Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A05P0154

POWER LOSS

ROBINSON R22 BETA HELICOPTER C-FQDQ
COURTENAY, BRITISH COLUMBIA, 10 nm N
24 JUNE 2005

Canada

Aviation Investigation Report

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Summary

The pilot of the Robinson R22 Beta helicopter (serial number 1398, registration C-FQDQ) was operating in an area about 10 nautical miles north of Courtenay, British Columbia, giving rides to volunteer interns at a local avian rescue society. He had completed four trips, then shut down and readied the helicopter for a flight to Courtenay Airpark, where he would refuel before returning to his home base at Boundary Bay Airport. On start-up, he ran the helicopter on the ground for about two minutes after re-engaging the clutch.

At approximately 1630 Pacific daylight time, the pilot lifted off, turned the helicopter 180 degrees to point toward his departure path, and raised collective to perform a confined-space take-off. The helicopter climbed to a height of about 60 feet above ground level when there were abnormal engine sounds and an apparent detonation. The engine became quiet, and the main rotor blades were almost stopped. The helicopter rotated about 270 degrees to the left in a rapid descent and struck the ground heavily with little or no forward speed. The pilot was severely injured. The helicopter was substantially damaged, but there was no post-crash fire.

Other Factual Information

The pilot held a current commercial pilot licence with fixed-wing aircraft and helicopter type endorsements, the latter obtained in January 1987. He had owned the helicopter since 1993, and had flown all of its accumulated 1660.6 hours, except for 245.9 hours that were accumulated in the United States before the helicopter was imported and rebuilt subsequent to a roll-over accident. The pilot had 32 years of experience flying with commercial airlines.

At the time of the accident, the weather conditions were suitable for flight in accordance with visual flight rules. The 1600 Pacific daylight time[1] weather for Comox (10 miles southeast) was reported as wind 020° True at 4 knots, visibility 20 statute miles, ceiling 7000 feet, temperature 19°C, and dew point 12°C. Rain showers occurred at the site soon after the accident. The site elevation was about 300 feet above sea level.

The helicopter was powered by an Avco Lycoming O-320 B2C 160-horsepower (hp) engine, de-rated to 124 hp maximum continuous power. The helicopter was being operated with 100LL AVGAS. It is a governed engine, meaning that a constant rpm is maintained during power transients as commanded through collective lever positioning. The pilot monitors the engine manifold pressure gauge to ascertain the power being produced. The pilot had checked available power prior to and during the rides given and found it normal. He used about 24 inches of manifold pressure for his confined-space take-off.

The pilot did not recall applying carburetor heat prior to departure or during take-off. The helicopter was equipped with a carburetor heat gauge that indicates temperature at the carburetor. The gauge has a yellow warning band between -15°C and 5°C. The gauge is placarded to advise the pilot to apply full carburetor heat and ignore the gauge below 18 inches of manifold pressure. The Robinson Helicopter Company Pilot's Operating Handbook states that operation within this carburetor temperature range (yellow) without carburetor heat must be avoided at any power setting.

According to the carburetor icing chart in *Aeronautical Information Publication* (A.I.P. Canada), Section AIR 2.3, an air temperature of 19°C and a dew point of 12°C fall in the "moderate icing at cruise power" or "serious icing at descent power" sector (see Appendix A). Indicators of carburetor ice would normally be a drop in manifold pressure and engine rpm. Severe icing will result in engine stoppage. The Robinson Helicopter Company Pilot's Operating Handbook states, "The pilot may be unaware of carburetor ice formation as the governor will automatically increase throttle and maintain constant manifold pressure and rpm."

The helicopter is equipped with a low-inertia rotor, susceptible to rapid loss of rotor rpm if mishandled. If rotor rpm significantly decreases at a slow airspeed, rotor stall may be inevitable. The Robinson Helicopter Company Pilot's Operating Handbook provides Safety Notices regarding low-rotor stall and carburetor ice.[2]

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1 All times are Pacific daylight time (Coordinated Universal Time minus seven hours).

2 SN-10 "Fatal Accidents Caused by Low RPM Rotor Stall"; SN-24 "Low RPM Rotor Stall Can be Fatal"; and SN-25 "Carburetor Ice."

The accident helicopter was examined at the TSB regional facility. This examination revealed the following:

- The engine and related systems were deemed to be in an acceptable condition to allow the engine to be run. The engine was tested at a manufacturer-approved engine overhaul and repair facility and found capable of producing full power.
- A 5-amp fuse was found installed where a 1.5-amp, in-line fuse prevents the belt-tension actuator from overloading the drive belts.
- The carburetor heat control was found in the "COLD"/Unheated air position.
- Impact marks indicated that the carburetor heat guillotine slider valve was opened to allow the intake of filtered but unheated outside air.
- The fuel system was intact and serviceable, there were no fuel leaks, and the main tank contained 22 litres of fuel.
- The pilot had installed a portable global positioning system (GPS) unit and temporarily secured it with clecos[3] onto the side of the instrument console. It was powered continuously from a terminal at the clutch tensioner switch and protected with a 2-amp fuse.

During the 12-year inspection, which was started on 25 April 2005 and completed on 16 May 2005, about 32.5 flight hours before the accident, it was found that the left-side collective push-pull (P/P) tube glued-on protection sleeve (P/N A143-1) and the guide bushing (P/N C439-9) were worn. The tube and the guide support bracket (P/N A432-1) had worn excessively when the guide bushing (P/N C439-9) had been extruded from the bracket during operation. In this original installation, the guide support bracket had a guide bushing (P/N C439-9) inserted and trapped between two metal layers of the guide bracket. A guide bushing was substituted during the 12-year inspection and a substitute airworthy P/P tube was re-installed. On the day of the occurrence, at 1659.9 airframe hours, a collective P/P tube guide upgrade kit (P/N KI-130) was installed. A new fuel sender unit (P/N A550-1) was installed due to faulty fuel quantity measurement. The fuel gauge was calibrated before the pilot refuelled for his trip to the aviary.

Analysis

The weather conditions at the time of the occurrence were conducive to carburetor icing. However, if the pilot did not closely monitor the engine instruments, the formation of carburetor ice would initially be hidden while the governor was maintaining a constant manifold pressure and engine rpm. Therefore, whenever icing conditions are suspected, the pilot must apply carburetor heat as required. The pilot did not recall applying carburetor heat prior to departure or during take-off. There was nothing found to indicate that a mechanical

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3 A cleco is a spring-loaded clamp used to temporarily hold parts together for rivetting. Special pliers are used to insert clecos into holes.

fault or failure affected the operation of the engine. Although it is not conclusive that carburetor ice affected the engine, it is likely that this occurred. The engine had been operating for a couple of minutes on the ground and then in the air in conditions conducive to carburetor ice. It is likely that the ice adversely affected engine performance and resulted in the engine stoppage.

The Robinson R22B helicopter's low-inertia rotor design is susceptible to rapid loss of rotor rpm if mishandled, and quick recovery action is required by the pilot. In this occurrence, when the engine stopped, there was little airspeed or altitude to be traded for energy to the rotor system. If rotor rpm significantly decreases at a slow airspeed, rotor stall will be inevitable. Following the loss of engine power, the main rotor RPM decayed rapidly and the pilot was unable to recover the RPM or arrest the helicopter's descent.

During the 12-year inspection, it was discovered that the collective P/P tube guide bushing had been extruded from its supporting structural bracket; the P/P tube had chafed through the protection sleeve and worn excessively. Failure of this primary flight control would have rendered the helicopter uncontrollable.

A 5-amp fuse was found installed where a 1.5-amp, in-line fuse over-current protection is required to prevent the belt tension actuator from overloading the drive belts. This overloading could occur if both the tension microswitches and the extension limit switch failed to limit both the extension of the actuator and the increasing tension on the drive belts.

The pilot had installed a holding fixture for a portable GPS unit onto the side of the instrument console, secured temporarily with clecos. The GPS was powered continuously from a terminal at the clutch switch. Failure of the temporary fastening could lead to an electrical fire if arcing of the GPS power wiring occurred.

Findings as to Causes and Contributing Factors

1. The pilot did not recall applying carburetor heat prior to departure or during take-off. It is likely that carburetor ice adversely affected engine performance and caused the engine to stop operating.

2. Following the loss of engine power, the main rotor rpm decayed rapidly to an unrecoverable speed and the pilot was unable to arrest the helicopter's descent.

Findings as to Risk

1. When replaced, the push-pull tube was found to have worn excessively. Failure of this primary flight control would render a helicopter uncontrollable.

2. Incorrect over-current fuse protection of the belt tension actuator may lead to overloading of the drive belts.

3. A global positioning system unit was secured with clecos onto the side of the instrument console. Failure of the temporary fastening could lead to an electrical fire.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 22 November 2005.

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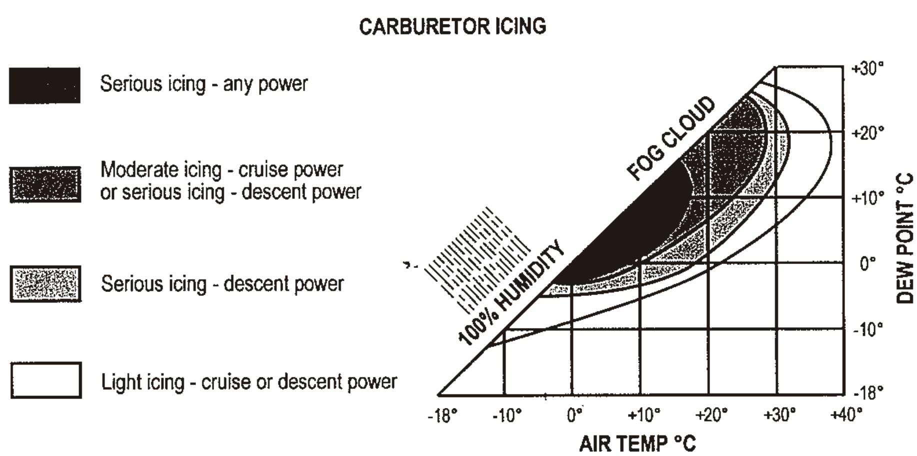
Appendix A – Carburetor Icing

Excerpt from the *Aeronautical Information Publication*, Section AIR 2.3:

> Carburetor icing is a common cause of general aviation accidents. Fuel injected engines have very few induction system icing accidents, but otherwise no airplane and engine combination stands out. Most carburetor icing related engine failure happens during normal cruise. Possibly this is as a result of decreased pilot awareness that carburetor icing will occur at high power settings as well as during descents with reduced power.
>
> In most accidents involving carburetor icing, the pilot has not fully understood the carburetor heat system of the aircraft and what occurs when it is selected. Moreover, it is difficult to understand the countermeasures unless the process of ice formation in the carburetor is understood. Detailed descriptions of this process are available in most good aviation reference publications and any AME employed on type can readily explain the carburetor heat system. The latter is important because of differences in systems. The pilot must learn to accept a rough-running engine for a minute or so as the heat melts and loosens the ice which is then ingested into the engine. The following chart provides the range of temperature and relative humidity which could induce carburetor icing.



NOTE: This chart is not valid when operating on MOGAS. Due to its higher volatility, MOGAS is more susceptible to the formation of carburetor icing. In severe cases, ice may form at OATs up to 20°C higher than with AVGAS.