Australian Government
Australian Transport Safety Bureau

Forced landing involving Robinson R44, VH-SJK

16 km south of Sydney Airport, New South Wales, 17 December 2016

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Aviation Occurrence Investigation
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Addendum

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Forced landing involving Robinson R44, VH-SJK

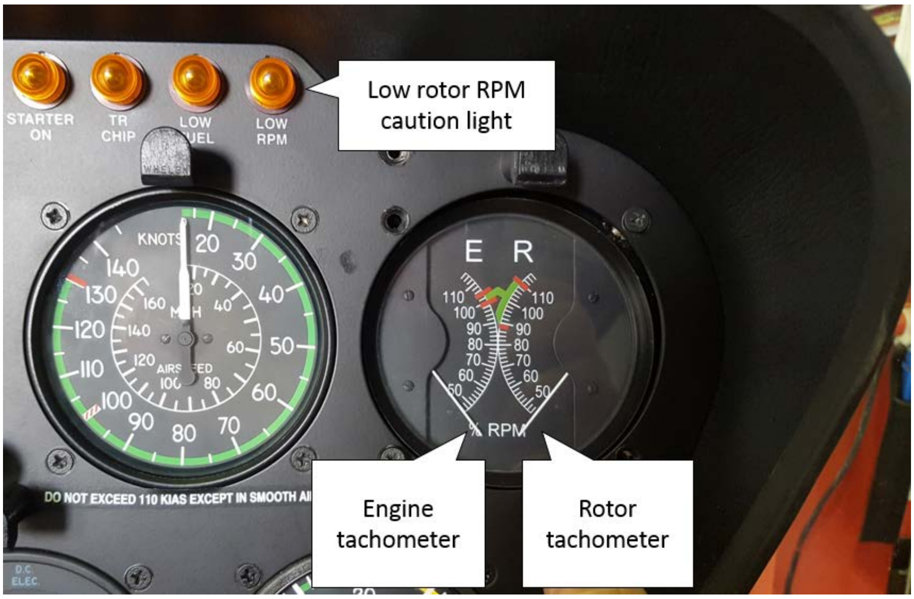
What happened

On 17 December 2016, at about 0855 Eastern Daylight-savings Time (EDT), a Robinson R44 II helicopter, registered VH-SJK, departed Sydney Airport, New South Wales (NSW), on a private flight to Kangaroo Valley, NSW. On board the helicopter were the pilot and three passengers.

The helicopter departed Sydney Airport and was flown at 500 ft over water to Cape Banks, on the north shore of Botany Bay, and then turned south to fly a coastal route over the water outside controlled airspace. About 16 km south of Sydney Airport, the pilot initiated a climb to keep the helicopter near the upper limit of non-controlled airspace. The helicopter was about 200–300 m offshore and climbing through 650 ft when the pilot heard the warning horn for low rotor RPM activate.

The pilot checked the engine and rotor tachometer and noted that the engine RPM was in the normal flight range, but the rotor RPM had degraded to about 85 per cent (Figure 1).[1] They immediately turned right towards land (coastal cliffs) while considering the possibility that it was an instrument fault. However, during the turn and again when over land, the rotor RPM tachometer indicated a decay in RPM whenever the pilot raised the collective.[2] The rotor RPM response to the pilot's collective movements indicated to the pilot that there was a genuine problem with the helicopter's drive system (see *Rotor drive system*).

Figure 1: VH-SJK engine and rotor tachometers



Source: Platinum Helicopters, annotated by ATSB

As soon as the helicopter was over land, the pilot identified a landing site, raised the collective to test the rotor RPM response, and, noting a decay in RPM, they lowered the collective to enter

1 Normal operating RPM for the engine and rotor is 102 per cent. The low rotor RPM warning horn and light indicate rotor RPM at 97 per cent or below.

2 Collective: 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.

autorotation[3] from about 300 ft above ground level at 70 kt. This was about 6–8 seconds after the warning horn activated, at which time the rotor RPM was about 80 per cent. The pilot landed the helicopter with about 7–8 kt forward speed using a standard autorotation flare and cushion technique[4] at their chosen landing site. The engine and rotor were still turning after the landing, so the pilot turned off the engine, electrics and fuel cock. The time was about 0910. A mobile phone was used to call rescue services. There were no injuries and the helicopter was substantially damaged.

Maintenance inspection

The pilot's maintenance organisation managed the recovery of the helicopter and post-recovery inspections and tests. On arrival at the landing site, the company's chief engineer noted that the damage to the surrounding bush indicated the helicopter was level with minimal forward speed during the landing. A functional check of the clutch actuator (see *Rotor drive system*) was performed on site before recovery and no fault was found with the operation.

A post-recovery maintenance inspection was conducted, which included a visual inspection and ground run of the helicopter (Figure 2). No fault was found with the engine, drive system or flight controls, but the visual inspection did find chaffing damage to a rotor tachometer wire, which was in intermittent contact with earth. Damage to the helicopter prevented a maintenance test flight.

Figure 2: VH-SJK ground running post-recovery

Source: Platinum Helicopters

An initial ground run was performed below maximum gross weight, which reached a power setting of 22 inches manifold pressure without fault. A subsequent ground run was performed after loading the helicopter to 200 kg greater than the maximum gross weight. On the second ground run a power setting of 27 inches manifold pressure, which exceeded the red line for maximum power, was reached before the helicopter became light on the skids. There was no indication of RPM decay from the engine or rotor. The chaffed rotor tachometer wire was deliberately shorted to earth during the ground runs, but did not produce any fault indications from the tachometer.

The drive belts and sheave alignment were inspected and found to be within the prescribed limits (see *Rotor drive system*). There was no indication of slippage between the drive belts and the

3 In a helicopter, this is a descent without engine power driving the rotors. Air flowing upwards through main rotor provides the driving force for rotor RPM.

4 The flare prior to landing from an autorotation reduces the forward airspeed and increases rotor RPM. After the flare, the collective is raised by the pilot to 'cushion' the touchdown, which minimises the rate of descent and therefore the vertical forces on the helicopter and occupants at touchdown. If there is no engine power driving the rotors, then the rotor RPM will decay when the pilot raises the collective, but the decay in rotor RPM is a secondary consideration to minimising the touchdown rate of descent.

sheaves. During the ground runs, there were no low rotor RPM faults and the low RPM horn activated at 97 per cent rotor tachometer indication, which was the correct setting in accordance with the manufacturer's specifications. The clutch oil was inspected for metal contamination in accordance with the maintenance manual procedure and no evidence of a defect was found. Following a recommendation from the manufacturer, the maintenance organisation performed a disassembly and examination of the clutch assembly (see *Rotor drive system*). No defects were found to indicate that the clutch was slipping.

Manufacturer's comments

The pilot operating handbook states that a 'power failure may be caused by either an engine or drive system failure and will usually be indicated by the low RPM horn.' The manufacturer reported that the low RPM horn and the rotor tachometer are on 'completely separate circuits, including the sensors. A failure of both systems simultaneously is extremely unlikely.' They also noted that the governor is only used to control engine RPM and operates on a separate system with its own sensor. Therefore, the reported fault was not associated with the operation of the governor if the engine RPM remained in the governed range.

The manufacturer noted that some power must have been being delivered to the main rotor, or the rotor RPM would have decayed rapidly before the helicopter entered autorotation. A situation in which the engine was running at normal RPM and the rotor at a low RPM could only occur if there was incomplete transfer of power between the engine and the input to the main rotor gearbox. The two power transmission junctures between the engine and input to the main rotor gearbox are the V-belts and the clutch (see *Rotor drive system*).

The manufacturer reviewed the maintenance organisation's photographs of the disassembled clutch assembly and agreed that there was no indication of the clutch slipping at a high power setting.

Rotor drive system

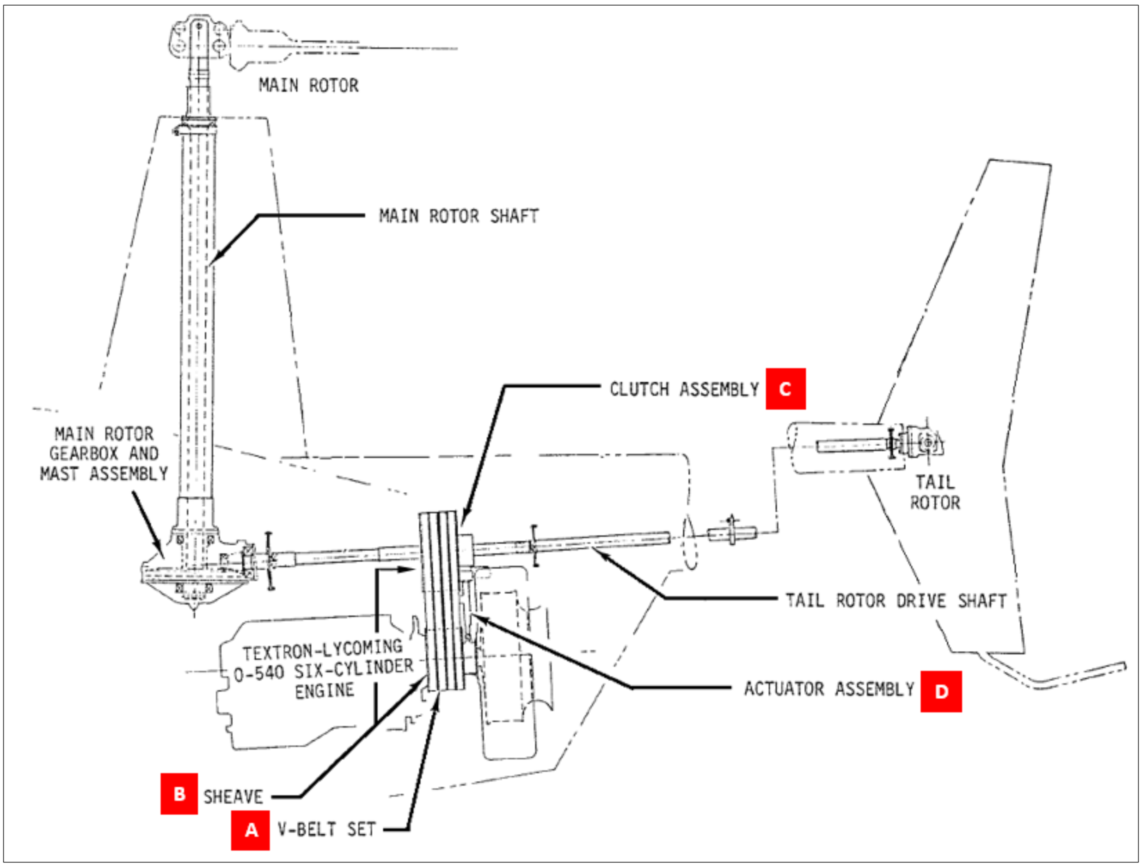
The rotors are driven by a V-belt sheave drive system, bolted directly to the crankshaft of the engine (Figure 3). Four, double V-belts (A) transmit power from a lower sheave to an upper sheave (B), which has a clutch in its hub (C). The clutch transmits power forward to the main rotor and aft to the tail rotor. A clutch actuator (D), positioned between the lower and upper sheave, extends to tension the V-belts and prevent slippage.

A clutch caution light is situated at the left end of the row of caution lights at the top of the instrument console. The Robinson R44 II Pilot's Operating Handbook provided the following explanation for the clutch caution light:

> indicates clutch actuator circuit is on, either engaging or disengaging clutch. When switch is in the ENGAGE position, light stays on until belts are properly tensioned. Never take-off before the light goes out.
>
> NOTE: Clutch light may come on momentarily during run-up or during flight to retention belts as they warm-up and stretch slightly. This is normal. If, however, the light flickers or comes on inflight and does not go out within 10 seconds, pull CLUTCH circuit breaker and land as soon as practical. Reduce power and land immediately if there are other indications of drive system failure (be prepared to enter autorotation). Inspect drive system for a possible malfunction.

The pilot observed the clutch light operation before take-off to be serviceable. However, they did not notice the clutch light during the emergency and therefore could not confirm if it activated. Their attention during the emergency was focussed on the rotor RPM, airspeed and identifying an emergency landing site.

Figure 3: R44 rotor drive system



Source: Manufacturer, annotated by ATSB

Low rotor RPM stall

During the emergency landing manoeuvre, the pilot reported that the rotor RPM reduced to about 80 per cent and was conscious of a potentially unrecoverable rotor stall condition if the RPM reduced any further. The manufacturer has previously published safety notice (SN-24) on the subject: *Low RPM rotor stall can be fatal*. The safety notice does not included a specific RPM at which this will occur, because there are several variables involved. However, it indicates that at heights above 40 or 50 feet above ground level, a low rotor RPM stall will likely be fatal. This is because the rate of descent airflow, following the initial stall, will deepen the stalled condition of the slowly rotating blades, 'making recovery virtually impossible, even with full down collective.'

Safety analysis

During the emergency, the pilot reported that the engine RPM did not decay and their only indications of a fault were the low rotor RPM horn and low rotor RPM as displayed on the rotor tachometer. The pilot could not exclude activation of the clutch light during the emergency, but there was no indication of belt slippage during the post-recovery inspections and ground run tests. An internal inspection of the clutch assembly did not find evidence of clutch slippage. When the pilot manoeuvred the helicopter prior to entering autorotation, they noticed the rotor RPM decay whenever they raised the collective. When they raised the collective to cushion the landing, the helicopter responded in a power-off manner. If there was no loss of power to the rotor, then the helicopter could be expected to climb as a result of the pilot raising the collective to cushion the landing. Therefore, the low rotor RPM was probably the result of a reduction of power input to the rotor from the engine. However, during the post-recovery inspections and ground run tests, no fault was found which could explain this condition.

ATSB comment

The ATSB notes that the pilot operating handbook directs the pilot to lower the collective immediately to maintain rotor RPM between 97 and 108 per cent, following a power failure. In this case the pilot elected to delay recovering RPM until they could reach a safe landing site, since immediately lowering collective would have resulted in ditching the helicopter in the ocean.

Findings

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

- The low rotor RPM was probably the result of a reduction in power input to the rotor from the engine, but the fault could not be reproduced during post-recovery tests.
- There was no evidence of clutch slippage occurring at a high power setting from the disassembly and inspection of the clutch assembly.

Safety message

The pilot reported that their lesson learned following this emergency was the importance of training and professional development. Although they only used their helicopter for private flights, they trained for a commercial helicopter licence to improve their knowledge and skill in handling their helicopter. They did not believe they could have flown a successful emergency landing without their previous recurrent proficiency training in practice autorotations.

General details

Occurrence details

Date and time:	17 December 2016 – 0910 EST	
Occurrence category:	Accident	
Primary occurrence type:	Forced landing	
Location:	16 km south of Sydney Airport, New South Wales	
	Latitude: 34° 05.85' S	Longitude: 151° 09.40' E

Aircraft details

Manufacturer and model:	Robinson Helicopter Company R44 II	
Registration:	VH-SJK	
Serial number:	12174	
Type of operation:	Private – pleasure / travel	
Persons on board:	Crew – 1	Passengers – 3
Injuries:	Crew – 0	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.