AVIATION OCCURRENCE REPORT

LOSS OF CONTROL

HELICO AIR SERVICES LTD.
BELL 206B (HELICOPTER) C-GQKV
TRENTON, NOVA SCOTIA
31 MARCH 1998

REPORT NUMBER A98A0042

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Summary

The Bell 206B helicopter, serial number 8, operated by Helico Air Services Ltd. departed the company's base at the Trenton Airport with the pilot and aircraft maintenance engineer (AME) onboard. The purpose of the flight was to identify and correct a minor vertical vibration reported by the company owner/operations manager, who had flown the helicopter earlier in the day. The occurrence flight was the third maintenance flight, and adjustments had been made by the AME following the two previous flights.

The helicopter was observed shortly after its departure at low altitude, in a nose-down spiralling descent near the airport. An air search located the wreckage in a wooded area east of the airport, about 275 feet from a road. The helicopter had hit the ground in a steep, nose-down, left-bank attitude. The impact forces compromised the cabin integrity, and the pilot and AME were fatally injured. The helicopter was destroyed.

Ce rapport est également disponible en français.

Other Factual Information

A student pilot at the Trenton Airport heard an unintelligible radio transmission on the Trenton unicom (universal communication) frequency that had caused him to look out the window of the building and observe the helicopter in descent. The student's instructor also heard the transmission. The accident took place at about 1200 Atlantic daylight time (ADT) in visual meteorological conditions, and winds were reported as light from the east.

The helicopter was manufactured in 1967 and was exported from the United States to Canada in 1977. It was originally powered by an Allison 250 C18 turbine engine but was converted to an Allison 250 C20 in 1980. Helico Air Services Ltd. had been operating the aircraft since the company's inception in 1993. The helicopter was equipped with an engine-out warning system that included an engine-out warning light and a warning horn. It was also equipped with dual flight controls and hydraulically boosted anti-torque pedals. It was not equipped with a low rotor rpm warning light or warning horn, nor was one required by regulation. At the time of the occurrence, the aircraft had 8,471.7 hours total time since new and had operated 81.5 hours since a 200-hour scheduled maintenance inspection was carried out on 19 December 1997. Fixed floats and new main rotor straps had been installed on 5 March 1998. A review of the aircraft technical records identified that the helicopter was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

The pilot started his flying career with the Romanian military in 1980, where he flew the Allouette III and Puma helicopters until leaving the military and Romania in 1990. He spent the next five years in Germany working in positions unrelated to aviation. In 1996, after arriving in Canada, he received 17.6 hours initial flight training on the Bell 206 helicopter and was issued his Canadian Commercial Helicopter license in June 1996. He started flying for Helico Air Services Ltd. in 1997 and received Bell 206 flight training from them in November 1997. At the time of the occurrence, the pilot was certified to fly Hughes 300 and Bell 206 helicopters. A review of the Transport Canada pilot file indicated he had about 1,034 hours total flight time on helicopters and about 124 hours on the Bell 206. The pilot's personal log books recorded about 1900 hours flight time (mostly on the Allouette). The investigation identified that he had flown civilian spray helicopters in Romania, but no supporting documentation was available.

The AME was issued his maintenance license in 1991 (helicopter) and was endorsed on the Bell 206 in 1992. He had been employed by the operator since 1993 and was well respected for his work ethic and his maintenance ability.

On the day of the occurrence the AME removed the cyclic and collective control sticks from the left seat position in preparation for the maintenance flight, leaving the anti-torque pedals installed. The cyclic and collective control sticks are removed by unscrewing a retaining collar at the stub shaft base. Covers are available to protect the stub shafts from potential interference by persons or equipment whenever the dual controls are removed. Wreckage examination identified that the stub shaft covers had not been installed. There is no requirement to install the protective covers, but more prudent maintenance practices would preclude flying with the stub shaft covers off and the dual anti-torque pedals installed when carrying out main rotor blade strobing.

The impact occurred about 3500 feet east of the departure runway end. The helicopter's descent through the trees resulted in localized tree damage overhead the wreckage site. The fuselage came to rest in an approximate 45-degree nose-down, 50-degree left-bank attitude, and the wreckage debris was primarily located with the main wreckage or within a ten-foot radius. The fuel bladder had punctured during the impact sequence which saturated the ground around the fuselage. There was no post-crash fire. There was no evidence of a bird strike or of any
pre-impact structural failure. The area surrounding the accident site was tree-covered except for a clear cut for electrical power lines just to the north and a road about 275 feet south of the accident site.

The helicopter had come to rest with the forward cockpit penetrated by the fork of a tree which compromised the area occupied by the pilot and the AME . The AME had been wearing a lap belt only, although the seat was also fitted with a shoulder harness. The pilot had been wearing a lap belt and shoulder harness; however, the impact forces were not survivable. Pilot autopsy results identified that he received multiple fatal injuries. He also had a compound fracture to his lower right leg. Toxicology tests were negative for both individuals.

The helicopter's mast had fractured during the impact sequence. The fracture location was below the trunnion drive splines just below the split cone support groove. The trunnion drive splines were torsionally displaced one half of a spline from the split-cone support splines in a clockwise direction as viewed from above. This spline displacement is consistent with transmission driving/main rotor resisting loads, as during tree impact. Numerous flight control push/pull tubes throughout the fuselage structure exhibited overload fractures as a result of the impact force. The rotor blades exhibited low rpm impact damage. The engine, transmission and mast, flight control hydraulic servos, and various cockpit instruments were removed from the wreckage site for further analysis.

The emergency locator transmitter (ELT) did not activate at impact. The unit was found buried in the ground with the switch in the OFF position. There was no indication that it had been selected to the armed position before the flight. The Bell JetRanger checklist found onboard the helicopter references the "Interior Check" "ELT—Armed and Secure." The ELT tested serviceable at the TSB regional facility.

A work paper found onboard the helicopter showed that the AME had made minor adjustments to the main rotor blade pitch links following the two previous maintenance flights. The adjustment procedure was routine and the AME was qualified and competent to complete the task. The pitch link adjustments were not contributory to the accident, and the strobing equipment external to the cabin was securely attached. The aircraft's weight and centre of gravity © of G) were determined to be within limits.

The helicopter engine was equipped with a CECO (Chandler Evans MC-40) fuel control system. A detailed engine examination was carried out at Standard Aero in Winnipeg, with representatives from the TSB, the engine manufacturer, the helicopter manufacturer and
Rilpa Enterprises Ltd. (a helicopter parts supplier to the Operator), in attendance. The examination identified that the engine had been operating at impact. Metal particles were found adhered to the third and fourth stage nozzles (guide vanes). The metal came from the inner surface of the centrifugal compressor scroll when contacted by the compressor rotor during the impact sequence. The particles entered the engine combustion section and melted before being deposited on the nozzles downstream. The engine accessories (compressor bleed valve, engine-driven fuel pump, fuel control unit, and power turbine governor) were also functionally tested and no discrepancies were found that would have affected the engine operation.

A freewheel assembly is mounted to the engine accessory gearbox and its outer race stub shaft is splined directly into the engine power takeoff gear shaft. A sprag clutch within the freewheel assembly transfers engine power to the main rotor transmission and rotor blades. The freewheel assembly was removed from the engine accessory gearbox and inspection identified that the outer race stub shaft spline was fractured. Examination of the mast and the freewheeling unit stub shaft spline fracture surface identified that the mode of failure was torsional overload.

Instrument examination identified that the engine-out warning light was not illuminated at the time of impact, the dual tachometer indicated the main rotor rpm (Nr) was at 67% and the power turbine rpm (N2) was at 73%, the indicated airspeed was 27 mph, and the attitude indicator was indicating a left, 30-degree roll.

The four hydraulic servo actuators were bench tested in accordance with Hydraulic Research Textron procedures. The two cyclic servos and the tail rotor servo performed normally but the collective servo was unserviceable. Further investigation identified that the collective servo had been damaged by impact forces.

There are some differences in flight characteristics when a helicopter is equipped with fixed floats as opposed to skid gear. The fixed floats increase drag in flight due to the increased surface area. Conversations with other Bell 206 pilots identified that any flight manoeuver, with airspeed, that increased the floats' cross-sectional profile to the slipstream could result in uncontrolled deviations and a loss of control.

A letter to the Department of Transport, in 1967, referenced an incident reported by a Bell 206 helicopter pilot where an inadvertent application of full left rudder pedal (anti-torque) by a passenger took place during forward flight. The helicopter was initially at 1,200 feet AGL with an airspeed of 120 mph. The helicopter yawed rapidly to the left with a slight pitch up, coupled with a roll to the right of about 90 to 100 degrees of bank. Recovery was completed with an estimated altitude loss of about 300 feet.

Another Bell 206 occurrence in 1967 resulted in the death of both flight crew members. The pilot had reported that the right anti-torque pedal would "creep" in flight. An AME was taken onboard and the pilot proceeded to demonstrate the condition. The accident report concluded that the pilot had lost control of the helicopter in an attempt to demonstrate the pedal creep. Flight tests carried out as part of that investigation confirmed that a loss of control could result at some speeds when a large anti-torque pedal movement was applied.

Verbal reports that rotor rpm decay related accidents had occurred due to less than full throttle position at take-off were also investigated. A data base review of Bell 206 helicopter occurrences did not corroborate these reports.

The Allison 250 C20 engine is a free turbine engine, meaning there is no mechanical coupling between the gas producer and power turbines. The gas producer turbine drives the compressor and the power turbine drives the rotor system through the appropriate reduction gearing. Hot gas discharged by the gas producer turbine is directed onto the power turbine, providing a gas coupling between the two turbine assemblies. For all practical purposes the power turbine speed and rotor speed must be maintained at full RPM. This is accomplished by varying the speed of the gas producer turbine (through fuel scheduling), when engine power demands change. An example of an increased power demand is when collective pitch is increased. If the gas producer turbine speed did not increase to compensate for the increased load on the power turbine, the rotor RPM would decay.

Analysis

The helicopter was observed in forward flight at low altitude and also in a nose-down spiralling descent before it disappeared from sight and hit the ground. This descent profile, and the confined tree damage at the accident site, is indicative of uncontrolled flight. There was a road about 275 feet from the impact site. The pilot would have chosen the road before the trees had an emergency or precautionary landing been initiated. Since there is no evidence of mechanical failure that would explain the transition from a controlled, level flight to the steep, nose-down descent, the analysis will focus on what other unanticipated event could have been a factor in this occurrence.

Normally, as collective is introduced at take-off, the pilot monitors the power turbine speed and uses the collective mounted governor trim switch (beep switch) to maintain power at 100%. If the throttle was rolled full open at take-off there could be a slight rotor rpm drop during climb out; however, the fuel control/governor would sense the drop, increase the fuel schedule and restore the rpm. The throttle would have to be set considerably off the full open position before the rotor rpm would drop to a value so low that control of the helicopter could not be maintained. This condition would not be expected during the blade strobing procedure until the latter stages, when a simulated autorotation is carried out to confirm that rotor rpm remains within a specific range. This (autorotation) check would, however, normally be initiated later in the flight profile, at a safe altitude and over the airport rather than at the time and area associated with the accident.

The rotor blade damage observed at the accident site was consistent with low rpm at impact, and the power turbine and rotor rpm instrument readings were captured at low rpm values. No mechanical deficiencies were identified that would have caused the rotor rpm to decay in flight. Possible reasons for these conditions are that the pilot may have increased collective pitch in an attempt to reduce the descent rate just prior to impact with the ground or he may have rolled off the throttle just before hitting the trees.

Although the left seat dual control sticks had been removed in preparation for the maintenance related flight, protective covers had not been installed over the stub shafts. Also, the anti-torque pedals just forward of the left crew seat position remained installed. During blade strobing on a maintenance flight, the AME would normally rest the test equipment on his lap or place it on the floor between his feet when making notes. The test equipment includes lengths of electrical cord for power supply and equipment operation. It is possible that the equipment or cord could have fallen on, or become entangled in, the exposed flight control stub shafts or the anti-torque pedals, thereby restricting pilot input to those controls. However, the probability that this contact would initiate the loss of helicopter control is considered unlikely. The pilot would be resting his feet on the anti-torque pedals and his hands would be on the cyclic and collective control levers. Any force applied to the control lever stub shafts or anti-torque pedals by this method would be felt by the pilot and easily opposed.

A distraction-causing event, such as the strobing equipment or the note pad falling off the AME's lap during the flight, and a subsequent attempt to grab the falling item, might have led to a leg being unintentionally extended and striking one of the anti-torque pedals with sufficient force to initiate a severe yaw. Information gathered from past occurrences has indicated that the helicopter would roll towards inverted if an abrupt input to the anti-torque pedals was applied. The roll rate would be greatest at high airspeeds, and if the helicopter was configured on fixed floats. A loss of control at low altitude would provide little time for the pilot to arrest the descent before striking the ground.

The fracture to the pilot's lower right leg is a possible indication that he was applying considerable force on the right anti-torque pedal. Hard right pedal input would be a recovery response to regain directional control.

Findings

1. The pilot and the AME were certified and qualified for the flight in accordance with existing regulations.

2. The aircraft weight and centre of gravity were within limits.

3. Records indicate that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

4. There was no evidence of any pre-impact mechanical or structural failure.

5. The ELT was found buried in the ground and had not activated. The switch was in the OFF position, and there was no evidence that it had been armed before the flight.

6. The engine was operating at impact and power was being transmitted to the main and tail rotors. The power turbine (N2) rpm was 73% and the main rotor rpm (Nr) was 67% at impact.

7. The damage observed on the rotor blades was consistent with low rotor rpm at impact.

8. The descent profile observed by the witness and the accident site tree and ground damage was consistent with an uncontrolled descent.

9. Abrupt helicopter attitude changes due to inappropriate anti-torque pedal input have been documented in past occurrences.

10. The dual control sticks (cyclic and collective) were removed before the maintenance flight, but the stub shaft protective covers were not installed and the left seat dual anti-torque pedals remained installed.

11. The test equipment is normally held on the AME's lap or placed on the floor between his feet and is in close proximity to the anti-torque pedals. The equipment also includes sufficient lengths of cord that contact with the pedals or stub shafts is possible.

12. The pilot had a compound fracture of the lower right leg, a possible indication that he was applying hard right pedal at the time of impact.

13. Right pedal input is a possible indication that the pilot was attempting to regain directional control of the helicopter.

Causes and Contributing Factors

The helicopter was observed in an uncontrolled descent from low altitude when it hit the ground. The cause of the uncontrolled descent could not be determined; however, in the absence of any evidence of mechanical or structural failure prior to impact, it is considered that the loss of control was likely a result of unintentional flight control input.

Safety Action Taken

Helico Air Service Limited has implemented a policy to ensure that all dual controls are removed and protective covers installed prior to flight.

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 04 March 1999.