AVIATION INVESTIGATION REPORT
A01C0064

FORCED LANDING—DYNAMIC ROLLOVER
HELI-MAX LTD.
MCDONNELL DOUGLAS 369E (HU50) C-FMHM
BAKER LAKE, NUNAVUT, 26 NM N
28 APRIL 2001

Aviation Investigation Report

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Summary

The helicopter was transporting rock core samples from Meadowbank Camp, Nunavut, to Baker Lake, a distance of approximately 50 nautical miles. A loud bang occurred while flying in level cruise flight at 500 feet above ground level, and the helicopter cyclic control immediately began to vibrate. A second bang followed almost immediately, and the anti-torque pedals began to vibrate. All engine indications were normal. Nevertheless, the pilot decided to make a precautionary landing at a site 26 nautical miles north of Baker Lake. Just before the helicopter touched down, the pilot lost his visual reference in whiteout conditions and blowing snow. The tail stinger and the right skid touched the snow-covered surface, and the helicopter rolled onto its right side. During the rollover, the main-rotor blades, the main-rotor head, and their respective control components sustained extensive damage. As the helicopter rolled onto its side, the pilot reduced the throttle to flight-idle. When everything settled, the uninjured pilot pulled the fuel shut-off selector, climbed from the helicopter, and moved away a safe distance. The accident occurred at 2035 central daylight time; sunset was at approximately 2130.

Ce rapport est également disponible en français.

Other Factual Information

The pilot had been flying as a commercial helicopter pilot since 1993. He held a valid Transport Canada Category 1 medical with no limitations. His Transport Canada commercial helicopter licence was endorsed for operating BH06, S-350, HU50, and HU52 helicopters. At the time of the occurrence, he had accumulated a total flying time of 3327 hours, with 88 hours on the HU50 (the occurrence aircraft type) and 303.6 hours on the NOTAR HU52N. He was well rested on the day of the occurrence and had flown less than two hours within the previous 24 hours.

On the morning of the occurrence, the pilot completed his daily inspections and certifications so that the helicopter would be ready should a medevac flight be required. At supper, the pilot was advised that the camp was preparing a shipment of core samples. When the core samples were ready, there was an opening in the weather at the camp, and enough time remained to complete the return trip before dark.

The community aerodrome radio station (CARS) weather recorded at 2100 central daylight time[1] for the Baker Lake, Nunavut, airport indicated the following: wind 100° at 13 knots, visibility 10 statute miles with light snow and drifting snow, a few clouds at 1100 feet, overcast clouds at 2500 feet, temperature −6°C, dewpoint −7°C, and altimeter setting 29.71 inches of mercury.

The pilot did not contact the CARS for weather information before the flight. Camp personnel called Baker Lake on behalf of the pilot and determined that the weather in the community was clearing. The pilot's estimate of the weather at Meadowbank Camp was essentially the same as the conditions recorded by the CARS. Camp personnel advised the shipper in Baker Lake that the pilot had checked the weather and would be conducting the flight. The shipper went to the airport and waited in the CARS for the helicopter's arrival.

The pilot reasoned that the intent of a flight itinerary had been fulfilled because the camp had called the shipper to be waiting for his arrival at Baker Lake. Although the company operations manual requires a written flight itinerary, the pilot did not complete one. Furthermore, he did not call the CARS to advise of the flight. During the flight and just before the occurrence, the pilot deviated slightly from a direct-line course to fly around a cloud / local squall.

Because he was not injured in the accident, the pilot reasoned that his situation might not be an emergency, and he was unsure whether to use the emergency locator transmitter (ELT). He turned the ELT on for a short time then off. Procedures outlined in the company operations manual and in Transport Canada's *Aeronautical Information Publication* direct that the ELT be turned on and remain that way until rescue. The Rescue Co-ordination Centre (RCC) at Trenton, Ontario, received the short-duration signal and determined the crash site location. The shipper was at the CARS when the RCC called to advise of an ELT signal 26 nautical miles north of Baker Lake, and the CARS operator was able to confirm that a helicopter was operating in that vicinity. The shipper called the camp and confirmed that the helicopter had not returned, then he made appropriate calls to begin arranging search parties. A search-and-rescue Hercules aircraft was dispatched from Winnipeg, Manitoba.

The local Royal Canadian Mounted Police (RCMP) detachment was advised of the occurrence. Under the RCMP's direction, ground search parties were dispatched from Meadowbank Camp and from Baker Lake. When the downed pilot saw the lights of search vehicles, he tried to attract their attention using the three flares

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

that were packed in the survival kit. None of the flares fired up into the sky; instead, they exited the flare tube and dropped almost immediately to the ground. The flares were two months from their date of expiry. The pilot turned on the helicopter lights and attracted the attention of the rescuers. The pilot was found approximately four hours after the accident. The crew of the Hercules aircraft were advised that the pilot was safe, and the aircraft returned to Winnipeg.

The survival kit flares were manufactured in January 1997, with an expiry date of July 2001. The flare manufacturer was unaware of any problems with the January 1997 production run. There are no specified requirements to test flare performance under extreme temperature conditions, but the flares have reportedly been tested under extreme cold, high heat, and high humidity. The flares were close to their expiry date and might have been on board the helicopter for nearly four years. It was thought that prolonged exposure of the flares to helicopter vibration might have caused the propellant within the flares to become packed down, reducing their performance. All three flares in the survival kit were used, so the condition of the propellant in the flares could not be determined. After the occurrence, the operator froze two flares from the January 1997 stock and tested them: neither flare fired.

Records indicate that the helicopter was being maintained in accordance with the provisions of the approved company maintenance manual. The helicopter had 66 hours remaining before the next maintenance inspection, and no defects were reported before the occurrence. The helicopter was equipped with main-rotor blades that were manufactured by Helicopter Technology Corporation. Technical records indicate that the blades had been inspected in accordance with the requirements of Helicopter Technology Corporation's *Mandatory Service Bulletin* No. 2100-2, issued 06 November 2000. While on remote contract, the pilot performed daily inspections of the helicopter and daily airworthiness directive inspections and certified them in the journey log. The pilot was appropriately trained and authorized to complete these tasks.

Inspection of the wreckage at the site revealed that the main-rotor head, the main-rotor blades, and the rotating and non-rotating flight control components for the main-rotor system had suffered extensive damage. Some failed components of the main-rotor control system were thrown from the helicopter and were not recovered. All components that remained with the helicopter and those that were subsequently recovered were visually inspected and found to have suffered brittle or bending overload failures. The damaged sections of all five main-rotor blades were recovered along with four of the five rotor blade dampers. The failure characteristics of the five main-rotor blades were consistent with the blades being intact, under control, and driven at the time of the dynamic rollover and the subsequent ground impact. It was considered unlikely that any component could separate, in flight, from the main-rotor control system and strike the tail-rotor system without causing a loss of control.

Inspection revealed that the tail-rotor drive components remained intact. The tail rotor turned normally when the main-rotor mast and main transmission were turned by hand. The tail boom was bent upwards, and the tail-rotor drive shaft sustained full-circumference scoring by contact with the internal surface of the tail boom. There was no indication of torsional twisting of the tail-rotor drive shaft. The tail-rotor pitch mechanism functioned appropriately at the tail-rotor assembly, but the control rod and bell crank in the vicinity of the control closet near the top of the helicopter had incurred overload failures.

Both tail-rotor blades, inboard of the leading-edge abrasion strips, had suffered a bending failure of approximately five degrees. The tip of each blade moved a uniform distance away from the tail boom. In addition to this uniform bending, the outer portions of each blade showed torsional twisting toward a more-coarse blade angle, with one of the blades twisted more than the other. Foreign object damage was noted at the tail-rotor drive fork and the tail-rotor pitch control links. The tail-rotor pitch control link attached to the less-twisted tail-rotor blade was bent to a greater degree than the pitch control link attached to the more-twisted tail-rotor blade.

To assess whether the tail-rotor blades failed in flight, the tail-rotor gearbox and the tail-rotor assembly were removed as a complete unit and forwarded to the TSB Engineering Laboratory for further inspection and analysis. It was determined that the outward bending of the tail-rotor blades most probably resulted from the tail-rotor blades contacting the snow-covered ground. The bends in the blades were unidirectional. It was assessed that the blades would have suffered two-way bending if they had failed in flight. The unequal bends in the pitch control links could have caused vibration but should not have caused in-flight bending of the blades in the manner noted.

The helicopter did not yaw to the left during the flight. Had the engine lost power, the helicopter would be expected to yaw to the left. Inspection of the engine and the engine compartment did not disclose any damage to the engine, engine mounts, or other engine-related components. The engine controls maintained continuity and functioned normally when operated from the cockpit. The fuel shut-off selector and valve were inspected and found to function normally. The engine fuel system was vacuum tested; no air leaks were present. The main-rotor drive shaft was removed. On inspection, it was evident that the shaft was torsionally twisted in a manner that was consistent with the shaft being driven when the main rotors struck the ground. The sprag clutch and the main transmission functioned normally, and the compressor and turbine sections of the engine could be turned freely by hand.

On the day before the occurrence, the helicopter had been fuelled from sealed drums at the camp. After the accident, a sample of fuel was obtained from the helicopter and forwarded to the TSB Engineering Laboratory. The fuel was tested and found to be good-quality Jet-B fuel with no sign of contaminants.

The operator had produced comprehensive maintenance, safety, and operations manuals. The operations manual outlined the pilot-in-command's procedures and responsibilities when away from base. These requirements included checking for current weather conditions before flight and filing a flight plan or a flight itinerary before flight. A company form was appended to the operations manual to complete these requirements. In the event of an accident, the ELT was to be turned on until rescue.

Analysis

Two distinct in-flight events occurred: one causing vibrations in the cyclic control; another causing vibrations in the anti-torque pedals. The bent tail boom and the bends in the tail-rotor blades were consistent with the stinger and the tail rotor contacting the snow-covered ground on landing. Both blades were bent in a consistent manner away from the tail boom, suggesting that the rotor blades were being driven at high speed when they contacted the denser medium of the snow. Additionally, the tail-rotor blades showed dissimilar torsional bending that could indicate that the blades were at different blade angles when they passed through the snow. The uneven bends in the tail-rotor pitch control links would result in dissimilar tail-rotor blade angles, and the blade with the greater blade angle was found to be more torsionally bent. It could not be determined what foreign object had come into contact with the tail-rotor pitch control links. Unequal blade angles, in flight, would result in anti-torque pedal vibrations similar to those described by the pilot.

The extensive damage to the main-rotor blades and the primary flight controls of the helicopter during the rollover precluded the determination of any subtle in-flight failure, loosening, or separation of a control component that might have resulted in the control vibrations. It was considered unlikely that a component could separate, in flight, from the main-rotor control system and strike the tail-rotor system without causing the helicopter to become uncontrollable. The fact that the pilot was able to arrest the descent, stop the forward motion, and control the yaw of the helicopter during the landing indicates that the helicopter was controllable.

The pilot did not follow the procedures outlined in the company operations manual that related to filing written flight itineraries and operation of the ELT.

It could not be determined why the flares failed to operate properly.

The following TSB Engineering Laboratory reports were completed:

LP 034/01—Fuel Sample Analysis
LP 035/01—Examination of Damage to Tail Rotor Blades

These reports are available upon request from the Transportation Safety Board of Canada.

Findings as to Causes and Contributing Factors

1. During the landing, the pilot lost visual reference in blowing snow, and the helicopter entered a dynamic rollover after touchdown.

2. Foreign object damage was noted on the tail rotor.

3. Extensive crash damage to the main-rotor blades, the main-rotor mast components, and the main-rotor control system precluded determining the cause of the pre-impact control vibrations.

4. The pre-impact control vibrations did not affect the overall controllability of the helicopter during the power-on landing.

Findings as to Risk

1. Although the company operations manual requires a written flight itinerary, the pilot did not complete one.

2. Although the company operations manual requires the pilot to turn the emergency locator transmitter on and leave it on after an accident, the pilot did not do so.

3. Flares from the survival kit did not function as intended and were ineffective as a means of attracting attention.

Safety Action Taken

- The operator reviewed the flight-following procedures that were outlined in the company operations manual and found them to be satisfactory. Company pilots were provided additional training to ensure that they follow the specified procedures.

- The company safety system was upgraded to emphasize the need for flight following and flight planning, with a preference for establishing a flight plan with local flight service stations.

- The operator has established Internet access to procedures (in addition to previously existing 24-hour phone and fax access), further ensuring that pilots and engineers can contact the company at all times.

- The operator has purchased two satellite phones to be used on those rare occasions when other communications methods are not available.

- The flares that were in the survival kit for the accident aircraft were in their last year of service. They were replaced with flares from a different manufacturer as they expired.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 01 May 2002.