CIVIL AVIATION AUTHORITY OF NEW ZEALAND

# AIRCRAFT ACCIDENT REPORT

## CAA OCCURRENCE NUMBER 10/3987

## ROBINSON R22 BETA

## ZK-HIP

## LOSS OF ROTOR RPM

## BLUFF HARBOUR

## 14 OCTOBER 2010

# Foreword

As a signatory to the Convention on International Civil Aviation 1944 (the Chicago Convention) New Zealand has international obligations in respect of the investigation of accidents and incidents. Pursuant to Articles 26 and 37 of the Chicago Convention, the International Civil Aviation Organisation (ICAO) issued Annex 13 to the Convention setting out International Standards and Recommended Practices in respect of the investigation of aircraft accidents and incidents.

New Zealand's international obligations are reflected in the Civil Aviation Act 1990 (the Act) and the Transport Accident Investigation Commission Act 1990 (the TAIC Act).

Section 72B(2)(d) and (e) of the Civil Aviation Act 1990 Act also provides:

> **72B Functions of Authority**
>
> (2) The Authority has the following functions:
>
> (d) To investigate and review civil aviation accidents and incidents in its capacity as the responsible safety and security authority, subject to the limitations set out in section 14(3) of the Transport Accident Investigation Commission Act 1990:
>
> (e) To notify the Transport Accident Investigation Commission in accordance with section 27 of this Act of accidents and incidents notified to the Authority:

Following notification to the Transport Accident Investigation Commission (the Commission) of any accident or incident which is notified to the Authority, an investigation may be conducted by the Commission in accordance with the TAIC Act. Civil Aviation Authority (CAA) may also investigate subject to the requirements of the TAIC Act.

The purpose of an investigation by the Commission is to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future, rather than to ascribe blame to any person.

CAA however investigates aviation accidents and incidents for a range of purposes under the Act. Investigations are primarily conducted for the purpose of preventing future accidents by determining the contributing factors or causes and then implementing appropriate preventive measures - in other words to restore safety margins to provide an acceptable level of risk. The focus of CAA safety investigations is therefore to establish the causes of the accident on the balance of probability.

Accident investigations do not always identify one dominant or 'proximate' cause. Often, an aviation accident is the last event in a chain of several events or factors, each of which may contribute to a greater or lesser degree, to the final outcome.

CAA investigations may also inform other regulatory-safety decision making or enforcement action by the Director.

In the case of a fatal aviation accident, the final CAA investigation report will generally be highly relevant to an inquiry, and in some circumstances, an inquest, conducted by a Coroner. CAA investigations are not however done for, or on behalf of a Coroner.

# Contents

## Glossary of Abbreviations:

| | |
|---|---|
| C | Celsius |
| CPL(H) | Commercial Pilot Licence (Helicopter) |
| E | east |
| FAA | Federal Aviation Administration |
| G | gravity |
| hPa | hectopascals |
| MHz | megahertz |
| NZDT | New Zealand Daylight Time |
| PPL(H) | Private Pilot Licence (Helicopter) |
| RPM | revolutions per minute |
| RPL | Recreational Pilot Licence |
| S | south |
| UTC | Coordinated Universal Time |
| WGS | World Geodetic System |

# DATA SUMMARY

## CAA OCCURRENCE No. 10/3987

| | |
|---|---|
| **Aircraft type, serial number and registration:** | Robinson R22 Beta, s/n 1804, ZK-HIP |
| **Number and type of engines:** | One, Lycoming O-320-B2C |
| **Year of manufacture:** | 1991 |
| **Date and time of accident:** | 14 October 2010, 1300 hours[1] (approximately) |
| **Location:** | Bluff Harbour<br>Latitude[2]: S 46° 33.5'<br>Longitude: E 168° 20.6' |
| **Type of flight:** | Training |
| **Persons on board:** | Crew: 2 |
| **Injuries:** | Crew: 2 Fatal |
| **Nature of damage:** | Aircraft destroyed |
| **Pilot-in-command's licence** | Commercial Pilot Licence (Helicopter) |
| **Pilot-in-command's age** | 29 years |
| **Pilot-in-command's total flying experience:** | 2856 hours,<br>1450 hours on type |
| **Information sources:** | Civil Aviation Authority Field Investigation |
| **Investigator in Charge:** | Mr S Walker |

[1] All times in this report are NZDT (UTC + 13 hours) unless otherwise specified.

[2] WGS-84 co-ordinates.

## Synopsis

The Civil Aviation Authority (CAA) was notified of a missing helicopter at 1620 hours on 14 October 2010. The instructor and student pilot were on a dual training exercise in the vicinity of Bluff Harbour. The helicopter was last seen to be carrying out climbing and descending manoeuvres. When the instructor failed to arrive at a prearranged meeting that afternoon the emergency services were contacted and a search was commenced. The helicopter was located the next day submerged in Bluff Harbour. Both occupants were found to be deceased. The Transport Accident Investigation Commission was notified shortly thereafter, but declined to investigate. A CAA Field Investigation was commenced later the same day.

# 1. Factual Information

### 1.1 History of the flight

1.1.1 The student pilot was the owner of the helicopter. On the morning of the day of the accident he flew the helicopter from his farm base at Winton to Invercargill Aerodrome, to meet the instructor and commence a training flight.

1.1.2 Both occupants then flew to a known hover training area adjacent to Heenan Road situated approximately 5 kilometres away, remaining within the Invercargill Aerodrome Control Zone. At 1245 hours, one of the occupants notified the Invercargill Control Tower that they were vacating the Control Zone.

1.1.3 The helicopter was observed by witnesses to repeatedly descend to low level over the coast of Bluff Harbour and then climb away.

1.1.4 Invercargill Control Tower attempted to contact ZK-HIP at 1312 hours to advise traffic information, with no response received. A further attempt was made 30 seconds later, again with no response.

1.1.5 After the helicopter failed to return, an aerial and land based search was commenced. The helicopter was found the following day submerged in approximately one metre of tidal water in Bluff Harbour. Both occupants were deceased.

1.1.6 The accident occurred in daylight, at approximately 1300 hours, in Bluff Harbour 2.7 kilometres south-east of Colyers Island. Grid reference NZ Topo50-CG10-432335, latitude S 46° 33.5', longitude E 168° 20.6'.

### 1.2 Injuries to persons

| *Injuries* | *Crew* | *Passengers* | *Other* |
|---|---|---|---|
| Fatal | 2 | 0 | 0 |
| Serious | 0 | 0 | 0 |
| Minor/None | 0 | 0 | |

**Table 1: Injuries to persons**

## 1.3 Damage to aircraft

1.3.1 The aircraft was destroyed.

## 1.4 Other damage

1.4.1 Nil.

## 1.5 Personnel information

1.5.1 The 67 year old student pilot was a qualified fixed wing pilot with approximately 2500 hours fixed wing experience. He had taken ownership of the helicopter in September 2009 and had accumulated 170 helicopter flight hours. On 15 October 2009 he failed an attempt at the PPL(H) flight test. During this flight test it was discovered that he had not carried out the full Robinson R22 safety awareness training that was certified in his Pilot's Logbook by a previous instructor on 30 September 2009. The flight examiner made a note of this omission in the PPL(H) flight test report.

1.5.2 On 19 December 2009 the instructor certified in the student's Pilot's Logbook that the student pilot had received instruction in all exercises required by CAR Part 61.105(5)[3]. On 18 and 22 January 2010 the student pilot received 0.9 and 0.8 hours of dual instruction respectively.

1.5.3 The student's Pilot's Logbook showed that, after the dual instruction, the student pilot accumulated 47.8 hours of consecutive solo unsupervised flight time. The student pilot re-commenced flights under dual instruction on 24 August 2010, until the accident flight. Invoices prepared by the instructor revealed that he provided 8 dual instructional flights for the student pilot for the purposes of PPL revision, totalling 8.2 hours. Training records associated with these flights included the following comments made by the instructor: 'a lot of bad habits, needs to work on basics again' and 'first half of lesson a complete mess'.

1.5.4 The instructor was 29 years of age and had 2856 hours of flight experience, of which, he had flown 1313 hours as an instructor. He held a CPL(H), a Category B flight instructor rating and type ratings for seven different types of helicopters.

## 1.6 Aircraft information

1.6.1 Robinson R22 Beta helicopter, registration ZK-HIP, was manufactured in 1991 and first registered in New Zealand on 3 November 1993. It was issued with a Non-Terminating Airworthiness Certificate on 12 August 2004.

1.6.2 ZK-HIP was fitted with a Lycoming O-320-B2C engine.

1.6.3 The total time logged in the helicopter's documentation was 3336.7 hours.

1.6.4 The last change of ownership was recorded in September 2009 after the student pilot purchased the helicopter.

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[3] Under CAR Part 61.105(5) a Pilot's Logbook needs to be certified by an instructor that the pilot has received instruction and demonstrated competency in certain skills, prior to conducting solo flight.

1.6.5 The helicopter had a current Annual Review of Airworthiness which had been conducted on 31 August 2010. No significant deficiencies were detected during the review.

1.6.6 The last 100 hour/annual scheduled inspection was performed on 22 March 2010. During this inspection the airframe total time since new was recorded in the Airframe Logbook as 3308.3 hours, and the total time since overhaul was recorded as 1627 hours. The Engine Logbook also detailed that the engine had completed 6638.5 hours since new and 421.8 hours since the last overhaul.

## 1.7 Meteorological information

1.7.1 On the day of the accident the weather was very favourable for the intended flight and the following conditions existed at the time the accident occurred: temperature 18ºC, dewpoint 10ºC, humidity of 48 percent, barometric pressure 1016 hPa and a light south westerly wind prevailed with good visibility. The conditions appeared to be not conducive with those that could be associated with the possibility of carburettor icing. Weather conditions were considered not to be a factor in the accident.

## 1.8 Aids to navigation

1.8.1 Nil.

## 1.9 Communications

1.9.1 Nil.

## 1.10 Aerodrome information

1.10.1 Nil.

## 1.11 Flight recorders

1.11.1 Nil.

## 1.12 Wreckage and impact information

1.12.1 The helicopter struck the surface of the water in Bluff Harbour in a high speed nose down attitude with the front left side striking the water first.

1.12.2 The forces from the impact with the water resulted in the crushing of the left front side of the cabin, the left side engine rocker covers, the tailboom and the left fuel tank. The main rotor mast was bent forward and to the left.

1.12.3 The main rotor blades had moved out of their normal plane of rotation during the accident sequence and had struck the left cabin door frame, the left front cross tube and the left skid toe.

1.12.4 At the time the helicopter struck the water, the main and tail rotor blades were not rotating. The tail rotor blades had deformed through ninety degrees to the normal plane of rotation, but had not struck the tailboom. Both main rotor blades exhibited creases in the upper surface conducive with static overload, due to upward air flow and loss of centrifugal force during flight.

1.12.5 The engine was not producing power at the time of impact.

1.12.6 The tail rotor drive shaft exhibited static bending and failure due to impact. There was no evidence of an in-flight failure of the tail rotor drive system.

1.12.7 The engine was removed from the wreckage and transported to an approved overhaul facility where it was then stripped and inspected. There was no evidence of a pre-existing mechanical defect that could have caused the accident. The engine ignition system was tested and inspected, revealing no abnormalities.

1.12.8 The rubber hand grip that is normally installed onto the left side cyclic control column (instructor's side) was found within the bounds of the wreckage, not installed in place on the cyclic column.

## 1.13 Medical and pathological information

1.13.1 Post-mortem examination showed that both occupants died of injuries consistent with a high-energy impact.

## 1.14 Fire

1.14.1 Fire did not occur.

## 1.15 Survival aspects

1.15.1 The helicopter was equipped with an Artex ME406 MHz ELT which had activated. Due to being submerged in seawater the ELT was not able to produce a useful signal on either 406 MHz or 121.5 MHz until the rescue helicopters were in the immediate vicinity of the accident site. Only then was a weak homing signal on 121.5 MHz detected.

1.15.2 The accident was not survivable.

## 1.16 Tests and research

1.16.1 Nil.

## 1.17 Organisational and management information

1.17.1 Nil.

## 1.18 Additional information

1.18.1 Nil.

## 1.19 Useful or effective investigation techniques

1.19.1 Nil.

## 2. Analysis

2.1 The examination of the wreckage indicated that the helicopter struck the surface of the water after falling from a significant altitude.

2.2 The engine was not developing power at the time of the impact and the main and tail rotors were not rotating. This indicates that the occupants had no control of the helicopter at the time of the impact.

2.3 It is likely that, during the flight, training for the actions required to recover from a loss of power were being conducted. The response to this eventuality is for the pilot to instinctively and immediately lower the collective control lever and enter an 'autorotation'[4], while monitoring rotor RPM.

2.4 The speed at which the pilot interprets and reacts to the cues alerting him to a loss of power is critical to prevent a low rotor RPM stall, particularly in helicopters that have low rotor inertia such as the Robinson R22. This is reflected in two Safety Notices (SN), issued by Robinson Helicopter Company, (see Appendix 1).

The phenomenon of low rotor RPM stall is explained in the following two Safety Notices:

SN-24 Low Rotor RPM Stall Can Be Fatal

*'Rotor stall, on the other hand can occur at any airspeed and when it does the rotor stops producing lift required to support the helicopter and the aircraft literally falls out of the sky.'*

SN-10 Fatal Accidents Caused by Low Rotor RPM Stall - describes how low rotor RPM stall can be avoided:

'*No matter what causes the low rotor RPM the pilot must first roll on the throttle and lower the collective simultaneously to recover RPM before investigating the problem. It must be a conditioned reflex.'*

2.5 The fact that the student pilot had evidently not carried out the Robinson R22 safety awareness training as certified in his Pilot's Logbook meant that the student pilot was probably knowledge deficient in elements critical to the safe operation of the Robinson R22 helicopter, such as described in the Robinson Helicopter Company Safety Notices.

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4 'A rotorcraft flight condition in which the lifting rotor is driven entirely by action of the air when the rotorcraft is in motion.' (FAA Regulation 14, Code of Federal Regulations, Part1).

2.6 The student pilot was a qualified fixed wing pilot, however, it was reported that he was finding it difficult to become proficient in the basics of operating helicopters. This difficulty had been demonstrated by the failure to pass the helicopter PPL(H) flight test 12 months previously, and comments made by the instructor in the student pilots recent training records indicated that he was not proficient in the basics of flying the helicopter. This proficiency is normally achieved in approximately 30 hours of flight training.

2.7 It was reported that the student pilot would often call the instructor for approval to conduct unsupervised flights at his farm. The 47.8 hours of solo flight time logged between flights with dual instruction was evidence that the student pilot carried out numerous helicopter flights without direct supervision. CAR 61.105(a)(6) required that, to fly solo without holding a PPL(H), the student pilot must obtain authorisation for these flights. The phone calls to the instructor may have been evidence of an informal arrangement for the required authorisations to be verbally provided. CAR 61.105(b) also required that the instructor monitor the actions of the student pilot during the solo flights, which the instructor had done through radio communications with the student pilot during these flights.

2.8 The substantial hours flown by the student pilot without direct supervision may have contributed to the difficulties he faced progressing with his proficiency. Without immediate correction by an instructor, poor handling techniques and errors can be consolidated leading to inaccurate flying, requiring additional effort to correct.

2.9 Robinson Helicopter Company acknowledged that there are important human factor considerations to be understood by pilots when transitioning from fixed wing to helicopter operations. In March 1993 they issued a safety notice, SN-29 ‘Airplane Pilots High Risk When Flying Helicopters’ explaining these considerations, (see Appendix 1). This safety notice explains how the instinctive action of a pilot, with many hours flying a fixed wing aircraft, can be fatal when inadvertently applied in response to an engine failure in a helicopter.

2.10 Whether a loss of power to the main rotors was as a result of an actual power loss, or simulated power loss during a training scenario, could not be positively established. However, as the helicopter had earlier been seen to be quickly descending and then climbing it seems likely that the instructor was conducting training in this aspect of helicopter proficiency. The requirement to react and respond appropriately is the same for both actual and simulated power loss scenarios. If the student pilot mishandled the loss of power, the instructor had to intervene immediately to prevent the decay in rotor RPM and associated low rotor RPM stall.

2.11 The fact that the hand grip from the instructor’s cyclic control was not in place in the wreckage is noteworthy. However, when reinstalled for the purposes of investigation, the rubber hand grip could not be removed without significant exertion and was likely to have come off the cyclic control column during the impact with the water.

## 3. Conclusions

3.1 The student pilot and instructor were both appropriately licensed and the instructor was appropriately rated for the flight.

3.2 The helicopter was in an airworthy condition prior to the accident and there was no evidence to suggest that mechanical failure contributed to the accident.

3.3 The helicopter struck the surface of the water after falling from a significant altitude.

3.4 The engine was producing no power at the time of the impact and the main and tail rotors had no appreciable energy.

3.5 The student pilot was not proficient in the accurate handling of the helicopter and was probably knowledge deficient in specific safety matters relating to the Robinson R22 helicopter.

3.6 It is likely that the student pilot mishandled the entry into an autorotation, possibly due to his instinctive recall of fixed wing stall recovery techniques, allowing low rotor RPM stall to develop, with insufficient time for the instructor to successfully intervene before the rotor RPM became irrecoverable.

3.7 The accident was not survivable due to impact forces.

## 4. Safety Actions

4.1 There are no safety actions relating to this accident.

| Report written by: | Authorised by: |
|---|---|
| S. Walker<br>Safety Investigator | John Kay<br>General Manager Safety Information |
| | Date |

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## Appendix 1. Robinson Helicopter Company Safety Notices:

ROBINSON
HELICOPTER COMPANY

### Safety Notice SN-24

Issued: Sep 86 Rev: Jun 94

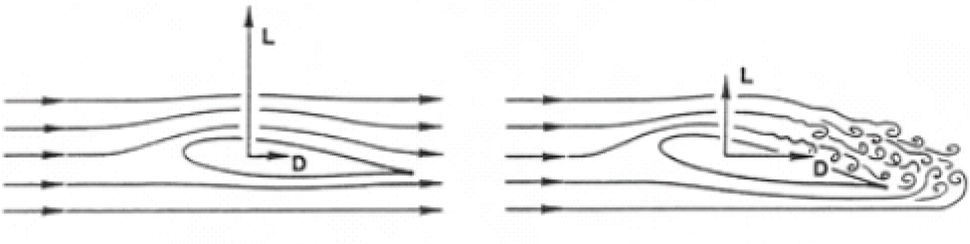
LOW RPM ROTOR STALL CAN BE FATAL

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.

Page 1 of 2

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-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 descend. 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 severly 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 tail cone 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-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, ie., 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 thecyclic 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.