

AVIATION INVESTIGATION REPORT

A01W0190

LOSS OF CONTROL—UNCONTROLLED ROTATION

CANADIAN HELICOPTERS

AEROSPATIALE AS 350BA C-FVVH

GRANDE CACHE, ALBERTA, 13 NM W

30 JULY 2001

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

## Aviation Investigation Report

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### *Summary*

The Canadian Helicopters Aerospatiale AS 350BA helicopter, serial number 2612, was transporting five field geologists to unspecified mountain locations to the west and northwest of Grande Cache, Alberta. After rejecting several landing sites because of uncertain winds, the pilot attempted to land on a shoulder at the crest and end of a mountain ridge. As the pilot entered a low hover, he lost directional control and the low main-rotor rpm warning sounded. The helicopter rotated to the left about the main-rotor axis, contacted the terrain, and rolled onto the right side. One passenger was seriously injured; the helicopter sustained substantial damage.

*Ce rapport est également disponible en français.*

## *Other Factual Information*

The pilot was certified and qualified in accordance with existing regulations. He had approximately 9400 hours of flight experience, of which approximately 60 hours had been accumulated on AS 350 helicopters. He had obtained the AS 350 type rating in March 2000, 16 months before the occurrence.

The weather at the time of the occurrence was suitable for visual flight rules flying. The sky condition reported at the crash site was as follows: high broken cloud, visibility unrestricted, winds from the southwest at 5 to 10 knots, temperature 12°C, and altimeter setting 29.81 inches of mercury. The wreckage was at 6250 feet above sea level. Given the pressure and the temperature, the density altitude was approximately 7500 feet.

The aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The engine (Turbomeca Arriel 1B) continued to run after impact. The fuel shut-off control was jammed due to impact damage, preventing normal shutdown of the engine. The pilot discharged a dry chemical fire extinguisher into the air intake to accomplish the shutdown.

Field inspection of the wreckage revealed no pre-impact abnormalities. The engine was transported to an engine shop for examination, torn down, and visually inspected. Except for the presence of fire extinguisher residue, no discrepancies were identified. The bleed valve and all external engine fuel/air components were installed on a test-cell engine and function checked. Following the test-cell run, the fuel control unit was bench tested at the manufacturer's facility and found to meet the manufacturer's specifications. No engine discrepancies that would have contributed to the occurrence were identified, and no indication of any system malfunction before or during the flight was found.

The helicopter's weight at the time of the accident was estimated to be approximately 4600 pounds. The helicopter flew for approximately 30 minutes before the accident. The take-off weight in Grande Cache, Alberta, would therefore have been approximately 4760 pounds. The maximum gross take-off weight for the helicopter was 4630 pounds. Actual passenger weights exceeded the estimates given to the pilot by 25 pounds. Operational equipment, not included in the basic empty weight, totalled 90 pounds rather than the 60 pounds assumed by the pilot. In addition to this, 15 pounds of extra survival equipment, of which the pilot was not aware, was stored in the tail boom.

Analysis of the out-of-ground-effect (OGE) hover chart in the flight manual showed a maximum permitted weight for the ambient conditions to be 4400 pounds. The in-ground effect (IGE) hover chart indicated a maximum weight of 4630 pounds under the same conditions.

Conditions of high weight and high density altitude can place a helicopter in a flight condition that requires more than the available power. A demand for engine torque (increased collective) exceeding that available will result in reduced main-rotor rpm and further loss of lift. If a pilot further increases the main-rotor collective pitch to maintain height above ground, main-rotor rpm erodes further. A small reduction of main-rotor rpm results in a proportionately larger loss of tail-rotor effectiveness (LTE).

In hover flight, a pilot deflects the tail-rotor control pedals to maintain the helicopter's heading. If tail-rotor effectiveness deteriorates to the pedal deflection limit, the helicopter will uncontrollably rotate around the main-rotor axis. This rotation tends to increase the angle of attack of the tail-rotor blade section and may lead to a tail-rotor blade stall and further LTE. To recover from this condition, a pilot normally reduces collective pitch to unload the main rotor.

The main rotor of Aerospatiale helicopters rotates clockwise, and right pedal input is required to counteract main-rotor rotation torque. LTE will result in uncontrolled rotation of the aircraft to the left.

It was reported that the pilot flew two reconnaissance passes before his final approach to the accident site. About 15 feet above the ground, as the helicopter approached the landing zone, torque and N<sub>1</sub> (gas generator rotation speed) were nearing their limits. Rotational control was lost just as the hover was initiated and was immediately followed by the low-rotor-rpm horn. The pilot did not lower the collective, and the helicopter contacted the ground while rotating to the left.

The shoulder at the intended landing site was relatively flat and level for a distance roughly equal to the width of the landing gear skids. The terrain dropped off rapidly to the right; it dropped off less steeply to the left. The helicopter came to rest 180° to the approach path heading, lying on its right side. The tail boom had broken off on a production rivet line just forward of the horizontal stabilizer. The forward end of the right skid had contacted the underside of the cabin. The main-rotor blades had struck the ground above the aircraft's final resting position.

The impact did not reduce the survival space in the cabin or the cockpit, and all occupants were wearing the available four-point lap belt / shoulder harness restraints. Four of the passengers were seated across the rear of the cabin. The seriously injured passenger was seated next to the right cabin door, to the right of the other three cabin passengers.

## *Analysis*

The pilot was entering a low hover above a rounded shoulder, at the crest and end of a mountain ridge, when he lost directional control. The rapid terrain drop-off to the right of the landing site and the shallow drop-off to the left would have reduced the performance benefits of ground effect as the helicopter entered the hover. The drop-offs would have contributed to the emergence of a flight condition more characteristic of an OGE hover. As a result, the main rotor would have had to generate additional lift for the pilot to stabilize and maintain the hover.

The pilot had underestimated the take-off weight on departure from Grande Cache. At the time of the accident, the helicopter was approximately 225 pounds over the weight for a successful OGE hover. When the pilot raised the collective to enter the hover and the main-rotor blade pitch increased, the required power exceeded the available power and the main-rotor rpm decreased. The reduction in main-rotor rpm brought about a decrease in tail-rotor rpm, resulting in a loss of directional control at an altitude that was insufficient to allow the pilot to reduce the collective and effect a recovery. The low-rotor-rpm horn sounded, and the helicopter entered an uncontrolled rotational descent to the ground. An unexpected wind shift or gust might have contributed to the occurrence; however, this could not be determined.

The injuries sustained by the rear passenger are consistent with the helicopter rolling onto its right side. Lateral forces from the weight of the three passengers sitting beside him and the impact during the roll sequence contributed to his injuries.

## *Findings as to Causes and Contributing Factors*

1. The pilot underestimated the gross weight of the aircraft, resulting in a take-off over maximum gross weight.

2. The out-of-ground-effect (OGE) hover, at a weight exceeding the limits on the OGE hover charts, most likely resulted in reduced main-rotor rpm and loss of tail-rotor effectiveness.

### *Other Findings*

1. The pilot was not aware that survival equipment was stored in the tail boom of the helicopter.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 02 April 2002.*