Australian Government
Australian Transport Safety Bureau

Loss of control involving Robinson R22, VH-WGB

221 km ENE of Port Hedland Airport, Western Australia, 12 May 2016

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2016-047
Final – 25 August 2016

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Publishing information

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Addendum

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Loss of control involving Robinson R22, VH-WGB

What happened

On 12 May 2016, the pilot of a Robinson R22 Beta II helicopter, registered VH-WGB, was conducting aerial work at a property about 221 km east-north-east (ENE) of Port Hedland, Western Australia.

The pilot was observing two other helicopters engaged in aerial mustering for the benefit of the pilot's own learning experience. The pilot's attention was divided between flying the helicopter at about 200 ft above ground level and observing the mustering helicopters, which were operating between ground level and about 200 ft.

At about 1030 Western Standard Time (WST), while manoeuvring the helicopter to observe the mustering operation, the pilot commenced a level 180° turn to the left into wind. At the time the helicopter entered the left turn, it was flying at about 40 kt airspeed with about a 15 kt tailwind component.

Just prior to exiting the turn, the pilot felt the helicopter 'kick'. The helicopter then yawed[1] rapidly to the right and pitched nose down. The pilot applied left pedal in an attempt to counteract the yaw, however, the helicopter did not respond normally to pedal[2] or cyclic[3] control inputs. The pilot also lowered the collective[4] and reduced the throttle. The helicopter pitch attitude[5] oscillated between a steep nose-down and a level attitude as the helicopter rotated towards the ground. As the helicopter neared the ground, the pilot applied aft cyclic, increased the throttle and raised the collective, which levelled the helicopter attitude and reduced the rate of descent.

The helicopter collided with the ground in a level attitude. The helicopter skids and seat collapsed following ground contact. During the accident sequence, the main rotor blades severed the tail boom. The pilot's helmet struck the cyclic and the pilot sustained minor injuries. The aircraft was substantially damaged (Figure 1).

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1 Term used to describe motion of an aircraft about its vertical or normal axis.

2 A primary helicopter flight control that is similar to an aircraft rudder. Pedal input changes the tail rotor thrust to provide heading control in the hover and balanced flight when the helicopter is in forward flight.

3 A primary helicopter flight control that is similar to an aircraft control column. Cyclic input tilts the main rotor disc varying the attitude of the helicopter and hence the lateral direction.

4 A primary helicopter flight control that simultaneously affects the pitch of all blades of a lifting rotor. Collective input is the main control for vertical velocity.

5 Pitch attitude is the angle between the vehicle longitudinal axis and defined reference plane, in this case the local horizon.

Figure 1: Accident site showing damage to VH-WGB

Source: Aircraft Operator

Pilot comments

The pilot provided the following comments:

- the wind was steady at about 15 kt from the south-east with occasional gusts to 20 kt
- the pilot was not sure what the 'kick' was, but thought it was due to the wind
- the pilot did not recognise a low gravity (weightless) situation and may have applied incorrect cyclic technique, resulting in the main rotor striking the tail boom
- the pilot thought that the tail boom was severed shortly after the kick because there was no response from the pedals to counteract the yaw and the helicopter immediately entered a nose down spiral
- the pilot's helmet was damaged during the collision, when it struck and broke the cyclic (Figure 2)
- wearing the helmet probably prevented a more serious injury from occurring.

Figure 2: Damage to pilot's helmet

Source: Helicopter pilot

Loss of tail rotor effectiveness

The United States Federal Aviation Administration (FAA) Helicopter flying handbook

The FAA Helicopter flying handbook chapter 11: Helicopter emergencies and hazards stated that loss of tail rotor effectiveness (LTE) is an uncommanded rapid yaw towards the advancing blade and is an aerodynamic condition caused by a control margin deficiency in the tail rotor. Tail rotor thrust is affected by numerous factors, including relative wind, forward airspeed, power setting and main rotor blade airflow interfering with airflow entering the tail rotor. There are several wind directions, relative to the nose of the helicopter which are conducive to LTE, including the following:

- 285–315°, which can lead to turbulent airflow from the main rotor disc interfering with the tail rotor
- 210–330°, which can lead to the development of unsteady airflow through the tail rotor.

The FAA handbook warns that a combination of factors in a particular situation can lead to more anti-torque required from the tail rotor than it can generate. In addition, low speed flight activities are a high risk activity for LTE. The FAA handbook provided the following recovery technique for a sudden unanticipated yaw:

- apply forward cyclic control to increase airspeed
- if altitude permits, reduce power
- as recovery is affected, adjust controls for normal forward flight.

Robinson Helicopter Company safety notice SN-42: Unanticipated yaw

The Robinson Helicopter Company advised that to avoid an unanticipated yaw, pilots should be aware of conditions (a left crosswind, for example) that may require large or rapid pedal inputs. They recommend practising slow, steady-rate hovering pedal turns to maintain proficiency in controlling yaw.

Low gravity (G) conditions

The FAA Helicopter flying handbook

The FAA handbook chapter 11 stated that semirigid rotor systems are especially susceptible to hazards from manoeuvres involving low accelerations of gravity (low-G or weightless) because the helicopter is designed to be suspended from the main rotor. In a low-G condition, such as abruptly pushing the cyclic forward, the helicopter airframe is not supported by the main rotor mast, which may allow the main rotor blades to exceed their normal flapping limits and contact the airframe.

The FAA handbook advised that in a low-G situation the pilot should first apply aft cyclic to return the lift and weight forces to balance and always adhere to the manufacturer's manoeuvring limitations and advisory data.

Robinson Helicopter Company safety notice SN-11: Low-G pushovers – extremely dangerous

The Robinson helicopter company issued safety notice SN-11 in October 1982, which stated:

> 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.

ATSB comment

When the pilot manoeuvred the helicopter into wind, it flew through two relative wind directions conducive to an LTE event. The pilot commented that they entered the turn at about 40 kt airspeed, but was actively scanning between flying the helicopter and observing the aerial mustering activity. It is likely that during the turn, the airspeed combined with the relative wind direction to initiate an LTE event. The recommended actions to recover from an LTE include the application of forward cyclic to increase airspeed. This could place the helicopter into a low-G condition if an abrupt forward cyclic input is made, and increase the risk of striking the tail boom if the forward cyclic input is followed by an abrupt and/or large aft cyclic input.

Safety message

Loss of tail rotor effectiveness and low-G conditions

To avoid the conditions which could lead to main rotor blade/fuselage contact accidents, the Robinson R22 Pilot's operating handbook recommends the following procedures for pilots:

- maintain cruise airspeeds between 60 kt and less than 0.9 V_{NE}[6], but no lower than 57 kt
- use maximum power on revolutions per minute at all times during powered flight
- avoid sideslip during flight and maintain in-trim flight at all times
- avoid large, rapid forward cyclic inputs in forward flight, and abrupt control inputs in turbulence.

Effectiveness of helmets in helicopter operations

The United States Army referenced two United States Army Aeromedical Research Laboratory studies of helmet effectiveness in USAARL report 93-2. The first study from the period 1957–1960 found that fatal head injuries were 2.4 times more common among unhelmeted occupants of potentially survivable helicopter accidents than among occupants wearing the army's APH-5 helmet. The second study from the period 1972–1988 found that the risk of fatal head injury was 6.3 times greater in unhelmeted occupants of potentially survivable helicopter accidents than among occupants wearing the army's SPH-4[7] helmet.

In a separate study (report 98-18) the Army Aeromedical Research Laboratory reviewed 459 accidents in the period 1990–1996 where helmet visor use was verified. They found that visor use was attributed to preventing facial injury in 102 (22.2%) accidents and reducing injury in 13 (2.8%) accidents.

This accident highlights the effectiveness of wearing a helmet to prevent a more serious injury. ATSB report AO-2014-058 provides an account of a serious head injury to an R22 pilot who was

[6] Never exceed speed.
[7] SPH-4 was the newer model helmet in use at the time period of the second study.

not wearing a helmet. In a later ATSB report, AO-2015-134, the operator commented that the pilot of an R22 accident would have suffered more serious head injuries if he was not wearing a helmet.

General details

Occurrence details

Date and time:	12 May 2016 – 1030 WST	
Occurrence category:	Accident	
Primary occurrence type:	Loss of control	
Location:	221 km ENE of Port Hedland Airport, Western Australia	
	Latitude: 19° 46.30' S	Longitude: 120° 38.30' E

Helicopter details

Manufacturer and model:	Robinson Helicopter Company R22 Beta	
Registration:	VH-WGB	
Serial number:	3326	
Type of operation:	Aerial work - other	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 1 (Minor)	Passengers – 0
Aircraft damage:	Substantial	

About the ATSB

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The ATSB 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; and 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 operations involving the travelling public.

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.

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.

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.

About this report

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope, fact-gathering investigation was conducted in order to produce a short summary report, and allow for greater industry awareness of potential safety issues and possible safety actions.