



Australian Government

Australian Transport Safety Bureau



ATSB TRANSPORT SAFETY REPORT

Aviation Occurrence Investigation AO-2009-032

Final

Collision with terrain
Gold Coast Aerodrome, Queensland
2 July 2009
VH-OML
Robinson Helicopter Company
R22 Beta II



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Figure 1 and 2: Background images courtesy of Google maps

Abstract

On 2 July 2009, the pilot of a Robinson Helicopter Company R22 Beta II, registered VH-OML, was conducting solo circuit training from the Gold Coast Aerodrome, Queensland. Weather conditions in the area at the time were fine, with light and variable winds.

At about 1015 Eastern Standard Time, the helicopter impacted terrain near the southern aerodrome boundary. The pilot was fatally injured and the helicopter seriously damaged.

There was no evidence of a pre-existing mechanical problem with the helicopter. The pilot had extensive previous experience in aeroplanes and the flight was his sixth solo helicopter flight towards his Private Pilot (Helicopter) Licence. The investigation found that the accident may have been a function of the pilot's control inputs.

As a result of this investigation, the helicopter operator has made a number of changes to their induction process, including the annotation in company records of instructors' ratings and their respective validity periods. In addition, the Civil Aviation Safety Authority has advised that it will review the requirements for initial pilot training and endorsement and recurrent training on Robinson R22 helicopters. Included will be a review of the Helicopter Flight Instructor's Manual to ensure that the required competencies are being covered by flight instructors and trained to students.

The Australian Transport Safety Bureau has issued a Safety Advisory Notice suggesting that operators consider action to ensure the validity of pilots' qualifications and ratings, and that competency standards are met.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which ‘saved the day’ or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: The ATSB’s assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

FACTUAL INFORMATION

History of the flight

On 2 July 2009, the pilot of a Robinson Helicopter Company R22 Beta II, registered VH-OML was carrying out solo circuit training from the Gold Coast Aerodrome, Queensland. The weather conditions in the area at the time were fine, with and light variable winds. At about 1014 Eastern Standard Time¹ the pilot took off from the western grass area of the aerodrome on a second circuit (Figure 1).

At about 1015, the helicopter impacted terrain near the southern aerodrome boundary. The pilot was fatally injured and the helicopter sustained serious damage².

Shortly after the takeoff, the pilot of a Cessna Company 172 (172) aeroplane was cleared for takeoff from the active runway 14, which is located east of the western grass area (Figure 1). After observing the helicopter and 172 depart, the aerodrome controller (ADC) concentrated on the other aircraft in the circuit and on other duties.

An airport worker, who was working on light fittings on taxiway Charlie south (Figure 1), reported that the helicopter tracked further to the east than normal and that it appeared initially that the helicopter was tracking towards the ocean. A number of witnesses on the ground and in the air stated that they saw the helicopter climbing, followed by a rolling motion that progressed into an exaggerated rolling and pitching movement. Several witnesses reported that, shortly after that movement, they saw a piece of the helicopter separate from the aircraft, followed by the helicopter rotating a number of times before descending almost vertically into trees near the aerodrome boundary.

The instructor pilot of the 172 notified the ADC that the helicopter had descended into trees. The ADC requested the instructor to orbit the accident site to assist in its location by the emergency response vehicles.

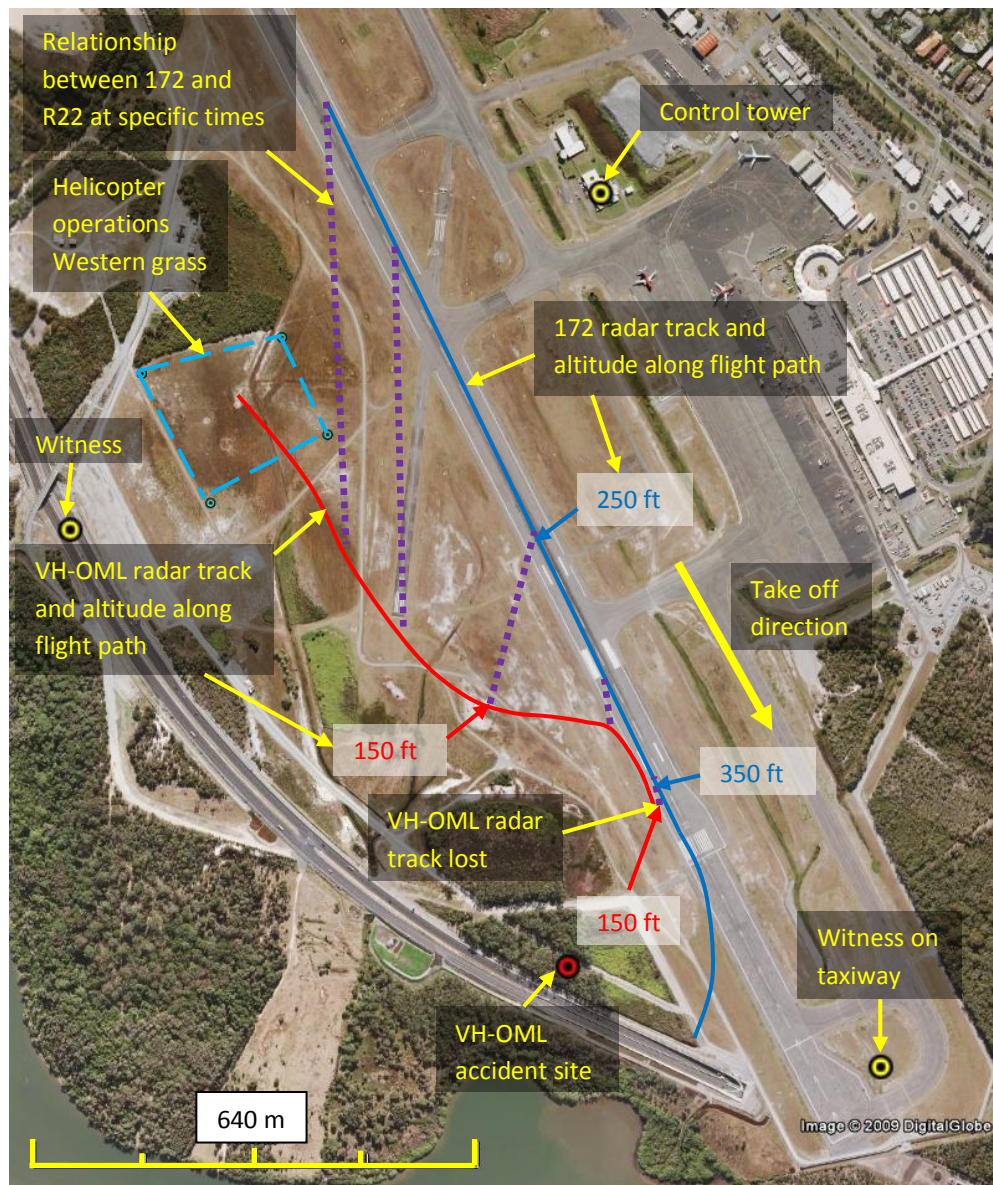
A replay of the recorded air traffic control radar data indicated that, after takeoff, the helicopter commenced a slow, gradual climbing left turn to a height of about 200 ft above mean sea level (AMSL) (Figure 1). When the helicopter was almost over the boundary of the runway 14 flight strip, it turned right and descended. The 172's radar track showed it to be slightly right (or west) of the runway centreline, and about 84 m to the left and behind the helicopter at that time.

The helicopter's radar recording ceased at 150 ft.

¹ The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) +10 hours.

² The Transport Safety Investigation Regulations 2003 definition of 'serious damage' includes the 'destruction of the transport vehicle'.

Figure 1: Gold Coast Aerodrome overview



Personnel information

The pilot

A review of the pilot's flying logbook indicated that he gained a Private Pilot (Aeroplane) Licence in September 1993, a Commercial Pilot (Aeroplane) Licence in July 1995 and a multi-engine command instrument rating in December 2003. The pilot's total aeroplane flying experience at 21 May 2009 was 2,787 hours.

The pilot commenced flying training for a Private Pilot (Helicopter) Licence in Robinson R22 helicopters on 27 May 2009. At the time of the occurrence, he had flown 25.5 hours, including 3.1 hours of solo flight. The accident flight was the pilot's sixth session of solo circuits.

The pilot held a current Class 1 medical certificate that was issued by the Civil Aviation Safety Authority (CASA) and had two restrictions; distance vision correction was required to be worn, and reading correction was required to be available while exercising the privileges of the respective licence. The investigation was unable to confirm whether the pilot was wearing his spectacles during the flight. No spectacles were found at the accident site.

Prior to the pilot's first solo flight in helicopters, the instructor who had carried out all of the pilot's helicopter training elected to have another instructor fly with the pilot in preparation for his first solo. After that check, and one more instructional flight with the original instructor, the pilot completed his first solo.

The pilot's training records did not indicate any areas of deficiency during his helicopter training that might have contributed to the occurrence. In particular, there was no mention of the pilot experiencing any control difficulty, or of the pilot overcontrolling the helicopter in forward flight. The pilot was described as a conscientious and capable student.

The pilot's flight instructor

The pilot's original instructor held an Air Transport Pilot (Helicopter) Licence, and a valid Class 1 medical certificate. The instructor's Grade 2 instructor rating was issued by CASA on 31 October 2007 and expired on 31 December 2008. At the time of the occurrence, the instructor had accrued about 1,800 hours of flying instruction.

Aircraft information

The Robinson Helicopter Company R22 Beta II helicopter, serial number 4312, was manufactured in the United States (US) in 2008 and had accumulated 485.3 hours total time in service at the time of the occurrence. The helicopter was powered by a Textron Lycoming O-360-J2A, four cylinder, normally-aspirated, air-cooled, horizontally-opposed piston engine.

Airworthiness and maintenance

A review of the maintenance logs indicated that the helicopter had been maintained in accordance with the Robinson Helicopter R22 maintenance schedule. The helicopter had a current Certificate of Registration and Certificate of Airworthiness. The current maintenance release was found in the aircraft and showed that there were no outstanding maintenance items or defects identified.

A 100-hourly periodic inspection was carried out 1 month prior to the accident with no major defects identified or requiring rectification at that time.

Meteorological information

The Bureau of Meteorology (BoM) advised that the Gold Coast Aerodrome was under the influence of a dry, south-west to westerly airflow. According to the area³ forecast, visibility was expected to reduce to 7 km in dust haze.

The aerodrome forecast that was valid for the time of the occurrence forecast a westerly wind at 12 kts, visibility greater than 10 km, and no cloud below 5,000 ft. The aerodrome's Automatic Weather Station recorded light and variable winds of less than 5 kts around the time of the occurrence.

The BoM indicated that flying conditions at the time of the occurrence were 'most likely good', and that the presence of turbulence below 200 ft above ground level was 'reasonably unlikely'. Dust haze was observed in the area.

The temperature at the time was 20 °C with a dewpoint of 13 °C. Application of those temperatures to a carburettor icing-probability predictive chart suggested a moderate icing risk at cruise power, and a serious icing risk at descent power.

The position of the sun at the time of the accident was established via the Geoscience Australia web site as:⁴

- azimuth⁵ - 98°04'04"
- altitude⁶ - 68°01'12".

Aerodrome information

The Gold Coast Aerodrome has two intersecting runways; runway 14/32⁷ and runway 17/35 and is at an elevation of 21 ft.

The facilities entry in the En Route Supplement Australia (ERSA) for the Gold Coast Aerodrome cautioned pilots of a bird hazard at the aerodrome. The air traffic control (ATC) staff who were on duty that day stated that the bird activity was 'low', with no bird sightings reported. There were no indications of a bird strike on any part of the wreckage.

Helicopter operations were generally conducted to/from an area to the west of runway 14/32 that was designated 'the western grass area'. The boundary of that area was marked by blue gable markers. Western grass circuit procedures were specified in the ERSA. In addition, a letter of agreement between Airservices Australia (Airservices) and the aerodrome's helicopter operators further affected those operations, including the requirement that the 'Upwind and final legs of WG [western grass] circuits [were] to be flown parallel to runway 14/32 unless otherwise approved by ATC.'

³ For the purposes of providing aviation weather forecasts to pilots, Australia is subdivided into a number of forecast areas. Gold Coast Aerodrome was located in Area 40.

⁴ <http://www.ga.gov.au/geodesy/astro/smpos.jsp>

⁵ The clockwise horizontal angle from true north to the sun (or moon).

⁶ The vertical angle from an ideal horizon to the sun (or moon).

⁷ Runway 14 was oriented south-east, on a bearing of 139° magnetic.

The western grass was not a designated helicopter landing site, and separation was not required to be given by ATC between aircraft and/or obstructions on the ground while operating within the confines of the western grass.

A map of the required helicopter circuit pattern was displayed in the operator's training school as a teaching aid. The pilot's original instructor had been briefed by the operator on the circuit pattern, and reported passing that information on to the pilot as part of the pilot's training.

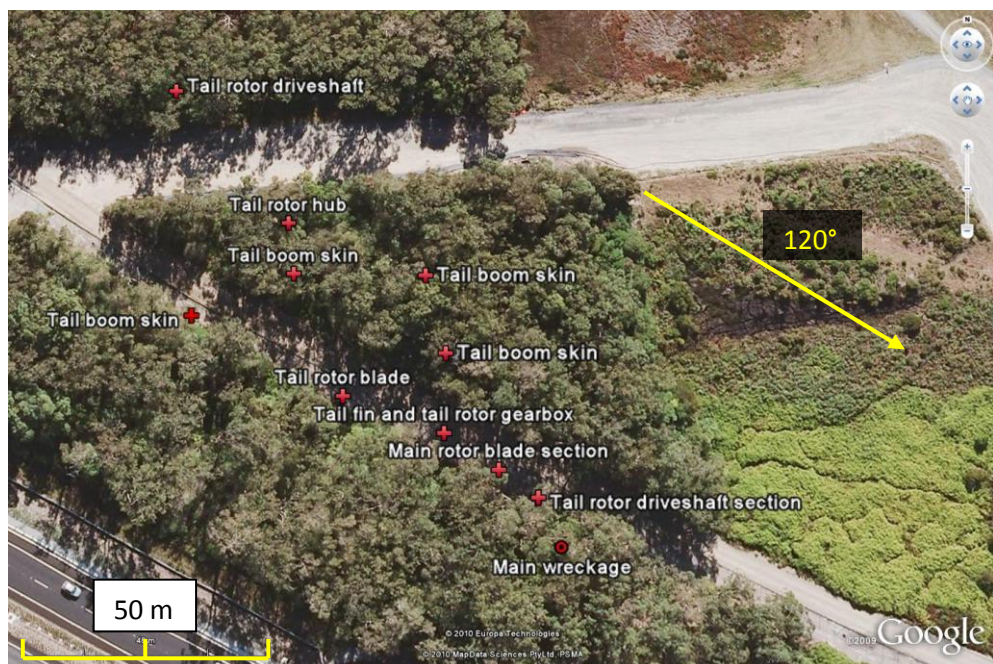
Aeroplane and helicopter traffic at the Gold Coast Aerodrome were subject to the wake turbulence⁸ separation standards as published in the Airservices Manual of Air Traffic Services.

Wreckage and impact information

Wreckage distribution

The wreckage of the helicopter was located about 240 m to the west of the runway 14 centreline (Figure 1). The wreckage, including pieces of the tail boom skin, tail rotor driveshaft and tail rotor, was dispersed in a heavily wooded area, over a distance of about 130 m (Figure 2). The approximate bearing of the wreckage trail was 120°. The helicopter came to rest facing back along the direction of flight, lying on an angle of about 30° to the right of vertical (Figure 3).

Figure 2: Wreckage site



After an extensive search along the wreckage trail and general area, all of the helicopter was accounted for at the accident site, with the exception of a 30 cm

⁸ Turbulence from wing tip vortices that result from the creation of lift. Those from large, heavy aircraft are very powerful and persistent, and are capable of causing control difficulties for smaller aircraft.

section of tail rotor driveshaft and about 30 cm of the outer portion of one of the tail rotor blades. The corresponding fracture surfaces on the remaining tail rotor driveshaft and tail rotor blade showed that those fractures were a result of impact overload.

Figure 3: Main wreckage



The wreckage was removed from the accident site and relocated to a secure hangar for detailed examination (Figure 4). The deformation of the cabin and skid landing gear was consistent with high vertical impact forces.

Figure 4: Wreckage recovery



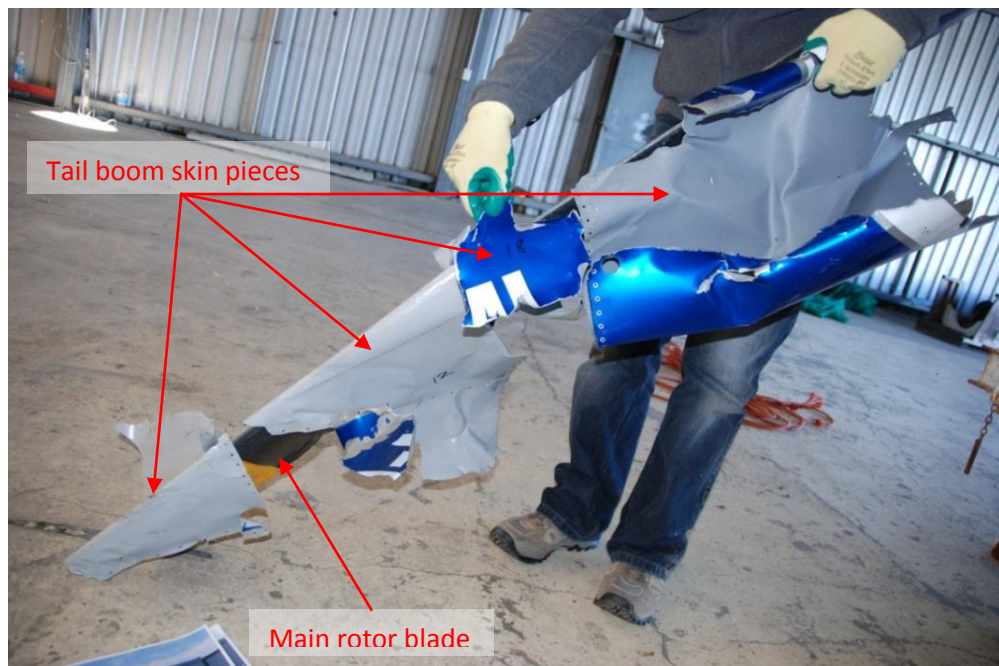
Tail boom assembly

The distribution of the tail boom assembly along the wreckage trail, and damage to the assembly was consistent with it having separated from the aircraft in flight. There was extensive deformation of the assembly (Figure 5), and evidence of paint transfer from the tail boom onto one of the main rotor blades. That blade aligned with the damaged tail boom (Figure 6).

Figure 5: 'Reconstructed' tail boom assembly

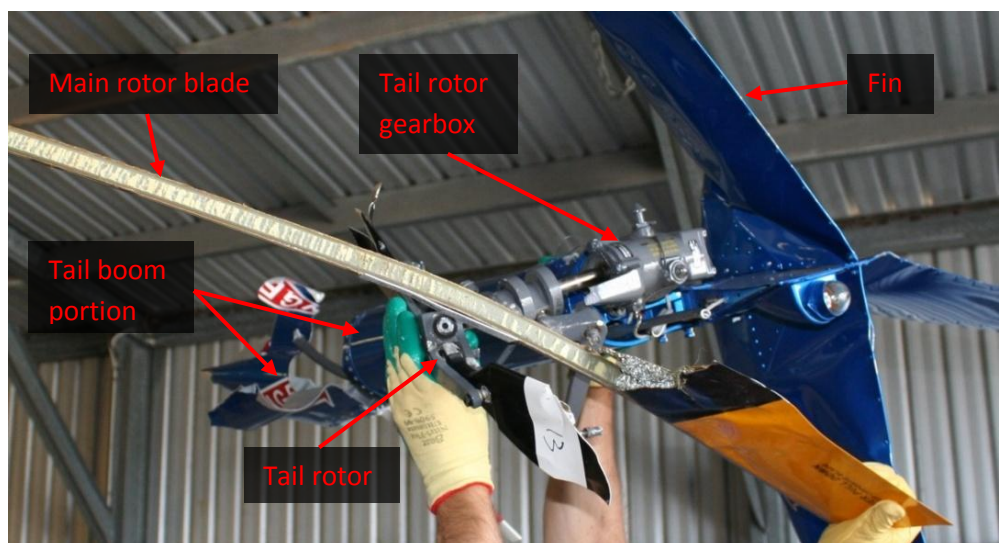


Figure 6: Tail boom assembly aligned with the affected main rotor blade



In addition, there were matching impact marks on one of the helicopter's main rotor blades and the tail rotor hub assembly (Figure 7).

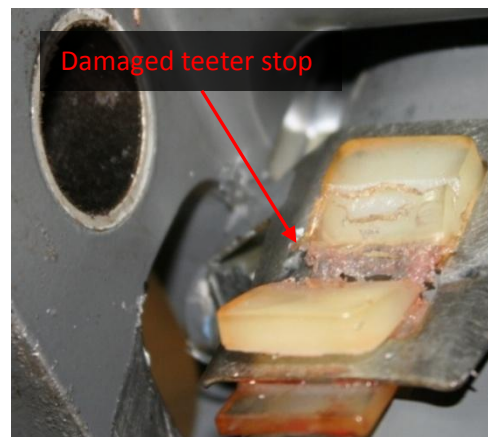
Figure 7: Main rotor blade to tail rotor hub contact



Main rotor and hub damage

Both main rotor blades were examined in detail and no pre-accident defects were identified. The main rotor blades were removed from the main rotor hub, which revealed severe deformation of the mast teeter stops (Figure 8).

Figure 8: Teeter stop damage



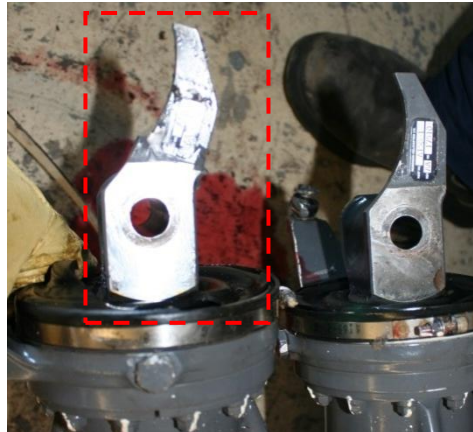
One main rotor blade displayed chord-wise creasing and paint transfer from the tail boom. The droop tusk on that main rotor blade was intact, with no distortion.

The other main rotor blade displayed signs of impact damage. There was a dent in the leading edge of the main rotor blade and the tip of the blade was bent forward (Figure 9). In addition, sections of the main rotor blade fairing had separated from the spar. The droop tusk on this main rotor blade was bent down (Figure 10).

Figure 9: Main rotor blade, displaying forward bending and missing fairing



Figure 10: Bent droop tusk (highlighted)

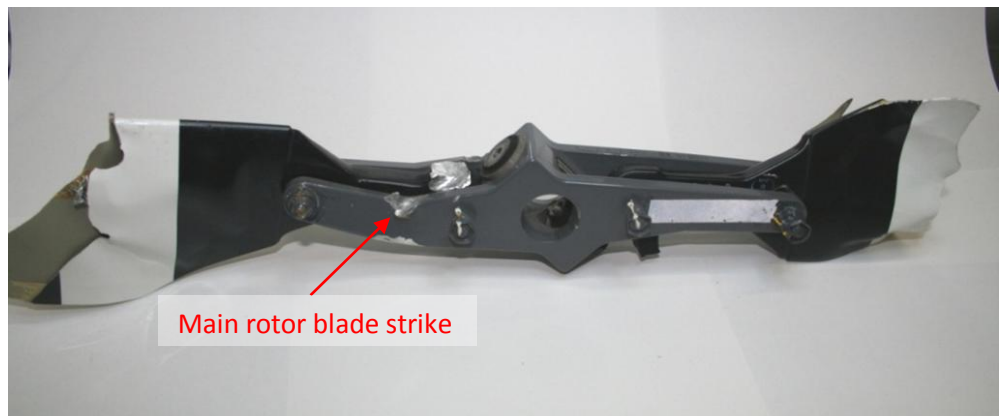


Tail rotor damage

The tail rotor hub showed damage consistent with a main rotor strike (Figure 11).

Specialist metallurgical examination of the tail rotor showed no evidence of any pre-existing defects, fatigue cracking, corrosion or other mechanical deficiencies that may have predisposed the assembly to premature failure.

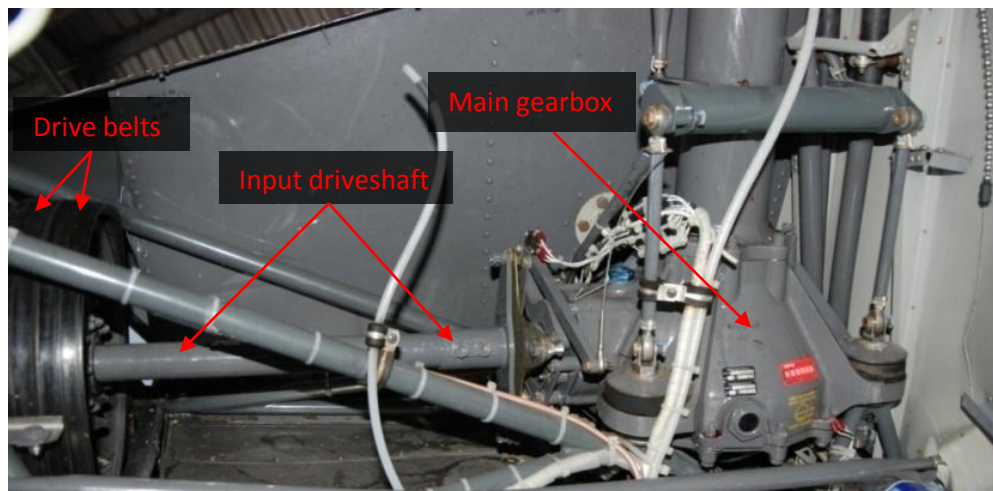
Figure 11: Tail rotor hub showing main rotor strike



Drive train

The continuity of the drive train was confirmed, with no pre-impact defects noted (Figure 12). When the helicopter was placed in the upright position, the main rotor was free to turn, and the input driveshaft turned in unison with the main rotor. That confirmed the continuity of the main rotor drive system.

Figure 12: Main rotor driveshaft and gearbox



Examination of the main and tail rotor drive systems did not reveal any condition that would have precluded their normal operation. The torsional damage to the tail rotor driveshaft was indicative of significant rotational energy when it was severed (Figure 13).

Figure 13: Tail rotor driveshaft with torsion damage



Flight controls

Examination of the flight controls did not reveal any condition that would have precluded normal operation.

Engine

The engine was inspected on site before being removed and taken to an engine overhaul facility where it was disassembled and inspected under the supervision of the Australian Transport Safety Bureau (ATSB). No pre-impact defects were identified during that inspection that would have precluded the normal operation of the engine.

The helicopter was fitted with a carburettor heat assist system to minimise the risk of carburettor icing. When activated, carburettor heat assist applied an appropriate

amount of hot air to the carburettor intake, depending on power demands. The system could be locked in the OFF position or unlocked to automatically vary the amount of hot air with varying power demands. The system was found in the automatic setting. The flying school advised that students were instructed to use the system on every flight in accordance with the Robinson R22 Pilot's Operating Handbook (POH).

Fuel

The helicopter was fitted with two fuel tanks. Both tanks' fill point caps were found attached and, although the left tank had been ruptured, a quantity of fuel remained in both tanks. No water or contaminants were noted in the tanks and the basic colour and smell of the remaining fuel indicated that the fuel was the correct type. There was a strong smell of fuel at the accident site.

The cockpit fuel selector was in the ON position. According to the aircraft's fuel record, there was a total of 65 L of fuel on board when the aircraft departed for the training flight. It was estimated that about 4 L of fuel would have been consumed during the first circuit, leaving about 60 L on board at the time of the accident.

The fuel used on the day came from the operator's fuel stock. Another of the operator's aircraft used the same fuel stock that day with no operational difficulties reported.

Medical and pathological information

The pilot's postmortem found no evidence of any medical condition that may have affected the pilot's performance. Toxicological testing for drugs and alcohol was negative.

Wake turbulence

The recorded radar data was reviewed for any medium and heavy jet departures and arrivals at the time of the occurrence. Jet aircraft activity was minimal, with an Airbus A320 aircraft landing on runway 14 about 1 minute before the R22 took off from the western grass.

Helicopter instructors that operated from the western grass area at various times had not encountered wake turbulence in that area.

The instructor in the 172 that took off shortly after the helicopter did not encounter wake turbulence.

Organisational and management information

The pilot's original instructor obtained his pilot's licence and instructor rating based on the instructor's New Zealand qualifications, and in accordance with the *Trans Tasman Mutual Recognition Act 1997*.

The induction process at the flying school was formalised and tracked by the completion of a flight crew administration induction checklist. A review of the original instructor's induction checklist confirmed the instructor's identification,

licence, medical status, log book details and various qualifications. Of note, the 'valid to' date for the instructor's medical certificate was not endorsed and there was no checklist item for an instructor rating and its validity period.

Civil Aviation Order 40.3.2 required a Grade 2 instructor rating to be renewed 1 year after the initial issue of the rating, and then on a biennial basis. All renewals were to be carried out by CASA or by an approved testing officer. In addition, instructors other than a school's CFI were required to undertake a standardisation and proficiency flight check with the CFI in the previous 12 months, before carrying out instructional duties. That requirement was included in the flying school's induction process.

A standardisation and proficiency flight check with the flying school's Chief Flying Instructor (CFI) was completed by the pilot's original instructor on 21 May 2009. Although recorded in the instructor's logbook, it had not been certified by the CFI as required by CAO 40.3.7 paragraph 11.7.

The pilot's original instructor reported that he believed that his standardisation and proficiency flight check that was carried out on 14 October 2008 satisfied the requirement for the renewal of his instructor rating, and was unaware of its expiration. The instructor was unfamiliar with the process and requirements for the renewal of an instructor rating.

Helicopter pilot training in Australia

From January 1993, the standards for helicopter pilot licence training were promulgated in the *Day VFR Syllabus – Helicopters* that was produced by CASA. Since 2002, the syllabus has been changed to present flying standards in a competency based format, and to introduce human factors and threat and error management standards.

A review of the version of the *Day VFR Syllabus – Helicopters* that was current at the time of writing this report found that, in regard to the recognition and management of threats, the unit *Threat and Error Management – Flight Standard*, stated:

- identifies relevant environmental or operational threats that are likely to affect the safety of the flight

and, in regard to the recognition and management of errors:

- applies checklists and standard operating procedures to prevent aircraft handling, procedural or communication errors; and identifies committed errors before safety is affected or aircraft enters an undesired aircraft state.

There was no specific reference to the risks associated with pilots' conversion from flying aeroplanes to flying helicopters, or of overcontrol.

There was no specific discussion in the *Day VFR Syllabus – Helicopters* of the risks associated with a pilot's transition from flying an aeroplane to flying a helicopter. In addition, Civil Aviation Regulation 5.93 allowed for a reduction in the minimum aeronautical experience requirements towards a private pilot (helicopter) licence when the person already held an aeroplane pilot licence. That reduction in hours was only applicable to the cross-country flight time. The minimum general flying

hours remained the same, affording the student the same aircraft basic handling exposure, regardless of their previous flying experience.

Additional information

The R22 was designed in 1973 and has been in production since 1979. The Robinson Helicopter Company also produces the R44, which is a four-place helicopter based on the R22 and with similar characteristics.

Due to relatively low acquisition and operating costs, the R22 has been used extensively as a primary rotorcraft trainer around the world. According to CASA's Civil Aircraft Register (as of 7 October 2009) there were a total of 828 Robinson helicopters on the Australian register. This comprised of 452 R22 and 376 R44 model helicopters. Not all of those helicopters were involved in flying training.

On 19 June 2004, the ATSB published research paper BE04/73 – *Light Utility Helicopter Safety in Australia*.⁹ That report found that, in terms of the accident rate per hours flown in the period 1990 to 2002, the R22:

- was as safe, if not safer, than other similar helicopter models
- had the lowest accident rate, and second lowest fatal accident rate.

Aircraft handling

The R22 has a very low inertia rotor system and is highly responsive in pitch and roll with only small control inputs required by the pilot. There is no hydraulic assistance. A number of R22 pilots have reported that the flight controls on the R22 are more sensitive than in other light helicopters.¹⁰

In 1984, a US Federal Aviation Administration (FAA) helicopter test pilot reported that the reaction of the R22 per inch (25 mm) of control input was high, making pilot-induced oscillations and overcontrolling tendencies much more noticeable than in other helicopters. Further, an FAA special certification review in 1994 stated that the R22 helicopter was very sensitive, requiring the pilot to be attentive at all times.

US investigation of R22 loss of main rotor control accidents

On 2 April 1996, the US National Transportation Safety Board (NTSB) released a special investigation report, *Robinson Helicopter Company R22 Loss of Main Rotor Control Accidents*, following several similar R22 and R44 loss of main rotor control accidents in which the NTSB had difficulty determining a cause. The NTSB report highlighted that the R22 is highly responsive to small flight control inputs in pitch and roll.

In its report, the NTSB reviewed 31 R22 and two R44 accidents from 1981 to 1995, in which the main rotor blade diverged from its normal path and struck the helicopter. This review included two accidents that occurred in Australia in 1992

⁹ http://www.atsb.gov.au/media/36750/Light_utility_helico.pdf

¹⁰ NTSB/SIR-96/03

and 1995 (VH-HBK¹¹ and VH-BEI¹²). The following characteristics were common to all of the accidents examined:

- an in-flight breakup or main rotor blade contact with the airframe occurred before any collision with an object or terrain
- there was no evidence of damage to the airframe or engine that pre-existed the accident
- flight into adverse weather was not a factor
- pilot impairment from drugs or alcohol was not implicated.

The NTSB found that, when compared with other helicopters at that time, the R22 was involved in the most loss of control, non-loss of control and total fatal accidents per flight hour. In fact, per 100,000 flight hours the R22 fatal loss of control accident rate was more than three times higher than the other helicopter types examined. The NTSB report identified that the pilot in command at the time of each accident examined had a median flight time of:

- 127.5 hours in the R22
- 180 hours in all helicopters
- 790 hours in all aircraft.

The NTSB report also referred to a study that was conducted by the Georgia Tech School of Aerospace Engineering to develop a computer-based simulation of the R22, including of its rotor system dynamics. The results of that study suggested that multiple large and abrupt control inputs could lead directly to mast bumping¹³ or to high main rotor blade angles of attack, either of which could lead to a loss of main rotor control. A loss of main rotor control can rapidly increase main rotor blade flapping¹⁴ from acceptable to excessive angles in only one or two rotor revolutions. In this case, a pilot is left little response time to correct the situation. In an R22, where the main rotor blades operate at about 530 RPM, it would take less than 0.5 seconds for the rotor to diverge from the normal plane of rotation to strike the fuselage of the helicopter.

¹¹ http://www.atsb.gov.au/publications/investigation_reports/1992/aair/aair199202579.aspx

¹² http://www.atsb.gov.au/publications/investigation_reports/1995/aair/aair199502225.aspx

¹³ Generally a result of pilot technique, the phenomenon occurs when the helicopter's main rotor hub is allowed to make contact with, and deform the main rotor mast.

¹⁴ The angular oscillation, or rise and fall of the main rotor blade about its horizontal pivot point.

In conclusion the report stated:

The Safety Board recognizes that all of the loss of control accidents may not have resulted from a single scenario. Some may have involved low rotor rpm leading to blade stall and some may have involved turbulence. The high responsiveness of the helicopter to flight control input combined with possible lack of pilot skills, knowledge, proficiency, or alertness could also offer possible explanations for some of the subject accidents. Further, because of the high responsiveness of the R22 to cyclic input and the rapidness with which the rotor blade could diverge and strike the fuselage, it is possible that diversion of attention to tasks such as retrieving charts, tuning radios, or turning to look at something could result in a control input and subsequent change in aircraft attitude that requires corrective action which even an experienced pilot may have inadvertently respond with a large, abrupt movement of the cyclic control.

US action in response to R22 loss of main rotor control accidents

In 1994, the FAA published a special airworthiness alert that cautioned R22 pilots to avoid abrupt cyclic inputs and to reduce manoeuvring speeds to the extent possible. On 15 February 1995, the FAA issued a flight standardization board (FSB) report for the R22 and R44 helicopters. The FSB report recommended stringent requirements for all future training in the R22 and R44. On 23 February 1995, the FAA issued Special Federal Aviation Regulation (SFAR) 73 (Appendix A). The SFAR altered the normal helicopter biennial flight review requirements in the US by requiring: R22 and R44 pilots to perform proficiency reviews as appropriate; an increase in the amount of dual training required before a pilot may receive their private pilot helicopter certificate; and the mandating of special awareness training that was specific to the R22 and R44 helicopters.

In the period between the issue of SFAR 73 and the publication of the NTSB loss of main rotor control report, there were no in-flight rotor/fuselage contacts involving R22 helicopters in the US. The NTSB recommended that SFAR 73, the FSB specifications and ADs applicable to the operation of R22 and R44 helicopters be made permanent. The FAA extended the expiration date of SFAR 73 a number of times, before making it permanent on 26 May 2009 by issuing SFAR 73-2. SFAR 73-2 will remain in effect in the US until it is revised or rescinded.

In February 1996, the Civil Aviation Authority of New Zealand (NZCAA) adapted a number of the requirements of SFAR 73 to the New Zealand context by issuing airworthiness directive (AD) DCA/R22/27. The AD introduced an amendment to the R22 POH limitations section, in respect of the necessary pilot experience on the type.

There were no Robinson helicopter-specific training requirements in Australia. However, CASA has already announced safety action in response to ATSB investigation report AO-2008-062, the investigation into the collision with terrain that occurred 6 km north-east of Purnululu Aircraft Landing Area, Western Australia on 14 September 2008 and involved an R44 helicopter.¹⁵ That safety action included the review of the requirements for endorsement and recurrent training on R22/R44 helicopters.

¹⁵ Available at www.atsb.gov.au

In addition to the US regulatory requirements, the Robinson Helicopter Company has issued a number of safety notices in relation to the operation of R22 and R44 helicopters (Appendix B). Those safety notices include:

- SN – 10 – *Fatal accidents caused by low RPM rotor stall* and SN - 24 - *Low rotor RPM stall can be fatal*. Those safety notices related to the risk in R22 and R44 helicopters of a pilot allowing the main rotor RPM to critically reduce, to the extent that the situation may be unrecoverable.
- SN – 11 – *Low-g pushovers – extremely dangerous*. This safety notice examined the risk of low or negative g in R22 and R44 helicopters, and the potential for pilots in such circumstances to sever the helicopter's main rotor mast and/or tail boom.
- SN – 20 – *Beware of demonstration or initial training flights* and SN - 29 - *Airplane pilots high risk when flying helicopters*. Those safety notices related to the risk of inappropriate control inputs in helicopters by inexperienced or non-pilots, and by experienced aeroplane pilots having little experience in helicopters.

Main rotor stall

Main rotor stall was highlighted in the NTSB report *Robinson Helicopter Company R22 Loss of Main Rotor Control Accidents* as a possible factor in a number of the loss of control accidents examined. A number of ATSB investigation reports have also identified main rotor stall as a factor, including investigation 200600979 and, more recently, investigation AO-2008-062 (both available at www.atsb.gov.au).

If a pilot does not respond quickly and appropriately to a developing low rotor RPM situation, the main rotor RPM will continue decreasing with the coning of the blades,¹⁶ and an associated loss of lift. The result can be an accelerating rate of descent. Any application of collective¹⁷ to arrest the descent further reduces rotor RPM. The situation can rapidly deteriorate into a vicious cycle that culminates in the rotor blades effectively stalling and losing all lift. Once the blades are aerodynamically stalled, in-flight recovery is almost impossible.

Aeroplane-to-helicopter pilot conversion

When a pilot is experienced in aeroplane operations, the necessary skills are highly automated and do not require conscious thought. While learning to fly a helicopter, the helicopter-specific skills are still being learnt and may not be automatic. In situations where the pilot is required to react suddenly to an unexpected stimulus, it is possible that the pilot will revert to previously-automated behaviours for an aeroplane, which may not be appropriate to helicopters and result in unintended outcomes.

Safety Notice - 29 discussed a number of the differences in the necessary skills to fly an aeroplane and a helicopter, including when a pilot wants to commence a descent. In an aeroplane, the pilot only needs to push the control stick forward. In a

¹⁶ The coning angle is the angle between the longitudinal axis of a lifting rotor blade and its tip path plane or plane of rotation (assuming no blade bending).

¹⁷ Pilot control in helicopters that simultaneously affects the pitch of all blades of a lifting rotor. Main control for vertical velocity.

helicopter, the pilot must lower the collective with very little movement of the cyclic stick.¹⁸ In an R22, a rapid forward movement of the cyclic could result in a low-g¹⁹ condition, which could cause mast bumping and a subsequent tail boom strike.

¹⁸ A primary helicopter flight control that is similar to an aeroplane control column. Cyclic input tilts the main rotor disc varying the attitude of the helicopter.

¹⁹ 1 g is the nominal value for vertical acceleration that is recorded when the aircraft is on the ground. In flight, vertical acceleration values represent the combined effects of flight manoeuvring loads and turbulence.

ANALYSIS

Introduction

There was no evidence that pilot impairment or incapacitation was a factor. The satisfactory completion by the pilot of the previous circuit would suggest that he was probably wearing the necessary distance vision correction at that time. The inability to locate the pilot's spectacles was most probably a function of the violent nature of the descent to the ground and ground impact, and the spectacles being thrown from the aircraft.

The benign weather and observed light and variable wind at the time did not explain the pilot's convergence with the runway. Similarly, the lack of weather-related or wake turbulence meant that the ambient conditions should not have affected the pilot's ability to control the helicopter. The position of the sun suggested that it was not a factor, and that any shadow from the following C172 would not have impacted on the flight.

The completion of the previous circuit without any suggestion of carburettor icing having effect, suggested that it was likely the student complied with the operator's requirement to use the automatic carburettor heat system for each flight. On that basis, and given the climb power presumably set immediately prior to the occurrence and the as-found position of the carburettor heat assist selector, the investigation discounted carburettor icing as a factor in the occurrence.

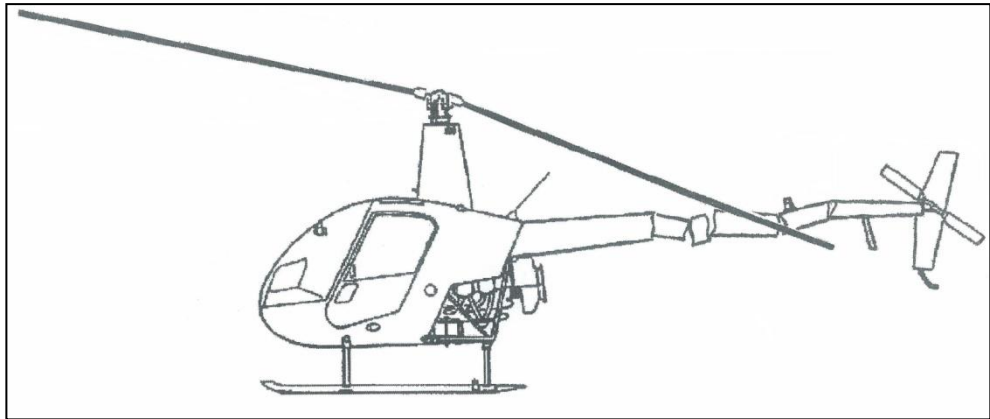
The physical and technical evidence was consistent, and showed no pre-existing mechanical defect associated with the airframe or engine with the potential to have contributed to the accident. There was no evidence that the amount or quality of the fuel on board was a factor.

In the absence of any evidence that a birdstrike or other external distraction might have lead to the accident, this analysis will review the physical evidence, and discuss a number of operational scenarios that could have precipitated the accident.

Wreckage examination

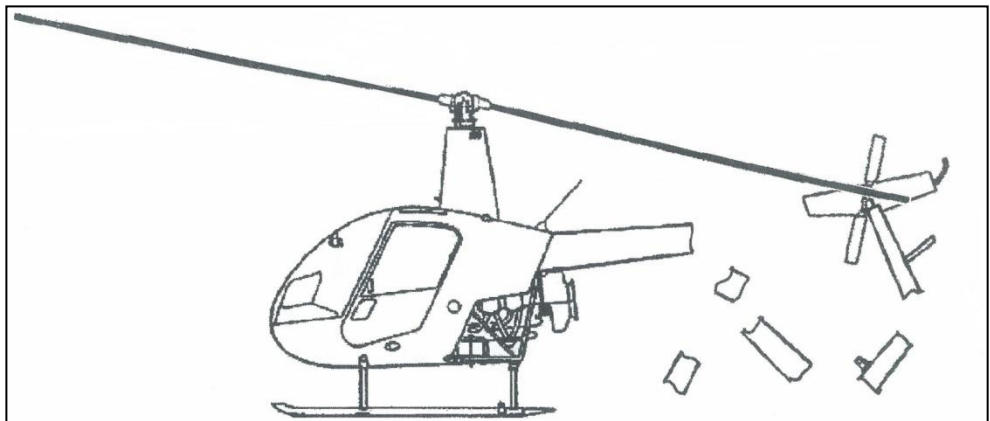
The impact damage to the tail boom and the tail rotor hub indicated that the main rotor blades struck the tail twice before the helicopter impacted the ground. The first strike passed through and severed the mid section of the tail boom (Figure 14). That was consistent with the fracture surfaces of the tail rotor driveshaft, which were due to impact with the main rotor blades, and not a result of an in-flight failure.

Figure 14: First strike²⁰



The dimension of the main rotor blades and their position relative to the tail rotor meant that the second strike can only have occurred after the severed section of the boom and tail rotor assembly had separated from the helicopter (Figure 15). The dual strike was consistent with the likely normal main rotor RPM at that time, and with the rapid movement of the now-detached tail rotor assembly into the path of the main rotor.

Figure 15: Subsequent strike²⁰



The damage to the helicopter would have rapidly decreased its forward speed. That would explain the almost vertical swath through the trees prior to ground impact, and the severe deformation to the helicopter's main structure as a result of the high vertical velocity at impact.

Operational aspects

The operational factors with the potential to have contributed to the main rotor impact with the tail boom include main rotor stall, a low-g pushover manoeuvre, over or mal control by the pilot, or a combination of those factors.

²⁰ Main rotor blade and head and other component positions are for illustrative purposes only.

Main rotor stall

The stable climb configuration immediately prior to the accident lessened the likelihood that main rotor stall was a factor. In addition, although there was severe deformation of the mast teeter stops consistent with mast bumping, the damage to the main rotors did not indicate low main rotor RPM. On that basis, main rotor stall leading to severing of the tail boom was discounted.

Low-g pushover

There was no indication by the witnesses of a rapid pull up in the climb by the pilot that might have contributed to low or negative g. However, the reported rolling motion that progressed into an exaggerated rolling and pitching movement, could have resulted in low or negative g. Although there was severe deformation of the mast teeter stops, and main rotor impact with the tail boom, the main rotor mast was not severed, and there were no reports of a rapid roll to the right that would have indicated a low-g pushover manoeuvre by the pilot.

Pilot over or mal control

The relative positions of the 172 and helicopter made it unlikely that the pilot of the helicopter saw the 172. However, it could be expected that the pilot was aware of the 172 as a result of the pre-take-off radio transmissions between air traffic control and the 172.

Aeroplane and helicopter pilots employ similar techniques in order to track parallel to runways and to not impact on other aerodrome users. In that light, and given the light and variable wind at the time, the investigation was unable to explain the experienced aeroplane pilot's convergence with the runway prior to the accident.

However, the investigation could not discount that the pilot, on recognising his proximity to the runway, and the implications for his separation from the 172, quickly amended his climb to remain below the 172 and changed direction to clear the runway. Consistent with the warning at Robinson Helicopter Company Safety Notice – 29 (SN – 29) *Airplane pilots high risk when flying helicopters*, any perceived danger or pressure felt by the pilot to clear the runway could have caused the pilot to revert to his more automated aeroplane control techniques. Any forward movement of the cyclic, equivalent to the control input in an aeroplane to level off or to initiate a descent, had the potential to induce low or negative g in the helicopter. As highlighted in SN – 29, the possible effects of that over or mal control included mast bump and the main rotor blades impacting the helicopter.

Conclusion

In the absence of any evidence that main rotor stall or low-g manoeuvre had contributed to the development of the accident, it was concluded that over or mal control by the experienced aeroplane pilot was the most likely precursor to the accident. While there was insufficient evidence to establish the specific type of that over or mal control, the adoption in Australia of relevant elements of Federal Aviation Administration Special Federal Aviation Regulation 73-2 has the potential to reduce the risk of over control in future R22 and R44 operations.

Original instructor's expired instructor rating

The reason for the original instructor's expired rating not being identified was that the flying school's induction process did not explicitly check and record that information. Any risk that the standard of instruction provided by the unrated original instructor had contributed to the accident was mitigated by the pilot's pre-solo assessment flight being carried out by an independent, rated instructor.

FINDINGS

From the evidence available, the following findings are made with respect to the collision with terrain that occurred at Gold Coast Aerodrome, Queensland on 2 July 2009, and involved Robinson R22 Beta II helicopter, registered VH-OML, and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- Consistent with over or mal control by the pilot, the helicopter was observed to pitch, roll and yaw shortly before a component separated from the helicopter.

Other safety factors

- The pilot took off from the western grass and converged with the active runway and into a potential conflict with a departing light aircraft.
- The instructor's Grade 2 instructor rating expired 6 months prior to the accident.
- The helicopter operator's induction checklist did not include the notation of instructors' ratings and validity periods. *[Minor safety issue]*
- There were no specific training requirements for Robinson helicopters in Australia, such as those in Federal Aviation Administration Special Federal Aviation Regulation 73-2. *[Minor safety issue]*

Other key findings

- There was no pre-existing mechanical defect associated with the airframe or engine.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Civil Aviation Safety Authority

Robinson-specific helicopter training

Safety issue

There were no specific training requirements for Robinson helicopters in Australia, such as those in Federal Aviation Administration Special Federal Aviation Regulation 73-2.

Action taken by the Civil Aviation Safety Authority

The Civil Aviation Safety Authority (CASA) has advised that it will review the requirements for initial pilot training and endorsement and recurrent training on Robinson R22 helicopters. Included will be a review of the Helicopter Flight Instructor's Manual to ensure that the required competencies are being covered by flight instructors and trained to students.

ATSB assessment of response/action

The ATSB is satisfied that the action taken by CASA adequately addresses the safety issue.

Operator certification of rating validity

Helicopter operator

Safety issue

The helicopter operator's induction checklist did not include the notation of instructors' ratings and validity periods.

Action taken by the helicopter operator

As a result of this occurrence, the operator has advised of the adoption in its manuals of a:

- formal checklist requiring certification by either the Chief Flying Instructor or an approved Base Manager for each pilot inducted into the operator's system.
- time-limited validity period, which will trigger a revalidation process on procedures as well as an interim check flight.

ATSB assessment of response/action

The ATSB is satisfied that the action taken by the operator adequately addresses the safety issue.

Australian Transport Safety Bureau

Safety issue

The helicopter operator's induction checklist did not include the notation of instructors' ratings and validity periods.

Action taken by the ATSB

Unless operators actively track the qualifications, endorsements, ratings and recency of their staff, there is the risk that pilots and instructors may operate aircraft with invalid qualifications and not be at the specified competency standard required for the task. Pilots, including those who have gained their Australian ratings as part of the *Trans Tasman Mutual Recognition Act 1997*, need to be aware of the different requirements regarding rating renewals in Australia. A valid rating is an important measure of competency.

Operators need to be able to assure themselves that pilots' qualifications are valid, and their competence confirmed when allocating tasks. On that basis, the ATSB issues the following Safety Advisory Notice.

ATSB Safety Advisory Notice AO-2009-032-SAN-019

The Australian Transport Safety Bureau suggests that operators and pilots should consider the safety implications of this safety issue and take action where considered appropriate.

APPENDIX A: FEDERAL AVIATION ADMINISTRATION SPECIAL FEDERAL AVIATION REGULATION 73

The following information is a direct extract from Special Federal Aviation Regulation (SFAR) 73:

Applicability. Under the procedures prescribed herein, this SFAR applies to all persons who seek to manipulate the controls or act as pilot in command of a Robinson model R-22 or R-44 helicopter. The requirements stated in this SFAR are in addition to the current requirements of part 61.

2. Required training, aeronautical experience, endorsements, and flight review.

(a) Awareness Training:

(1) Except as provided in paragraph (a)(2) of this section, no person may manipulate the controls of a Robinson model R-22 or R-44 helicopter after March 27, 1995 for the purpose of flight unless the awareness training specified in paragraph (a)(3) of this section is completed and the person's logbook has been endorsed by a certified flight instructor authorized under paragraph (b)(5) of this section.

(2) A person who holds a rotorcraft category and helicopter class rating on their pilot certificate and meets the experience requirements of paragraph (b)(1) or (b)(2) of this section may not manipulate the controls of a Robinson model R-22 or R-44 helicopter for the purpose of flight after April 26, 1995 unless the awareness training specified in paragraph (a)(3) of this section is completed and the person's logbook has been endorsed by a certified flight instructor authorized under paragraph (b)(5) of this section.

(3) Awareness training must be conducted by a certified flight instructor who has been endorsed under paragraph (b)(5) of this section and consists of instruction in 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.

(4) A person who can show satisfactory completion of the manufacturer's safety course after January 1, 1994, may obtain an endorsement from an FAA aviation safety inspector in lieu of completing the awareness training required in paragraphs (a)(1) and (a)(2) of this section.

(b) Aeronautical Experience:

(1) No person may act as pilot in command of a Robinson model R-22 unless that person:

- (i) has had at least 200 flight hours in helicopters, at least 50 flight hours of which were in the Robinson R-22; or

(ii) has had at least 10 hours dual instruction in the Robinson R-22 and has received an endorsement from a certified flight instructor authorized under paragraph (b)(5) of this section that the individual has been given the training required by this paragraph and is proficient to act as pilot in command of an R-22. Beginning 12 calendar months after the date of the endorsement, the individual may not act as pilot in command unless the individual has completed a flight review in an R-22 within the preceding 12 calendar months and obtained an endorsement for that flight review. The dual instruction must include at least the following abnormal and emergency procedures flight training:

- (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 manoeuvres and proper recovery procedures.

(2) No person may act as pilot in command of a Robinson model R-44 unless that person:

(i) has had at least 200 flight hours in helicopters, at least 50 flight hours of which were in the Robinson R-44; or

(ii) has had at least 10 hours dual instruction in the Robinson R-44 and has received an endorsement from a certified flight instructor authorized under paragraph (b)(5) of this section that the individual has been given the training required by this paragraph and is proficient to act as pilot in command of an R-44. Beginning 12 calendar months after the date of the endorsement, the individual may not act as pilot in command unless the individual has completed a flight review in an R-44 within the preceding 12 calendar months and obtained an endorsement for that flight review. The dual instruction must include at least the following abnormal and emergency procedures flight training:

- (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 manoeuvres and proper recovery procedures.

(3) A person who does not hold a rotorcraft category and helicopter class rating must have had at least 20 hours of dual instruction in a Robinson R-22 helicopter prior to operating it in solo flight. In addition, the person must obtain an endorsement from a certified flight instructor authorized under paragraph (b)(5) of this section that instruction has been given in those manoeuvres and procedures, and the instructor has found the applicant proficient to solo a Robinson R-22. This endorsement is valid for a period of 90 days. 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 manoeuvres and proper recovery procedures.

(4) A person who does not hold a rotorcraft category and helicopter class rating must have had at least 20 hours of dual instruction in a Robinson R-44 helicopter prior to operating it in solo flight. In addition, the person must obtain an endorsement from a certified flight instructor authorized under paragraph (b)(5) of this section that instruction has been given in those manoeuvres and procedures, and the instructor has found the applicant proficient to solo a Robinson R-44. This endorsement is valid for a period of 90 days. 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 manoeuvres and proper recovery procedures.

(5) No certificated flight instructor may provide instruction or conduct a flight review in a Robinson model R-22 or R-44 unless that instructor:

- (i) Completes the awareness training in paragraph 2(a) of this SFAR,
- (ii) Meets the experience requirements of paragraphs 2(b)(1)(i) of this SFAR for the R-22, or 2(b)(2)(i) of this SFAR for the R-44,
- (iii) Has completed flight training in an R-22, R-44, 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 manoeuvres and proper recovery procedures.
- (iv) Been authorized by endorsement from an FAA aviation safety inspector or authorized designated examiner that the instructor has completed the appropriate training, meets the experience requirements and has satisfactorily demonstrated an ability to provide instruction on the general subject areas of paragraph 2(a)(3) of this SFAR, and the flight training identified in paragraph 2(b)(5)(iii) of this SFAR.

(c) Flight Review:

- (1) No flight review completed to satisfy Sec. 61.56 by an individual after becoming eligible to function as pilot in command in a Robinson R-22 helicopter shall be valid for the operation of R-22 helicopter unless that flight review was taken in an R-22.
- (2) No flight review completed to satisfy Sec. 61.56 by individual after becoming eligible to function as pilot in command in a Robinson R-44 helicopter shall be valid for the operation of R-44 helicopter unless that flight review was taken in the R-44.
- (3) The flight review will include a review of the awareness training subject areas of paragraph 2(a)(3) of this SFAR and the flight training identified in paragraph 2(b) of this SFAR.

(d) Currency Requirements: No person may act as pilot in command of a Robinson model R-22 or R-44 helicopter carrying passengers unless the pilot in command has met the recency of flight experience requirements of Sec. 61.57 in an R-22 or R-44, as appropriate.

3. Expiration date. This SFAR expires December 31, 1997, unless sooner superseded or rescinded.

APPENDIX B: HELICOPTER MANUFACTURER SAFETY NOTICES

Safety Notice SN-10

Issued: Oct 82 Rev: Feb 89; Jun 94

FATAL ACCIDENTS CAUSED BY LOW RPM ROTOR STALL

A primary cause of fatal accidents in light helicopters is failure to maintain rotor RPM. To avoid this, every pilot must have his reflexes conditioned so he will instantly add throttle and lower collective to maintain RPM in any emergency.

The R22 and R44 have demonstrated excellent crashworthiness as long as the pilot flies the aircraft all the way to the ground and executes a flare at the bottom to reduce his airspeed and rate of descent. Even when going down into rough terrain, trees, wires or water, he must force himself to lower the collective to maintain RPM until just before impact. The ship may roll over and be severely damaged, but the occupants have an excellent chance of walking away from it without injury.

Power available from the engine is directly proportional to RPM. If the RPM drops 10%, there is 10% less power. With less power, the helicopter will start to settle, and if the collective is raised to stop it from settling, the RPM will be pulled down even lower, causing the ship to settle even faster. If the pilot not only fails to lower collective, but instead pulls up on the collective to keep the ship from going down, the rotor will stall almost immediately. When it stalls, the blades will either "blow back" and cut off the tailcone or it will just stop flying, allowing the helicopter to fall at an extreme rate. In either case, the resulting crash is likely to be fatal.

No matter what causes the low rotor RPM, the pilot must first roll on throttle and lower the collective simultaneously to recover RPM before investigating the problem. It must be a conditioned reflex. In forward flight, applying aft cyclic to bleed off airspeed will also help recover lost RPM.

Safety Notice SN-11

Issued: Oct 82 Rev: Nov 00

LOW-G PUSHOVERS - EXTREMELY 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.

NEVER PERFORM A LOW-G PUSHOVER!!

Safety Notice SN-20

Issued: Sep 85 Rev: Jun 94

BEWARE OF DEMONSTRATION OR INITIAL TRAINING FLIGHTS

A disproportionate number of fatal and non-fatal accidents occur during demonstration or initial training flights. The accidents occur because individuals other than the pilot are allowed to manipulate the controls without being properly prepared or indoctrinated.

If a student begins to lose control of the aircraft, an experienced flight instructor can easily regain control provided the student does not make any large or abrupt control movements. If, however, the student becomes momentarily confused and makes a sudden large control input in the wrong direction, even the most experienced instructor may not be able to recover control. Instructors are usually prepared to handle the situation where the student loses control and does nothing, but they are seldom prepared for the student who loses control and does the wrong thing.

Before allowing someone to touch the controls of the aircraft, they must be thoroughly indoctrinated concerning the extreme sensitivity of the controls in a light helicopter. They must be firmly instructed to never make a large or sudden movement with the controls. And, the pilot-in-command must be prepared to instantly grip the controls should the student start to make a wrong move.

Safety Notice SN-24

Issued: Sep 86 Rev: Jun 94

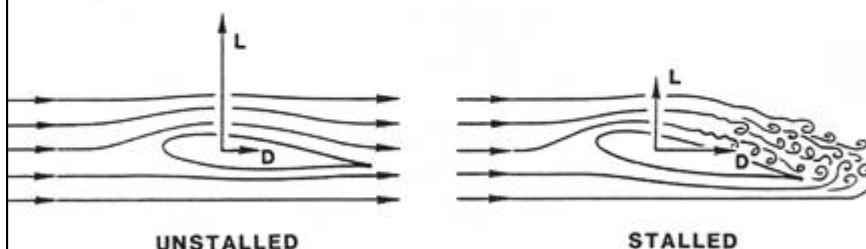
LOW RPM ROTOR STALL CAN BE FATAL

Rotor stall due to low RPM causes a very high percentage of helicopter accidents, both fatal and non-fatal. Frequently misunderstood, rotor stall is not to be confused with retreating tip stall which occurs only at high forward speeds when stall occurs over a small portion of the retreating blade tip. Retreating tip stall causes vibration and control problems, but the rotor is still very capable of providing sufficient lift to support the weight of the helicopter.

Rotor stall, on the other hand, can occur at any airspeed and when it does, the rotor stops producing the lift required to support the helicopter and the aircraft literally falls out of the sky. Fortunately, rotor stall accidents most often occur close to the ground during takeoff or landing and the helicopter falls only four or five feet. The helicopter is wrecked but the occupants survive. However, rotor stall also occurs at higher altitudes and when it happens at heights above 40 or 50 feet AGL it is most likely to be fatal.

Rotor stall is very similar to the stall of an airplane wing at low airspeeds. As the airspeed of an airplane gets lower, the nose-up angle, or angle-of-attack, of the wing must be higher for the wing to produce the lift required to support the weight of the airplane. At a critical angle (about 15 degrees), the airflow over the wing will separate and stall, causing a sudden loss of lift and a very large increase in drag. The airplane pilot recovers by lowering the nose of the airplane to reduce the wing angle-of-attack below stall and adds power to recover the lost airspeed.

The same thing happens during rotor stall with a helicopter except it occurs due to low rotor RPM instead of low airspeed. As the RPM of the rotor gets lower, the angle-of-attack of the rotor blades must be higher to generate the lift required to support the weight of the helicopter. Even if the collective is not raised by the pilot to provide the higher blade angle, the helicopter will start to descend until the



Wing or rotor blade unstalled and stalled.

Safety Notice SN-24 (continued)

upward movement of air to the rotor provides the necessary increase in blade angle-of-attack. As with the airplane wing, the blade airfoil will stall at a critical angle, resulting in a sudden loss of lift and a large increase in drag. The increased drag on the blades acts like a huge rotor brake causing the rotor RPM to rapidly decrease, further increasing the rotor stall. As the helicopter begins to fall, the upward rushing air continues to increase the angle-of-attack on the slowly rotating blades, making recovery virtually impossible, even with full down collective.

When the rotor stalls, it does not do so symmetrically because any forward airspeed of the helicopter will produce a higher airflow on the advancing blade than on the retreating blade. This causes the retreating blade to stall first, allowing it to dive as it goes aft while the advancing blade is still climbing as it goes forward. The resulting low aft blade and high forward blade become a rapid aft tilting of the rotor disc sometimes referred to as "rotor blow-back". Also, as the helicopter begins to fall, the upward flow of air under the tail surfaces tends to pitch the aircraft nose-down. These two effects, combined with aft cyclic by the pilot attempting to keep the nose from dropping, will frequently allow the rotor blades to blow back and chop off the tailboom as the stalled helicopter falls. Due to the magnitude of the forces involved and the flexibility of rotor blades, rotor teeter stops will not prevent the boom chop. The resulting boom chop, however, is academic, as the aircraft and its occupants are already doomed by the stalled rotor before the chop occurs.

Safety Notice SN-29

Issued: Mar 93 Rev: Jun 94

AIRPLANE PILOTS HIGH RISK WHEN FLYING HELICOPTERS

There have been a number of fatal accidents involving experienced pilots who have many hours in airplanes but with only limited experience flying helicopters.

The ingrained reactions of an experienced airplane pilot can be deadly when flying a helicopter. The airplane pilot may fly the helicopter well when doing normal maneuvers under ordinary conditions when there is time to think about the proper control response. But when required to react suddenly under unexpected circumstances, he may revert to his airplane reactions and commit a fatal error. Under those conditions, his hands and feet move purely by reaction without conscious thought. Those reactions may well be based on his greater experience, i.e., the reactions developed flying airplanes.

For example, in an airplane his reaction to a warning horn (stall) would be to immediately go forward with the stick and add power. In a helicopter, application of forward stick when the pilot hears a horn (low RPM) would drive the RPM even lower and could result in rotor stall, especially if he also "adds power" (up collective). In less than one second the pilot could stall his rotor, causing the helicopter to fall out of the sky.

Another example is the reaction necessary to make the aircraft go down. If the helicopter pilot must suddenly descend to avoid a bird or another aircraft, he rapidly lowers the collective with very little movement of the cyclic stick. In the same situation, the airplane pilot would push the stick forward to dive. A rapid forward movement of the helicopter cyclic stick under these conditions would result in a low "G" condition which could cause mast bumping, resulting in separation of the rotor shaft or one blade striking the fuselage. A similar situation exists when terminating a climb after a pull-up. The airplane pilot does it with forward stick. The helicopter pilot must use his collective or a very gradual, gentle application of forward cyclic.

To stay alive in the helicopter, the experienced airplane pilot must devote considerable time and effort to developing safe helicopter reactions. The helicopter reactions must be stronger and take precedence over the pilot's airplane reactions because everything happens faster in a helicopter. The pilot does not have time to realize he made the wrong move, think about it, and then correct it. It's too late; the rotor has already stalled or a blade has already struck the airframe and there is no chance of recovery. To develop safe helicopter reactions, the airplane pilot must practice each procedure over and over again with a competent instructor until his hands and feet will always make the right move without requiring conscious thought. **AND, ABOVE ALL, HE MUST NEVER ABRUPTLY PUSH THE CYCLIC STICK FORWARD.**

Also see Safety Notices SN-11 and SN-24.

APPENDIX C: SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

- the helicopter operator
- the maintainer of the helicopter
- the student pilot's instructor
- a number of witnesses at the Gold Coast Aerodrome
- the Bureau of Meteorology
- Airservices Australia (Airservices)
- the Civil Aviation Safety Authority (CASA)
- the United States Federal Aviation Administration and National Transportation Safety Board
- the helicopter manufacturer
- the NSW Police Force.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the aircraft operator and maintainer, the student pilot's instructor, the aerodrome operator, CASA and Airservices.

A submission was received from CASA. That submission was reviewed and where considered appropriate, the text of the report was amended accordingly.

Collision with terrain, Gold Coast Aerodrome, Queensland, 2 July 2009
VH-OMI, Robinson Helicopter Company R22 Beta II