



Transport Accident  
Investigation  
Commission

## Watchlist 2024

# Robinson helicopters: mast bumping accidents in NZ

### **What is the problem?**

The Transport Accident Investigation Commission is concerned about the number of accidents in New Zealand in which Robinson helicopters have experienced 'mast bumping'. These accidents have raised concerns about the risks of flying these helicopters in the mountainous terrain and weather conditions that are common in New Zealand.

Mast bumping results from contact between an inner part of a main rotor blade or rotor hub and the main rotor drive shaft (or 'mast'). Serious mast bumping in flight usually results in the helicopter breaking up in flight, which is fatal for those on board.

Part of the problem is that the available evidence has not allowed the circumstances and contributing factors of all of these 'mast bumping' accidents to

be fully determined. However, a significant proportion have been found to have occurred in 'low-G'\* flight conditions. The rotor design of Robinson helicopters means they are susceptible to mast bumping in 'low-G' conditions. Low-G can be caused by large or abrupt flight control inputs or by turbulence. The risk of mast bumping in turbulence increases with high power settings and operating at high speed and light weight.

### **What is the solution?**

Operators must select a type of aircraft suited to the risk profile of the intended use. Similarly, all pilots must understand the helicopter's operating limitations, avoid circumstances which could see these inadvertently exceeded, and receive proper training in the causes, dangers, and prevention of mast bumping, including in low-G conditions. It is particularly important for Robinson

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\* A low-G condition occurs when an object is subjected to a net vertical force less than the force of gravity.

When the vertical force is zero, the object is described as being 'weightless'.

pilots to be aware of the risks of flying a lightly loaded helicopter at high speed in turbulence. Prohibitions against in-flight low-G demonstrations must be observed, and low-G recovery training must be conducted only on the ground.

The regulatory environment must:

- support high quality training and improved pilot awareness of mast bumping risks, including in low-G conditions
- require the manufacturer to clearly state the limitations of the helicopters

- encourage use of the helicopter as appropriate to the operating conditions.

We encourage further research into the factors that can lead to mast bumping and the dynamic loading characteristics of the rotor hub and drive shaft assembly.

The widespread use of cockpit video recorders and/or other means of data capture would provide useful data to investigations.

The Commission acknowledges that since this item was placed on the Watchlist, good progress has been made in implementing some of these measures.

## **What is mast bumping and why is it serious?**

Mast bumping is contact between an inner part of a main rotor blade or a rotor hub and the main rotor drive shaft. The rotor design of Robinson helicopters means they are susceptible to mast bumping during low-G flight conditions. Low-G conditions can arise in turbulence. Significant areas of New Zealand terrain are mountainous, and they are often exposed to strong wind.

Serious mast bumping that occurs in flight usually results in the helicopter breaking up during flight, which is fatal for those on board. For this reason, it is often difficult to determine exactly what happened to cause the mast bump.

Since 1991 the Commission or the Civil Aviation Authority (CAA) have investigated 15 mast bumping accidents or incidents involving Robinson helicopters. Six of these accidents occurred between 2012 and 2015 and the most recent in 2018 (see the table on the last page). Nineteen people have died in the 15 accidents, including ten in known low-G mast bumping accidents.

## What recommendations have we made?

We have made various recommendations to the CAA on awareness and pilot training.<sup>1,3</sup> We also made recommendations about installing cockpit video recorders and/or other means of data capture in certain classes of helicopter.<sup>2</sup> Such systems are essential for helping to determine why accidents happen.

In November 2020, we released our report into the fatal crash of an R44 in Wanaka in 2018.<sup>3</sup> We noted that investigations into loss-of-control or mast bumping accidents involving Robinson helicopters continue to be hampered by a lack of data. Allied with this is a lack of understanding of how the main rotor performs in adverse conditions. This lack of factual information has limited the effectiveness of safety investigations. One of the recommendations from an earlier inquiry<sup>4</sup> was that the FAA reinstate research into the dynamic behaviour of the Robinson's rotor system under conditions of low-G.

## Why is the Commission concerned?

The Commission's recommendations have sought concerted actions by regulatory authorities, the manufacturer, operators, instructors and pilots to promote the safe operation of Robinson helicopters in the New Zealand environment; and to better understand the helicopter's operating characteristics and the factors that can lead to mast bumping.

The Commission acknowledges the high degree of attention that all parties are giving to these safety matters, the progress that has been made in many of the safety issues we have raised. The number of Robinson helicopters registered in New Zealand has reduced from 335 in early 2014 to 205 in 2023. The CAA has advised that the Robinson helicopter accident rate has reduced.

We remain of the view that, given New Zealand pilots are more likely to encounter turbulence than pilots in some other parts of the world where Robinson helicopters are used, there continues to be a pressing need to understand the helicopter's operating characteristics and the factors that can lead to mast bumping.

## ***Mast bumping accidents in New Zealand, March 2024***

<b>Reference</b>	<b>Report title</b>	<b>Fatalities</b>
*TAIC AO-1991-001	Robinson R22 Beta ZK-HDC, main rotor separation after mast bumping in turbulence, near Hukerenui, North Auckland, 4 January 1991	1
CAA 96/3239	Robinson R22 Beta ZK-HDD, Matawai, Gisborne, 5 December 1996	2
CAA 02/71	Robinson R22 Beta ZK-HEZ, Balfour Range, near Fox Glacier, 14 January 2002	2
CAA 03/127	Robinson R22 Beta ZK-HUL, Masterton, 17 January 2003	1
*CAA 04/39	Robinson R22 Beta ZK-HXT, 10 km north-east of Taupo, 10 January 2004	2
*TAIC AO-2008-007	Robinson R22 Alpha ZK-HXR, loss of control, Lake Wanaka, 1 November 2008	1
CAA 10/3987	Robinson R22 Beta ZK-HIP, loss of rotor RPM, Bluff Harbour, 14 October 2010	2
TAIC AO-2011-003	Robinson R22 Beta ZK-HMU, inflight break-up, near Mt Aspiring, 27 April 2011	2
*CAA 12/4957	Robinson R22 Beta ZK-HCG, loss of main rotor control, Cardrona Valley, Wanaka, 8 November 2012	1
*TAIC AO-2013-003	Robinson R66 ZK-IHU, inflight break-up, Kaweka Range, 9 March 2013	1
*TAIC AO-2013-005	Robinson R22 Beta ZK-HIE, inflight loss of control, near New Plymouth, 30 March 2013	0
*TAIC AO-2014-006	Robinson R44 Helicopter ZK-HBQ, in-flight break-up, Kahurangi National Park, 7 October 2014	1
*TAIC AO-2015-002	Robinson R44 ZK-IPY, Mast bump and in-flight break-up, Lochy River, near Queenstown, 19 February 2015	2
*CAA 15/1229	Robinson R22 Beta ZK-HMW, mast bump, Clevedon, 19 March 2015	0
TAIC AO-2018-006	Robinson R44 Helicopter, ZK-HTB, collision with lake, Wanaka, 21 July 2018	1

### \* Known low-G accidents

For more information about these accidents see Appendix 1 to Transport Accident Investigation Commission *Report AO-2015-002: Mast bump and in-flight break-up, Robinson R44, ZK-IPY Lochy River, near Queenstown, 19 February 2015*

[AO-2015-002 | TAIC](#)

# References to reports and recommendations

<sup>1</sup> AO-2011-003: *In-flight break-up ZK-HMU, Robinson R22, near Mount Aspiring, 27 April 2011*

[AO-2011-003 | TAIC](#)

Safety recommendations 003/14, 004/14

<sup>2</sup> AO-2015-002: *Mast bump and in-flight break-up, Robinson R44, ZK-IPY Lochy River, near Queenstown, 19 February 2015*

[AO-2015-002 | TAIC](#)

Safety recommendations 014/16, 015/16

<sup>3</sup> AO-2018-006: *Robinson R44 Helicopter, ZK-HTB, collision with lake, Wanaka, 21 July 2018*

[AO-2018-006 | TAIC](#)

<sup>4</sup> AO-2013-003: *Robinson R66, ZK-IHU, Mast bump and In-flight break-up, Kaweka Range, 9 March 2013*

[AO-2013-003 | TAIC](#)

Safety recommendations 002/16, 004/16, 005/16, 011/16

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*Te Kōmihana Tirotiro Aituā Waka*

**Transport Accident Investigation Commission**

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