atmospheric pollution that had resulted in a loss of compressor efficiency of about 14 per cent. This condition can typically result in below-specification engine power checks, and high turbine outlet temperature (TOT) during lifting operations. An engine power check had been conducted on 14 September 1996, about 45 hours prior to the accident, at which time the engine exceeded standard specifications. It was determined that bentonite was not being used at the accident drilling site, suggesting that the material may have been ingested elsewhere, at an earlier time. The actual source of this material and its effect on engine performance was not determined.

The engine, fitted with a substitute compressor, was successfully test run without any indication of power fluctuations or uncommanded decelerations. The only significant discrepancy noted prior to the run was a bleed valve that was slow to move to the closed position when tested with regulated air pressure. Manual exercise of the bleed valve resulted in normal operation. The binding appears to have been a post-occurrence event, related to the material found on and around the valve. Some of this material had adhered to the valve stem when it was in the closed position and had contaminated the stem guide bearing area.

The pilot had a total of over 13,000 hours, with over 8,000 hours on helicopters. He had flown the McDonnell-Douglas (formerly Hughes) 369 for over 2,600 hours in similar operations, and would be considered highly experienced.

While conducting vertical reference work, the pilot had removed the left door and was not using the available shoulder harness. The pilot was operating with the engine auto-relight system ON and the engine anti-ice OFF.

---

[2] Units are consistent with official manuals, documents, and instructions used by or issued to the crew.

The estimated weight of the helicopter at the time of the occurrence was 2,048 pounds, and the hover ceiling out of ground effect (HOGE) performance was estimated at 15,800 feet. The pilot indicated there was no snow buildup on the exterior surface of the helicopter, but inspections of the plenum for snow accumulation were not conducted as the helicopter was refuelled while running during the work.

The helicopter manufacturer's *Flight Manual*, "Normal Procedures" (Section IV), 4-6 "Actions Before Take-off," states the following requirement: "Use engine anti-icing when OAT is below 5 degrees Celsius (41 degrees Fahrenheit) and visible moisture is present." The engine anti-ice system prevents ice buildup on the engine inlet support struts which could break off and damage the compressor blades.

The *Flight Manual*, Limitations, (Section II), Chapter 2.3, Flight Restrictions, states the following:

> Flight operation is permitted in falling or blowing snow only if the Automatic Engine Reignition Kit and Engine Failure Warning System are installed and operable. Whenever the helicopter has been parked outside or has been in flight during falling snow, determine that the engine inlet area and all helicopter exterior surfaces are completely free of accumulated ice and snow. In addition, open the plenum chamber door and visually determine that the inlet screen or particle separator (if installed) have not become clogged with ice and snow. This inspection and removal of ice and snow shall be accomplished prior to the next flight.

Discussions with other operators of McDonnell-Douglas 369D helicopters indicate that they had also experienced numerous losses of engine power (flame-outs) in falling snow, and had installed optional engine air deflector kits, which eliminated the problem. The kit consists of a plate that covers the normal air intake on the "doghouse" and prevents snow from directly entering the particle separator. Installation of this kit is currently not mandatory.

On 30 September 1982, the Allison Engine Company issued a Commercial Service Letter warning of engine flame-outs due to snow or ice ingestion on the Allison 250 series engines. The letter states:

> Owners, operators and pilots are warned that helicopters using this engine in falling or blowing snow, or icing conditions, require special equipment. Snow or ice can build up on aircraft parts, inlet ducts or plenum chambers and break loose in "slugs". Slugs of snow or ice entering the compressor of these engines can cause flame-out. Helicopter manufacturers use different approaches to prevent slugs of snow or ice from being ingested by the engine. Some of these devices include special particle separators, reverse inlet scoops, and various types of inlet screens. Additionally, some helicopters utilize auto-reignition kits to relight the engine in the event that a flame-out occurs. <u>It is the responsibility of the owner, operator and pilot to determine that the helicopter is properly equipped and the devices are in proper working order for operation in conditions where snow and ice can build up on the aircraft.</u> It is also very important to inspect the engine inlet area on the pre-flight check when the aircraft has been exposed to an ice, snow, or sleet storm. Accumulations of ice and/or snow can collect in remote areas of the engine inlet air flow path. Removal of these accumulations is necessary, especially downstream of the protective devices, to prevent a possible flame-out caused by the break-off of these accumulations during flight

Analysis

The information gathered indicates that the pilot experienced a flame-out and an automatic relight while climbing after lift-off. This would have caused a loss of main rotor rpm, and would have resulted in the cyclic control response problem reported by the pilot. Although the engine compressor contamination observed could result in

decreased power output, it would not be expected to cause a flame-out. The most likely cause of engine flame-out in this occurrence would be the sudden dislodging of an accumulation of snow in the air intake plenum, which is consistent with the experiences of other operators of this model helicopter. The successful elimination of snow-induced flame-outs on other similar helicopters following installation of an air deflector kit, indicates that the installation of such a kit on this aircraft probably would have prevented the occurrence.

The pilot made the decision to attempt a forced landing on the slope because he believed that any problems with the flight controls may have become more critical if he tried to fly downslope to flatter ground. The pilot's helmet was effective in reducing the severity of his head injuries during the forced landing. The unsecured passenger would probably have sustained fewer injuries if he had been wearing his lap belt.

The following Engineering Branch reports were completed:

LP 138/96 - Compressor Contamination
LP 139/96 - Engine Investigation

Findings

1. The helicopter had been operating in light falling snow during the day.

2. The helicopter was not fitted with an optional engine air inlet deflector kit.

3. The sudden loss of engine power (flame-out) was most likely the result of snow ingestion.

4. The engine compressor was contaminated with bentonite, but this would not be expected to cause a flame-out.

5. The passenger was not wearing his seat-belt, and was thrown out of the helicopter during the forced landing.
6. The pilot's helmet was effective in reducing head injury.

7. The pilot had not selected the engine anti-ice ON, as required by the flight manual.

Causes and Contributing Factors

The helicopter experienced a sudden loss of engine power (flame-out) during climb-out, likely as the result of the dislodging of a snow deposit in the air inlet plenum. A contributing factor was that the optional engine air intake deflector kit had not been installed on this helicopter.

Safety Action

Action Taken

Subsequent to this occurrence, a TSB Aviation Safety Advisory was forwarded to Transport Canada, suggesting a review of the MD 369 Series requirements for flight in falling/blowing snow with a view to validating the adequacy

of the existing limitations, and to assess the safety benefit gained from having a requirement of installing an air deflector kit as part of these limitations.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 7 August, 1997.