Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A09P0210

IN-FLIGHT BREAKUP

KOOTENAY VALLEY HELICOPTERS LTD.
ROBINSON R44 ASTRO (HELICOPTER) C-FKAJ
CRESTON, BRITISH COLUMBIA, 8.5 nm NW
22 JULY 2009

Canada

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 Robinson R44 Astro helicopter (registration C-FKAJ, serial number 0324) took off from the Kootenay Valley Helicopters Ltd. heliport near Creston, British Columbia, at about 1245 Pacific Daylight Time with only the student pilot on board. The helicopter was on a daylight visual flight rules flight in visual meteorological conditions in the local training area, practicing flight manoeuvres. At about 1400, while flying over level marshland, the helicopter experienced an in-flight breakup. The helicopter struck the ground about 8.5 nautical miles northwest of Creston, at an elevation of 2100 feet above sea level. The bulk of the fuselage fell into the Kootenay River, leaving a wreckage path of several hundred metres. The student pilot was fatally injured and the helicopter was destroyed by in-flight and ground impact forces. There was no fire. The emergency locator transmitter was functioning when found; however, no signal was detected because the unit was under water and it was designed to transmit a signal on 121.5 and 243 MHz, which are no longer monitored by the search and rescue satellite system.

Ce rapport est également disponible en français.

Other Factual Information

The helicopter was owned by Kootenay Valley Helicopters Ltd. (KVH) of Creston, British Columbia, and was operated from the KVH training facility situated about 3.5 nautical miles (nm) southwest of the Creston municipal airport.

The accident flight was an authorized solo flight by the student pilot, with a planned duration of 1.5 hours. The principal focus of the flight was continuing practice in confined area operations and steep turn manoeuvres. During the pre-flight planning discussions with the instructor, the student pilot acknowledged the proposed training agenda and instructions. The student pilot's training progress and the flight data transmitted by the onboard flight tracking unit indicate that it was most likely that the student pilot was carrying out the mission tasks when the accident occurred.

The flight was the student pilot's second of the day in C-FKAJ. The first flight had been about 1.5 hours in duration and had been mostly spent in the circuit at the Creston Airport with his instructor. All communications with the student pilot on the day of the accident were normal, and there was no indication of any mechanical, navigational, environmental, or personal concerns either before or during his flights.

The accident site is located at 49°12.68' N, 116°39.55' W, and lies about 15 nm north of the KVH heliport facility. The site lies within a local waterfowl refuge known for its population of large migratory birds and, on the day of the accident, many birds were seen in the marshlands and adjacent waterways. In-flight tracking data and wreckage distribution and trajectory paths show that the helicopter passed over this area.

The Student Pilot

The student held a student pilot permit (helicopter) issued by Transport Canada (TC) and a Category 1 medical certificate without limitation, both valid until May 2014. The student pilot had begun his flying training with KVH in May 2009 with the intention of gaining a Canadian commercial pilot licence (helicopter). He had not flown as a pilot before beginning this helicopter course and, at the time of the accident, had accumulated about 52 hours of total flight time, comprising dual and solo flights only on the accident Robinson R44 helicopter.

The student pilot was a mature student and had been progressing satisfactorily with the formal KVH training syllabus. A review of his flight training records and flight times revealed no departures from existing flying training standards, norms, progress, or flight time regulations, and nothing remarkable was found regarding the student pilot's activities in the previous 48 hours.

The student pilot was considered to be an assiduous student of helicopter flight and operations. As well, he had gathered considerable knowledge about the dangerous consequences of in-flight collision with birds, and showed great interest in bird-avoidance precautions and helicopter handling techniques. The student pilot was highly aware of the potential for collision with birds and the attendant results.

Area Weather conditions

Creston is about equidistant from Cranbrook and Castlegar, British Columbia. The aviation routine weather reports (METARs) for both of these airports show that, during the time surrounding the accident (1400 [1]), the weather conditions at those airports were suitable for visual flight rules (VFR) flight and had remained steady. The wind was light, 8 knots from the southeast, with few clouds, and an air temperature of about 34°C.

No formal weather observations for the area of the accident exist. However, the weather in the general area for the time leading up to the accident was consistent with visual meteorological conditions (VMC), with no precipitation, unlimited visibility, light winds, and the outside air temperature estimated at 35°C. Weather was not a factor in this accident.

Helicopter

The Robinson R44 Astro helicopter has a Textron Lycoming O-540-F1B5 carbureted engine delivering 260 horsepower. The helicopter has a maximum gross weight of 2400 pounds. A review of the logbooks and maintenance records indicates that the helicopter had been certificated, equipped, and maintained in accordance with existing regulations and approved maintenance procedures. At the time of the accident, the helicopter had accumulated about 3280 hours time since new. The helicopter was not equipped with a flight recorder nor was it required by regulation.

Weight and Balance

The helicopter had an empty weight of 1461.9 pounds, with a centre of gravity (CG) of 106.4 inches. [2] Before take-off on the accident flight, the student pilot had filled both external fuel tanks to 35 US gallons, for a total of 210 pounds. TSB calculations show that the helicopter likely weighed in the order of 1820 pounds at take-off from KVH with a CG of 101.49 inches (square in Figure 1). As the flight progressed and fuel was consumed, the CG would have moved forward toward the zero-fuel weight position of 101.2 inches (triangle in Figure 1). At the time of the accident, the weight and balance (circle in Figure 1) was likely within the prescribed limits and near the aft region of the CG envelope. The main rotor mast is 100 inches from the datum.

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

2 The empty weight CG is without either pilot or fuel on board. The fact that the CG moves forward so quickly is a design characteristic of the R44.

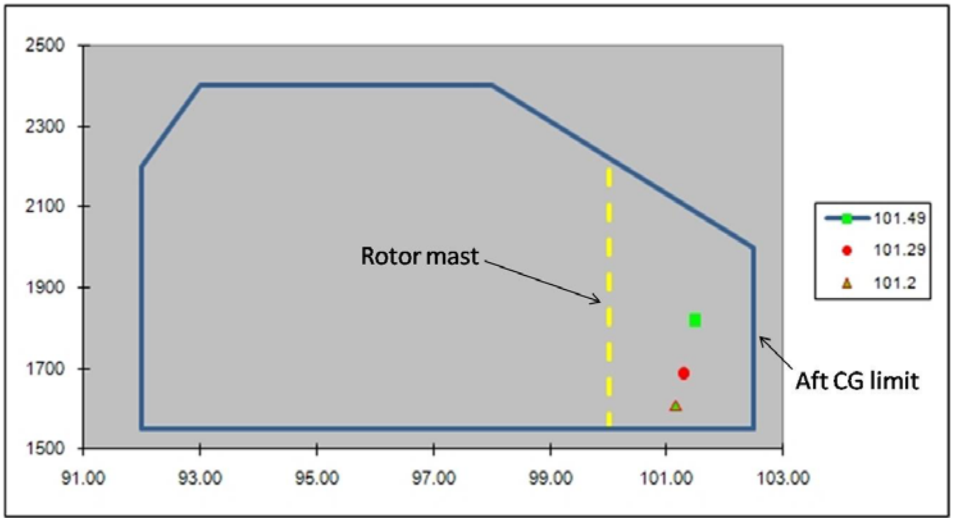

Figure 1. CG Envelope C-FKAJ

Flight with an aft CG condition within the certificated flight envelope is permissible. An aft CG condition, in flight, requires the pilot to maintain a more forward cyclic stick input, thus reducing the available forward cyclic stick travel. Under normal circumstances, this condition is an operational characteristic of helicopter flight, and requires cautious cyclic movement to avoid reaching the forward limit of longitudinal cyclic travel. However, the amount of available cyclic movement may be insufficient for the pilot to control the helicopter under some unusual conditions.

Accident Site

Several lighter objects from the helicopter were found in the marshland near the river edge. The main cabin/transmission section fell into a narrow section of the adjacent Kootenay River (see Photo 1). The wreckage was located near the shoreline. There was no evidence of tree strikes along the river or in the marsh. The tail rotor section was located in the river about 30 metres from the main wreckage in 50 feet of water.

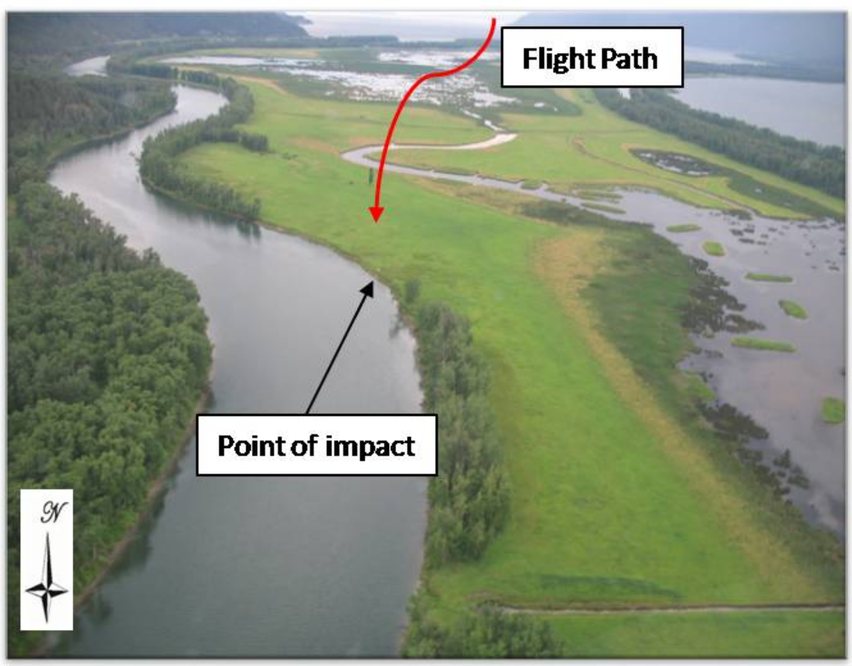

Photo 1. Accident flight path

The trail of wreckage shows that the helicopter broke up in flight near the southern end of Duck Lake, and fell in a southerly direction towards the river, a trajectory path of about 100 metres. The damage to the helicopter indicates that the helicopter fuselage struck the river left side low, almost in a level attitude.

Wreckage Description

The helicopter was destroyed and extensively crushed by impact forces. The airframe had broken into three main sections:

- the cockpit, cabin, and main fuselage;
- the engine compartment and the main transmission; and
- the tail rotor section.

Examination of the wreckage revealed no evidence of pre-impact control system or airframe failures that might have initiated the breakup; there was no evidence of a bird strike.

The cockpit/cabin section and the engine/transmission section were joined only by the wiring looms and flight control tubing. Several pieces of the fuselage and tailboom were found near the main wreckage site, indicating that they had been torn off in flight; several bore signs of main rotor blade impact.

The main rotor gearbox exhibited damage consistent with high vertical forces, likely as a result of the impact with the river. The main rotor mast and rotor head exhibited damage that demonstrated severe blade flapping and mast bumping. One of the pitch change links exhibited bending overload failure, one of the spindle tusks was fractured, and the polyurethane mast bumpers were crushed, consistent with damage resulting from the divergence of the main rotor blades from their normal plane of rotation.

All the rotor system components were found within the wreckage, with the exception of a section of one main rotor blade. Of the two main rotor blades (herein called red and blue for ease of identification), the whole red blade was still attached to the blade hub but the main spar was bent and fractured 60 inches from the root; the trailing edge remained intact. The red blade showed evidence of impact with the tailboom precisely matching the damage on the tailboom (see Photo 2).

The blue blade had broken off 28 inches from the blade root. The remainder of the blade was not found except for a 36-inch piece of mid-blade afterbody retrieved from the river near the main impact site. It is unlikely that this piece separated in flight because no anomalies were seen in the honeycomb or skin bonding; all broken edges appear to be single overload fractures. Furthermore, it is unlikely that such a light piece would have landed in the same location as the main wreckage had it come off where the helicopter broke apart.

The TSB Laboratory examined the fractured surfaces of both main rotor blades. No indications of progressive fatigue failure were observed on the spar fracture surfaces. The presence of features such as 45° shear lips and plastic deformation is consistent with failure by overstress. Therefore, it is considered that the blade fractures occurred as a result of overstress and that fatigue did not play a role in the failures. Accordingly, given the nature of the terrain, the airframe and rotor damage, and the proximity of the wreckage parts, it was concluded that the rotor blades broke at impact with the water.

The tail rotor section, including a section of tailboom, was found to be cleanly severed in flight by the main rotor blades. The damage seen on the tail rotor and gearbox was light, with only minor damage to one of the blade tips. The section of tailboom that had been severed showed minor damage also evidently caused by impact with the water. A single tail rotor blade slap mark was seen on the side of the tailboom, directly beneath the tail rotor disc arc, and had been made on water contact.

Flight Control and Drive Train Continuity

Control continuity was confirmed for all flight controls in the main wreckage; none of the components showed signs of disconnect or premature failure. The continuity of the tail rotor drive train could not be established, nor that of the tail rotor pitch control linkage, because a section of tailboom was missing. The main and tail rotor gearboxes, as well as the engine freewheel unit, were examined and no malfunction or pre-existing anomaly was found.

Rotor Blade Energy

The damage to the main rotor blades is consistent with a rotor system striking the airframe while turning at moderate rpm, and is characteristic of moderate rotor system energy. By design, the R44 helicopter has a low inertia rotor system, that is, both the rotor rpm and energy decrease rapidly following in-flight loading, but they can return just as quickly. In this helicopter, moderate rotor rpm can be less than the minimum required for controlled flight; the actual rpm, however, could not be determined.

Engine Examination

A review of the helicopter maintenance records reveals that all the required maintenance and service instructions for both the engine and the helicopter had been completed in accordance with *Canadian Aviation Regulations* and instructions. The engine service time at the time of the accident was about 1080 hours SMOH (since major overhaul).

Impact signatures and evidence at the accident site, as well as the damage to the engine itself, were characteristic of an engine striking terrain (or water) while running. TSB investigators removed the engine from the airframe and examined it at the TSB regional wreckage examination facility in Richmond, British Columbia. The engine was later examined in greater detail at an approved engine maintenance and overhaul facility in Kelowna, British Columbia. There was no indication of a pre-existing condition that would have prevented the engine from performing normally.

Rotor-Tailboom Contact

Barring in-flight failure of one of the primary flight controls for helicopter attitude, there are few likely reasons for main rotor blade–to–tailboom contact (see Photo 2), namely:

- a loss of main rotor rpm below the minimum value required for controlled flight;
- large main rotor blade flapping angles;
- less than 1 *g* manoeuvring forces; or
- a combination of these factors.

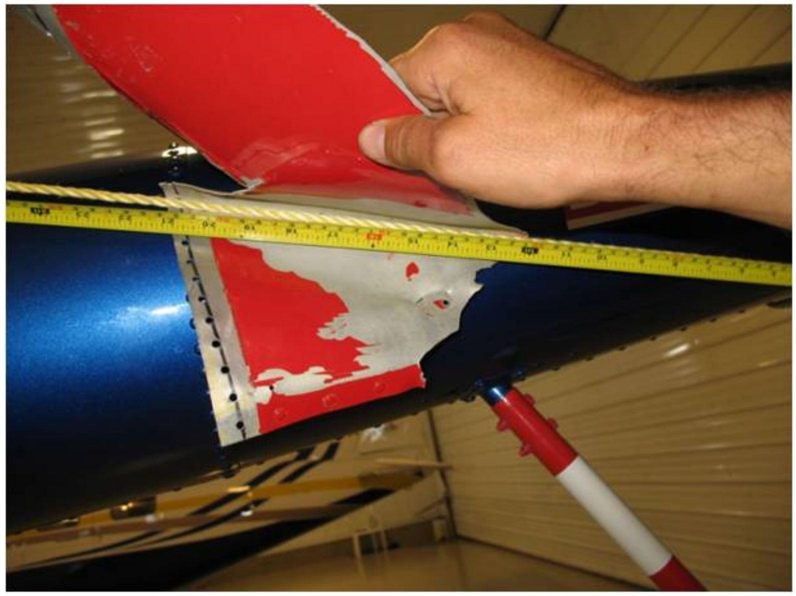

Photo 2. Tailboom rotor blade strike

The damage patterns to the main rotor and the fuselage suggest moderate rotor energy and rpm, although no definitive rpm could be ascertained.

The airframe damage indicates that the tail rotor assembly was intact at main rotor blade impact, and there was no sign of contact with any other component.

Survivability

Damage to the helicopter is consistent with the dynamics of in-flight breakup, with extreme rotor blade–fuselage impact forces, and high-speed deceleration forces from water contact; such a combination of impact forces exceeds human tolerance. The accident was not survivable.

The emergency locator transmitter (ELT) carried on the helicopter was a Pointer Sentry 3000, operating on frequencies 121.5 and 243 MHz. As of 01 February 2009, the COSPAS-SARSAT satellite system is no longer capable of receiving or tracking aircraft ELTs on either frequency. Accordingly, the accident ELT was ineffective as a passive location device.

Warnings Concerning Low-g Manoeuvres

Section 2 (Limitations) of the TC–approved Rotorcraft Flight Manual (RFM) prohibits low-*g* cyclic pushover manoeuvres and warns of the following:

> A pushover (forward cyclic maneuver) performed from level flight or following a pull-up causes a low-g (near weightless) condition which can result in catastrophic loss of lateral control. To eliminate a low-g condition, immediately apply gentle aft cyclic. Should a right roll commence during a low-g condition, apply gentle aft cyclic to reload the rotor before applying lateral cyclic to stop the roll.

In a similar vein, Robinson Safety Notice SN-11 (revised November 2000) deals with low-*g* pushovers and identifies the manoeuvre as dangerous:

> Pushing the cyclic forward following a pull-up or rapid climb, or even from level flight, produces a low-*g* (weightless) flight condition. If the helicopter is still pitching forward when the pilot applies aft cyclic to reload the rotor, the rotor disc may tilt aft relative to the fuselage before it is reloaded. The main rotor torque reaction will then combine with tail rotor thrust to produce a powerful right rolling moment on the fuselage. With no lift from the rotor, there is no lateral control to stop the rapid right roll and mast bumping can occur. Severe in-flight mast bumping usually results in main rotor shaft separation and/or rotor blade contact with the fuselage.
>
> The rotor must be reloaded before lateral cyclic can stop the right roll. To reload the rotor, apply an immediate gentle aft cyclic, but avoid any large aft cyclic inputs. (The low-*g* which occurs during a rapid autorotation entry is not a problem because lowering collective reduces both rotor lift and rotor torque at the same time.)
>
> Never attempt to demonstrate or experiment with low-*g* maneuvers, regardless of your skill or experience level. Even highly experienced test pilots have been killed investigating the low-*g* flight condition. Always use great care to avoid any maneuver which could result in a low-*g* condition. Low-g mast bumping accidents are almost always fatal.

Low-g Conditions and Mast Bumping

In general, most helicopter rotor blades flap to equalize the lift generated across the plane of the rotor disk and to provide control of the helicopter. Flapping stops are incorporated in the rotor design [3] to limit the amplitude of flapping that can occur during start-up or shut-down when rotor speeds are slow. Sudden changes in attitude, as induced by abrupt cyclic input due to

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[3] Note that some of the nomenclature in this generic description of mast bumping does not directly apply to the R44 helicopter; for example, the R44 design uses a teetering hinge and two coning hinges. Nonetheless, the phenomenon is identical.

mechanical failure, can increase flapping angles to as much as 70 per cent of the rotor/shaft limit. If the flapping angles exceed the design limit, the rotor blades static stops will contact the mast (mast bumping) and, if this contact is sufficiently violent, the mast will be damaged and can separate in flight. Flapping angles increase moderately with high forward speed, low rotor rpm, high density altitude, high gross weight, and turbulence.

Low-speed flight at extreme CG positions can induce even larger flapping angles. The most critical manoeuvre in regard to mast bumping is the forward pushover manoeuvre. Abrupt displacement of the main rotor disk well in excess of the flapping angle may cause the static stops to strike the mast and initiate the destructive forces associated with mast bumping.

For cyclic control, most helicopters depend primarily on tilting the main rotor thrust vector to produce control moments about the CG, causing the helicopter to roll or pitch in the desired direction. Pushing the cyclic control forward abruptly from either straight-and-level flight or after a climb can put the helicopter into a low-*g* flight condition. In forward flight, when a push-over is performed, the angle of attack and thrust of the rotor is reduced, causing a low-*g* flight condition.

During such low-*g* conditions, the lateral cyclic has little effect, if any, because rotor thrust has been reduced. In an anticlockwise rotor system, such as the R44, there is no main rotor thrust component to the left to counteract the tail rotor thrust to the right, and because the tail rotor is above the CG, the tail rotor thrust causes the helicopter to roll rapidly to the right. If the pilot attempts to stop the right roll by applying full left cyclic before regaining main rotor thrust, the rotor can exceed its flapping limits and cause structural failure of the rotor shaft due to mast bumping, or it may allow a blade to contact the airframe.

In a low-*g* condition, improper corrective action could lead to the main rotor hub contacting the rotor mast. The contact with the mast becomes more violent with each successive flapping motion. This, in turn, creates a greater flapping displacement. The result could be a severely damaged rotor mast, or the main rotor system could separate from the helicopter.

Causes of Helicopter In-Flight Breakups

In addition to catastrophic mast bumping as a cause of in-flight breakup, the pilot can induce main rotor disk excursions in several ways, including:

- high bank angles, and
- rapid cyclic control movement.

With high bank angles, the rotor system can be unloaded by the pilot not maintaining positive *g* throughout the manoeuvre and recovery. As well, rapid cyclic reversals in roll or pitch can displace the rotor disk plane faster than the fuselage can respond, leading to blade–to–fuselage contact.

National Transportation Safety Board Special Investigation Report

Since 1981, the United States National Transportation Safety Board (NTSB) has investigated or researched many R22 and R44 accidents (domestic and foreign) involving an in-flight loss of main rotor control and contact of the main rotor blades with the tailboom or fuselage of the helicopter. Most of these resulted in in-flight breakups.

As a result of these accidents, and prompted by an accident that occurred during an instructional flight near Richmond, California, on 29 June 1992, the NTSB conducted a Special Investigation Report (SIR) [4] into Robinson R22 and R44 accidents involving loss of main rotor control and fuselage strikes.

The NTSB initially focused on R22 accidents in which the main rotor blade diverged from its normal path and struck the helicopter. When similar R44 accidents began to occur, the scope of the SIR was expanded to include that helicopter model. The safety issues discussed in the SIR include:

- the need for appropriate measures to reduce the probability of loss of main rotor control accidents;
- the need for continued research to study flight control systems and main rotor blade dynamics in lightweight, low rotor inertia helicopters;
- the need for operational requirements to be addressed during future certification of lightweight, low rotor inertia helicopters; and
- the need for the Federal Aviation Administration (FAA) to review and revise, as necessary, its procedures to ensure that internal recommendations, particularly those addressed in special certification reviews, are appropriately resolved and brought to closure.

R22/R44 Special Training and Experience Requirements – United States Federal Aviation Administration

The R22 is a two-seat, reciprocating engine-powered helicopter that is frequently used as a low-cost initial student training aircraft. The R44 is a four-seat helicopter with operating characteristics and design features that are quite similar to the R22. The R22 is the smallest helicopter in its class and both models incorporate a unique cyclic control and teetering rotor system. Certain aerodynamic and design features of the helicopters cause specific flight characteristics that require particular pilot awareness and responsiveness.

As a result of several safety recommendations issued by the United States NTSB in 1994 and 1995, the United States FAA determined that specific training and experience requirements were necessary for the safe operation of Robinson R22 and R44 model helicopters.

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4 National Transportation Safety Board, Special Investigation Report into Robinson Helicopter Company R22 Loss of Main Rotor Control Accidents, adopted 02 April 1996.

On 01 March 1995, the FAA issued Special Federal Aviation Regulation (SFAR) 73. Essentially, SFAR 73 amended Part 61 of Chapter I of Title 14, *Code of Federal Regulations* (14 CFR, part 61), which details the certification requirements for pilots and flight instructors. This SFAR specifically augmented pilot certification for the Robinson R22 and R44 model helicopters in order to maintain the safe operation of these helicopters.

In summary, SFAR 73 requires special training and experience for pilots performing pilot-in-command or certified flight instructor duties (for student instruction or flight reviews) on the Robinson R22 or R44 helicopters (see Appendix A). The original SFAR was initially issued on an emergency basis, and was continued on 26 May 2009. The FAA believes that the specific training and qualification requirements in SFAR 73 contributed significantly to reducing the number and types of accidents traditionally associated with these helicopters.

In support of the SFAR conditions, the FAA concluded that

> The potential safety benefits from the rule will be a reduction in the number of fatal accidents that occur in the Robinson helicopters associated with low-*g* maneuvers that may result in main rotor/airframe contact. The reduction in the number of accidents would be due to the increased level of safety due to specific flight training and awareness training requirements for all individuals operating Robinson R-22 and R-44 aircraft.

Applicability of Special Federal Aviation Regulation 73 in Canada

In Canada, TC regulates all flight training and flight instructor qualifications for helicopters. Regarding the Robinson R22 and R44, TC has not introduced similar regulations to United States SFAR 73, and the provisions of the SFAR do not apply to Canadian pilots. In Canada, unlike the United States where a group rating is issued, each helicopter type must be individually added to a helicopter licence. In past investigations, [5] the TSB has noted that this TC licensing methodology is a superior practice. However, while the TC syllabus requirements for helicopter flight instruction in Canada generally include some of the elements of SFAR 73, not all elements are addressed.

The TSB conducted an informal poll of selected TC civil aviation inspectors and helicopter flight school operators after the accident. As a result, the TSB learned that there is significant difference in the practical application of the TC syllabus instructions regarding the content of flight instruction for R22 and R44 helicopters specific to the issues contained in SFAR 73. Furthermore, it is clear that there are situations where Canadian pilots of Robinson helicopters have not been exposed to similar flight or ground training prescribed by the SFAR, either recently or at all.

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[5] TSB reports A05F0025 and A06P0123, and TSB occurrence A06F0084.

Analysis

The lack of an onboard flight recorder hindered the accurate reconstruction of the flight.

Based on the proposed training agenda, the student pilot's intentions, and the flight tracking unit data, it is most likely that the student pilot had been following the proposed training plan and was practicing steep turns in the area when the accident occurred.

Wreckage damage and distribution also indicate that the lead event was the main rotor flapping down into the tailboom severing the tail rotor driveshaft, tailboom, and tail rotor assembly in one unit. This damage and loss of airframe structure was catastrophic and immediately rendered the helicopter uncontrollable.

The cause of this excessive rotor flapping could not be identified, and this analysis explores the possible reasons and circumstance for this aerodynamic phenomenon.

Mast Bumping

Main rotor blade impact marks on the tailboom are indications of extreme in-flight rotor flapping. Frequently, such rotor strikes signify low-to-moderate rotor rpm, and in this accident, the tailboom contact marks, the proximity of the separated components, and the rotor blade damage are all characteristic of a rotor strike being the initiating event of the in-flight breakup and resulting loss of control.

There are some situations where inappropriate pilot control inputs could influence excessive rotor flapping and mast bumping, which is a pre-condition for rotor–to–tailboom contact that often leads to in-flight breakup. For example, Robinson Helicopters warned pilots about the risk of low-*g* manoeuvres in the R44, stating that loss of control and mast bumping are often the result. In a similar fashion, rapid flight control deflection could lead to rotor instability and excessive rotor flapping angles.

Airframe examinations did not identify any mechanical condition that might have led to mast bumping. The other factor to consider, therefore, is pilot flight control inputs. Without flight data recorder information, the regime of flight and the student pilot's actions are unknown. However, several assumptions can be made, namely:

- no adverse mechanical condition existed;
- the helicopter was functioning correctly; and
- the student pilot was conducting steep turns.

Possible In-Flight Breakup Scenario

Given the above factors that eliminate mechanical cause, it is reasonable to propose that the student pilot inadvertently induced the conditions necessary to cause mast bumping. It is known that low-*g* maneuvering in the Robinson R44 helicopter can lead to excessive rotor flapping and mast bumping, as can some rapid and large collective or cyclic movements. It is clear that several combinations of flight circumstances exist that could lead to mast bumping, but the most plausible in this case is the student pilot manoeuvring quickly during a steep turn. In concert with an aft CG condition (forward cyclic bias), the student pilot may have had reduced forward cyclic travel.

The area where the accident occurred is known for its concentration of large migratory birds, and on the day of the accident, many birds were seen in the marshlands and adjacent waterways. The student pilot was well-versed on the consequences of bird strikes and had recently studied bird-avoidance techniques. He was characterized as being particularly sensitive to the dangers of collision with birds.

It is conceivable that the student pilot encountered a bird during his steep-turn practice. During his attempt to avoid it, he may have applied control inputs that led to excessive main rotor flapping and mast bumping. Had he also lowered the collective, pushed the nose forward, or both, he would have been even more greatly exposed to the large aerodynamic forces that cause mast bumping. Such reactive manoeuvring is instinctive and often rapid, and in conjunction with the control inputs and in-flight attitudes often seen in steep-turn manoeuvres, is likely to cause rotor path plane upset and reduced clearance from the tailboom. Such flight conditions make mast bumping almost inevitable. In-flight mast bumping is frequently irrecoverable and catastrophic, with either the mast being severed or a blade strike to the fuselage. In either case, the result is invariably fatal.

Flight Training and Experience for R22 and R44 Helicopters in Canada

United States SFAR 73 prescribes minimum requirements for pilots of R22 and R44 helicopters, both as the pilot-in-command, the student pilot, or the flight instructor. This regulation imposes specific training and experience criteria on United States licence holders because certain aerodynamic and design features of the helicopter cause specific flight characteristics that require particular pilot awareness and responsiveness. Following implementation of this SFAR in the United States, the in-flight breakup accident rate has fallen remarkably, suggesting that the provisions of the SFAR improve flight safety.

Relying solely upon the general awareness in the helicopter community of the operating vulnerabilities of the R22 and R44 helicopters, identified in SFAR 73, is inadequate in reducing the risk of in-flight upset (resulting from low-*g* manoeuvring or mast bumping for example) associated with these helicopters. While Canadian licensing requirements are more prescriptive, it can be reasonably argued that Canadian R22 and R44 pilots are at risk of inadvertent in-flight upset in the absence of the exposure to, and instruction about, the issues raised by the United States SFAR.

The following TSB Laboratory reports were completed:

LP 119/2009 – Examination of Fan Assembly
LP 151/2009 – Crankshaft Examination
LP 152/2009 – Examination of Rotor Blades

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

Findings as to Causes and Contributing Factors

1. During flight, an undetermined flight manoeuvre caused the main rotor blades to strike the tailboom.

2. The blades severed the tailboom and tail rotor assembly, resulting in an in-flight breakup rendering the helicopter uncontrollable.

Findings as to Risk

1. Low-level flight operations in areas known for migratory bird traffic increase the exposure to the hazards of bird strike and require the highest level of attention and caution.

2. In the absence of the exposure to, and the instruction about, the issues raised by United States Special Federal Aviation Regulation 73, some Canadian R22 and R44 pilots are at risk of inadvertent in-flight upset from low-*g* manoeuvring or mast bumping.

Other Finding

1. It is possible that, while manoeuvring to avoid a bird, the student pilot may have caused excessive main rotor blade flapping angles and mast bumping.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 22 July 2010.

Visit the Transportation Safety Board's Web site (www.bst-tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A – Synopsis of United States Special Federal Aviation Regulation 73

Special Federal Aviation Regulation 73 – Robinson R22/R44 Special Training and Experience Requirements

The Special Federal Aviation Regulation (SFAR) applies to all persons who seek to manipulate the controls or act as pilot-in-command of a Robinson R22 or R44 helicopter. The requirements stated in this SFAR are in addition to the current requirements of Part 61 and prescribe the required training, aeronautical experience, endorsements, and flight review.

In summary, the content of the SFAR applicable to the R44 follows.

(a) <u>Awareness Training</u>:

(1) a pilot must have specific *Awareness Training* (see item (3) below);
(2) a pilot must have specific *Aeronautical Experience* (see section (b) below);
(3) awareness training must include the following general subject areas:
- (i) energy management;
- (ii) mast bumping;
- (iii) low rotor rpm (blade stall);
- (iv) low G hazards; and
- (v) rotor rpm decay.

(b) <u>Aeronautical Experience</u>:

(1) the pilot-in-command of an R44 must have the following:
- (i) at least 200 flight hours in helicopters, at least 50 flight hours of which were in the R44 (the pilot may include up to 25 flight hours in the R22 in this 50-hour requirement); or
- (ii) at least 10 hours dual instruction in a Robinson helicopter, at least 5 hours of which must have been accomplished in the R44 helicopter and has been given the required training and is proficient to act as pilot-in-command of an R44. The dual instruction must include at least the following abnormal and emergency procedures:
  - (a) enhanced training in autorotation procedures;
  - (b) engine rotor RPM control without the use of the governor;
  - (c) low rotor RPM recognition and recovery; and
  - (d) effects of low G maneuvers and proper recovery procedures.

(2) a pilot without a helicopter licence must have had at least 20 hours of dual instruction in a Robinson R44 helicopter prior to operating it in solo flight, and be appropriately endorsed by a certificated flight instructor. The dual instruction must include at least the following abnormal and emergency procedures flight training:

(i) enhanced training in autorotation procedures;
(ii) engine rotor RPM control without the use of the governor;
(iii) low rotor RPM recognition and recovery; and
(iv) effects of low G maneuvers and proper recovery procedures.

(3) No certificated flight instructor may provide instruction or conduct a flight review in a Robinson R44 unless that instructor—

(i) completes the awareness training specified by this SFAR;
(ii) for the Robinson R44, has had at least 200 flight hours in helicopters, 50 flight hours of which were in Robinson helicopters. Up to 25 flight hours of Robinson R22 flight time may be credited toward the 50 hour requirement;
(iii) has completed flight training in a Robinson R22, R44, or both, on the following abnormal and emergency procedures—

(a) enhanced training in autorotation procedures;
(b) engine rotor RPM control without the use of the governor;
(c) low rotor RPM recognition and recovery; and
(d) effects of low G maneuvers and proper recovery procedures.

(iv) has been endorsed to have the appropriate training and experience requirements of this SFAR.

(c) Flight Review:

(1) must be completed in an R44; and
(2) must include the Awareness Training and the Flight Training of this SFAR.

(d) Currency Requirements:

No person may act as pilot-in-command of a Robinson R44 helicopter carrying passengers without the recency of flight experience requirements prescribed in 14 CFR part 61.57.