

Report prepared for Department of
Conservation on the use of Robinson
helicopters.

Total Aviation Quality Ltd

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Introduction

On 23rd December 2016, the Robinson Helicopter Company (RHC) produced its 12,000th helicopter at its facility in Torrance, California. The company produces three basic models – two-seat R22, four-seat R44 and five-seat turbine-powered R66. The various models are used extensively in New Zealand and throughout the world. There are 293 Robinsons on the New Zealand register, as at 1/05/17, representing about 40% of the New Zealand civil helicopter fleet. The type has been operated in New Zealand since the early 1980's (CAA Occ. 06-663 R22 HLC)¹ They are in use in a wide variety of tasks including pilot training, private and syndicate ownership, commercial and tourism operations, external load, general farming and agricultural operations.

On 31st October 2016, a Robinson R44 helicopter crashed while conducting a survey flight in Glenbervie Forest near Whangarei. The pilot and a forestry contractor on board were killed. Two days later, on 2nd November 2016, the Department of Conservation (DOC) issued a notice suspending the use of all Robinson helicopters for the transport of DOC Staff, volunteers and contractors. DOC's decision followed the fatal accident in Whangarei, and took account of the placing of Robinson helicopters on a Transport Accident Investigation Commission (TAIC) 'Watchlist' just a few days previously (27 October 2016).

TAIC had placed the Robinson helicopter on its Watchlist following the release of two recently published accident reports, [15-002] R44 IPY at Lochy River² and [13-003] R66 IHU³ in the Kaweka Ranges, released by TAIC on 25th August 2016 and 5th May 2016 respectively. Both reports identified a mast bump event followed by an in-flight break-up.

DOC's Director of Health and Safety, Harry Maher, said the decision was made to protect DOC staff including volunteers and contractors working directly for DOC. Mr. Maher stated, "The safety of our people is paramount so in light of the recent accident we are suspending the use of these helicopters for operations where DOC staff, volunteers and contractors are passengers."

Because of the uncertainty of the cause of the Whangarei crash at that time and concerns stated in the TAIC Watchlist, DOC's notice of suspension read that DOC would review its position as further information from CAA came to hand. On 1st December 2016, TAIC released an 'interim factual report' on the Whangarei accident stating that it was 'very unlikely' that the helicopter had broken up in flight or that the cause of the accident was mast-bumping, but that investigations into what the cause of the crash was, were continuing.

Note: At the time of writing this report another fatal Robinson helicopter accident report was released by TAIC on 29 March 2017 [14-006] R44 HBQ⁴ in Kahurangi National Park attributing the accident to in-flight break-up following a mast-bump event, killing the pilot.

Terms and Abbreviations

¹ www.caa.govt.nz CAA Occ. 06-663 R22 HLC

² <http://www.taic.org.nz> , [15-002] R44 IPY

³ <http://www.taic.org.nz> [13-003] R66 IHU

⁴ <http://www.taic.org.nz> [14-006] R44 HBQ

	The following terms or abbreviations are used in this report:
CAANZ	Civil Aviation Authority (New Zealand)
DOC	Department of Conservation
FAA	Federal Aviation Administration (United States)
FAR	Federal Aviation Regulation (United States)
CFR	Code of Federal Regulations (United States)
NTSB	National Transportation Safety Bureau (United States)
CASA	Civil Aviation Safety Authority (Australia)
ATSB	Australian Transport Safety Bureau
RHC	Robinson Helicopter Corporation
R22/R44/R66	Three Robinson helicopter models in production and in use in NZ
Low-G	Acceleration less than that due to the force of gravity. A feeling of weightlessness
Mast bump	Contact between the inboard end of a main rotor blade or the rotor hub and the main rotor drive shaft
TAQ	Total Aviation Quality Ltd.
TAIC	Transport Accident Investigation Commission (New Zealand)
SA	Safety Alert (Robinson Helicopter)
SN	Safety Notice (Robinson Helicopter)
SFAR 73	Special Federal Aviation Regulation No. 73 Robinson pilot safety awareness training
HSW Act	Health and Safety at Work Act 2015
PCBU	Person conducting a business or undertaking (HSW Act 2015)

Purpose

This report responds to a Brief (or terms of reference) provided to Total Aviation Quality Ltd. On 6th December 2016, DOC's Director of Health and Safety, Harry Maher, commissioned Total Aviation Quality Ltd. (TAQ) to provide independent advice on the Robinson helicopter safety issue in order to inform DOC's decision making process about future use of Robinson helicopters carrying DOC staff. The Brief provided by DOC reads:

“DOC is the single largest hirer of helicopters in NZ. We spend around \$15m per annum hiring helicopters throughout the country, including the hire of Robinson helicopters.

In the context of a number of fatalities over recent years, there has been an increasing level of concern in some aviation quarters relating to ‘mast bump’ accidents in Robinson helicopters in NZ. The CAANZ and TAIC have both provided information and commentary on the issue, and several communications of recent times have been specific about the mast bumping issue and potential solutions.

The ‘Lochy River’ TAIC investigation (15-002) and the placing of the Robinson type on the TAIC ‘Watchlist’ in October 2016 are particularly relevant to the matter. The flight profile associated with many DOC operations, mountainous conditions, high winds and occasionally severe turbulence, are the exact conditions identified by TAIC as being the most conducive to mast-bumping and in-flight break-up.”

While the writer is aware that other organisations may have mirrored DOC's decision and suspended or banned the use of Robinson helicopters, this report does not extend to, nor has it taken instruction from, any organisation other than the Department of Conservation.

Assumptions and Limitations

Because of the commonality of the design philosophy of the three Robinson helicopter models, R22, R44 and R66, in particular the low inertia two-bladed semi-rigid teetering main rotors with independent coning hinges, and the teetering cyclic control systems (both unique to the Robinson helicopter), this report does not differentiate between the models.

The issue around concerns associated with the safety of the design and/or operation of Robinson helicopters is extensively documented.

This report does not purport to cover all technical aspects of the design or of the operation of Robinson helicopters, nor every aspect of the various documents to which it refers or takes excerpts from.

Authorities such as the helicopter manufacturer (Robinson), US National Transport Safety Bureau (NTSB), US Federal Aviation Administration (FAA), New Zealand Civil Aviation Authority (CAA) and the NZ Transport Accident Investigation Commission (TAIC), are all on record with their respective positions.

These authorities are all very well informed. However, apart from the apparently agreed fact that Robinson helicopters can be susceptible to large, improper or abrupt control inputs (Robinson Safety Notices SN 20 and SN 32)⁵ increasing the likelihood of mast bumping and subsequent in-flight break-up, there is a divergence of opinions on why this is so.

The language used in this report is, as far as is practical, intentionally 'non-technical'

What is mast bumping?

As the term recurs throughout all documentation on the subject, a brief explanation is included for the sake of clarity. 'A mast bump event is not the initiating cause of an accident. It is part of the accident sequence', Kurt Robinson CEO Robinson Helicopters Corporation. The onset of mast bumping can be preceded by the helicopter entering a 'low-G' flight profile.

A 'mast bump' is a contact between an inner part of a main rotor blade or a rotor hub and the main rotor drive shaft (or 'mast') during blade rotation. With a R44 blade passing the nose of the aircraft 13 times per second, if one blade hub makes contact with the mast, the subsequent events happen extremely quickly.

Mast bumping usually results in the helicopter breaking up in flight, which is almost always fatal for those on board (RHC Safety Notice #11)⁶

What happens during the mast bump sequence is well understood. What is not well understood, or in fact is in contention, is what the circumstances were during a flight that created the conditions that induced the mast-bump.

Executive summary

Research in the preparation of this report has found opinions of the well-informed organisations regarding the design and/or safe operation of Robinson helicopters to be

⁵ <https://robinsonheli.com/robinson-safety-notices/> (RHC Safety Notices #20 & 32)

⁶ <https://robinsonheli.com/robinson-safety-notices/> (RHC Safety Notice #11)

polarized. Robinson Helicopter (RHC) is of the stated opinion that the safety concerns surrounding the phenomenon of mast bumping in their helicopters is attributable to inappropriate or incorrect control inputs of inexperienced or poorly trained pilots under certain flight conditions. In the company's written response to the TAIC Interim Report on the Whangarei accident [AO 2016-007]⁷ dated 30th November, RHC refers to previous New Zealand accidents involving Low G mast bumping, saying 'these appear to stem from certain training, operational culture and regulatory elements unique to New Zealand'.

RHC Safety Alert⁸ issued 18th November 2016 gives the assurance that mast bumping accidents are entirely avoidable if stated procedures are adhered to.

New Zealand CAA appears to agree with RHC that better training of pilots is the solution. The following statement is made on the CAA website⁹ "CAA considers that there is enough evidence to conclude that the operation of Robinson helicopters may endanger persons or property if pilots have not been properly trained in operation of the aircraft in certain conditions."

CAA's response to two TAIC recommendations resulted in changes to the Robinson Safety Awareness training for R22 and R44 pilots in New Zealand¹⁰. However, by its own admission (CAA letter to NZ Helicopter Assn. 2nd Feb. 2017), CAA believes these changes to the safety awareness training alone will not necessarily produce guaranteed or immediate results. It further states "the onus will remain on operators to operate the aircraft appropriately and to demonstrate an improved safety performance."

The US National Transportation Safety Bureau (NTSB) along with the NZ Transport Accident Investigation Commission (TAIC), on the other hand, is on record as holding a different view. Excerpts from a **Special Investigation Report into Robinson Loss of Main Rotor Control Accidents April 1996**¹¹: Notation 6405B, with respect to testing and certification of the rotor-head design, in part states:

"The Safety Board is concerned that adequate testing may not have been accomplished during certification to resolve possible adverse aerodynamic characteristics of the rotor and flight control systems of both the R22 and the R44. The Safety Board is concerned that the stability of the R44 and R22 main rotor blades may be compromised by an inherent rotor system design deficiency that may allow loss of control of the rotor system when operating the helicopter within the currently defined flight envelope and in a manner that would seem normal in other light helicopters".

The NZ Transport Accident Investigation Commission, (TAIC) is unambiguous in its position when on its website www.taic.org.nz it states¹²:

⁷ <http://www.taic.org.nz> [16-007 R44]

⁸ https://robinsonheli.com/wp-content/uploads/2017/01/sa_low_g_mast_bumping_accidents.pdf (RHC Safety Alert)

⁹ <https://www.caa.govt.nz/pilots/pilots/robinson-helicopter-safety/Implementation>

¹⁰ <https://www.caa.govt.nz/pilots/pilots/robinson-helicopter-safety/>

¹¹ <http://www.rotorshop.com/sir9603.pdf> **Special Investigation Report into Robinson Loss of Main Rotor Control Accidents April 1996:**

¹² <http://www.taic.org.nz/Watchlist2016/RobinsonhelicoptersmastbumpingaccidentsinNZ/tabid/293/language/en-US/Default.aspx>

“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. Part of the problem is that the available evidence has not allowed the circumstances and causes of all of these ‘mast bumping’ accidents to be fully determined.”

“Further research should be undertaken into the factors that can lead to mast bumping.”

While there is always room for better training to improve a pilot’s knowledge, skills and understanding of helicopter dynamics and performance, there remains a strongly stated contention on the part of the agencies (NTSB and TAIC) tasked with determining the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in future, that all circumstances surrounding flights that have resulted in mast-bump accidents may not be fully understood.

Despite the stated opinions of both agencies, at the time of writing this report, neither the helicopter manufacturer, RHC nor NZCAA have given any indication these concerns will be further investigated.

In the words of one submitter **“Despite the renewed emphasis on training, there has been no attempt at an enduring solution that would either confirm or remove the alleged uncertainties around the helicopter’s design”**.

The knowledge around unexplained mast bump events is unchanged from when DoC initiated their suspension in November 2016, with the exception that TAIC have subsequently stated that one fatal accident (R44 Glenberrie Forest) is ‘very unlikely’ to have been a mast bump event, but that another (R44 Kahurangi National Park) has been confirmed as being a mast bump event. Assuming DOC’s risk appetite is also unchanged since the issue of the suspension notice, the validity of the issue of that notice remains.

TAIC’s statement¹³ that *“Operators must select a type of aircraft suited to the risk profile of the intended use”* is inextricably linked to the DoC statement in their Brief provided to TAQ in commissioning this report – *“The flight profile associated with many DOC operations (mountainous conditions, high winds and (occasionally severe) turbulence are the exact conditions identified by TAIC as being the most conducive to mast-bumping and in-flight break-up.”*

Methodology

Consultation

In the preparation of this report a number of industry participants with a declared interest in the topic were consulted.

The Helicopter Association of New Zealand (HANZ) was advised, via Aviation New Zealand, of the appointment of TAQ to provide independent advice to DoC and invited to make a submission on behalf of its membership. HANZ through the Aviation New Zealand weekly

¹³ <http://www.taic.org.nz/Watchlist2016/RobinsonhelicoptersmastbumpingaccidentsinNZ/tabid/293/language/en-US/Default.aspx> ‘What is the solution’

Newsletter notified all recipients of the review and provided TAQ's email address for operators to make individual submissions. Three emails were received as a result. In conducting the review the writer has sought the input of very experienced Robinson pilots, two of whom have logged 16000 hrs and 13000 hrs on the helicopter type respectively. Their considered and constructive views are that if the helicopter is flown within its design limits by properly trained pilots it is a safe helicopter. Those views are respected.

Document review

Where available, links to documents reviewed in the preparation of this report are annotated by footnote.

Department of Conservation (DOC) Helicopter Operations

Different makes and models of helicopters are used by DOC in a wide variety of roles, including accessing some of the most mountainous and remote parts of the country.

DOC helicopter operations will, at many times, be conducted in geographical regions conducive to the generation of turbulence. The country is mountainous and subject to maritime climate patterns, as compared to a more benign continental climate. The presence and magnitude of turbulence is unpredictable. It may not be present at the commencement of a flight, but become prevalent to severe over the period of a flight or with a change in weather or topography during the conduct of a given flight.

It is common ground throughout RHC, CAA, NTSB and TAIC documentation that the three Robinson helicopter models have been shown to be susceptible to low G conditions and subsequent mast-bump on entry into, or flight in, turbulence, particularly when lightly loaded. This has resulted in:

- ⊙ Special training of pilots (uniquely mandated by legislation for pilots of Robinson R22s and R44s and not for any other helicopter model),
- ⊙ Additional cautionary limitations to airspeed (R44 and R66) for flights other than in 'smooth air',
- The promulgation of a manufacturer's Safety Alert recommending pilots slow down during periods of distraction such as tuning radios or conducting conversations with passengers,
- ⊙ The generation of two separate Robinson Safety Notices.
 - SN 11 advising pilots to take great care to avoid any maneuver that could result in a low G condition – adding that low G mast bump accidents are almost always fatal.
 - SN 32 (the wording of which was revised in May 2013 and again in February 2016) stating that flying in high winds or turbulence should be avoided.
 - SN 32 is supplemented by an instructional video placing further emphasis on the susceptibility of the R66 when operated at light weights.

Curiously, a further Robinson Safety Notice (SN 44 issued Feb. 2017)¹⁴ warns that *“carrying a passenger in and of itself increases risk because passengers add workload and distractions.”*

DOC is the single largest hirer of helicopters in NZ spending around \$15m per annum on helicopter hire. It must consider if the ongoing use of a helicopter type that attracts these precautionary, or even corrective, measures is appropriate to the conditions likely to be encountered in a flight profile typical of its operating environment, when alternative helicopter types are available.

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¹⁴ <https://robinsonheli.com/robinson-safety-notices/> (RHC Safety Notice #44)

Health and Safety at Work Act 2015 (The Act)

This report is not required to comment at length on the HSW Act. However, some basics must be stated for the sake of context. Under the Act, DOC as a PCBU, has the primary responsibility for the health and safety of workers and others influenced by its work. The Act states: All businesses must ensure, so far as is reasonably practicable, the health and safety of its workers and any other workers who are influenced or directed by the business. (e.g. In DOC context – its direct contractors and volunteers)

As a PCBU, DOC is required to identify and understand work-related health and safety risks; particularly those that have the potential to cause people serious injury or illness. It is required to do what is reasonable, what is practical and what it is able to do to eliminate or, where they can't be eliminated, minimise those risks.¹⁵

Robinson Helicopter Corporation (RHC)

The company manufactures helicopters at its base in Torrance, California. Various models of the three basic types (R22, R44 and R66) are in common use in New Zealand and throughout the world. All three types have a common two-bladed, semi-rigid teetering main rotor design. The blades have independent coning hinges, a feature unique to Robinson [TAIC]¹⁶

The company is of the stated opinion that the safety concerns surrounding the phenomenon of mast bumping in their helicopters is attributable to inappropriate or incorrect control inputs of inexperienced or poorly trained pilots.

Notably, one NZ accident victim had 4,500 hrs helicopter experience with 2,145 on Robinsons of which nearly 1,000 hrs were on R44s. Another (non-fatal), an 'A' Category helicopter instructor had 7100 hours of which 1900 hrs were instruction.

In November 2016, RHC published a **Safety Alert 'Low-G mast bumping accidents'** giving the assurance that mast bumping accidents are entirely avoidable if the following procedures are adhered to:

- Avoiding a 'low G' flight profile
- Avoiding cyclic 'push-overs'
- Applying the correct recovery technique in the event of an un-commanded low G situation
- Do not over-react or use excessive control inputs in turbulence
- Slow the aircraft down when flying in turbulence
- Slow the aircraft down at any time the flight is for the purpose of training or transition
- Slow the aircraft down anytime the pilot's full attention is not being applied to flying such as when talking to passengers or changing radio frequencies.

Robinson's Safety Alert advises pilots that if all the precursors to the mast bumping condition are avoided, in-flight break up will not occur. Given the large number of Robinson helicopters

¹⁵ www.worksafe.govt.nz

¹⁶ <http://www.taic.org.nz> [14-006] R44 HBQ para 3.3.4 pg. 6

flying around the world that have not experienced mast bumping and resultant in-flight break-up it is asserted that the conditions conducive to this phenomenon can be attributed to only two things:

- Environmental conditions e.g. turbulence and/or
- Inappropriate pilot inputs to the aircraft controls

RHC President, Kurt Robinson, disagreed with TAIC findings in their report [AO 2014-006 R44 HBQ] where he is quoted, *"I think the pilot was flying and doing something he shouldn't have been doing, unfortunately."* (Media report - Carla Penman Radio NZ 30th March 2017)¹⁷.

The position of Robinson is interpreted as being that the continued safe operation of their helicopters in New Zealand and around the world is dependent on properly trained pilots focussed on flying the helicopter and applying the correct control inputs throughout all flight regimes and operating the helicopter within its flight limitations at all times.

New Zealand Civil Aviation Authority (CAA)

The CAA's response to two TAIC recommendations resulted in changes to the Robinson Safety Awareness Training in NZ to more fully align with SFAR 73 *Robinson R-22/R-44 Special Training and Experience Requirements* mandated in the United States by FAA in 1995. Details of the consultation and a full summary of the resultant changes implemented by CAA are published on the CAA website.¹⁸

Key elements of the training include:

- A new syllabus of R22/R44 'Ground' and 'in-flight training' is prescribed.
- ⊙ The training will be completed by CAA certificated Part 119 and 141 organisations, or operators who have an approved Robinson safety course.
- ⊙ It will be delivered by suitably approved and qualified A or B-cat instructors.
- ⊙ A General Aviation examiner with Robinson safety awareness privileges must approve the A and B-cat instructors delivering the awareness training.
- ⊙ The training will be required when new pilots are type rated.
- ⊙ Ongoing training will be required every 24 months.
- ⊙ The pre-solo dual requirements on the R22 and R44 have been raised to 20 hours.

Of particular note is that NZCAA has declined to accept the TAIC recommendation that the improved Robinson Safety Awareness training requirements be extended to include pilots flying the R66 model. CAA's reply to this TAIC Safety Recommendation 002/16 is recorded on the TAIC website stating: *"The CAA's position on this is that on the basis that the FAA has twice rejected the inclusion of the Robinson R66 model in SFAR 73, the Director will not implement the recommendation, but will continue to monitor advice from Robinson Helicopters and the FAA with respect to the operation of R66 helicopters"*. The status of this TAIC Recommendation remains recorded as 'Open'.

¹⁷ <http://www.radionz.co.nz/news/national/327794/us-helicopter-maker-rejects-nz-crash-report>

¹⁸ <http://www.caa.govt.nz/pilots/pilots/robinson-helicopter-safety/>
http://www.caa.govt.nz/assets/legacy/pilots/robinson_conditions.pdf

TAIC's investigation into NZ's only R66 fatal accident [AO-2013-003] para 1.3 suggests that the R66 is as vulnerable as the smaller Robinson R22/R44 types to a catastrophic mast bump under certain conditions. The R66 has the same main rotor system design as R22 and R44.

In a letter to the NZ Helicopter Association in response to a NZHA request asking CAA to help remove Robinsons from the TAIC Watchlist on 2nd February 2017, CAA stated *"Implementing the recommendations will probably not be sufficient to remove the helicopter type from the watchlist. It is likely to take some years of operating the aircraft without accidents attributed to mast bumping as proof that the measures implemented have been effective. While the CAA can assist through various regulatory activities, and recent changes to safety awareness training and the Airworthiness Directive creating a yellow arc on the airspeed indicator for flight in turbulence are examples, the onus will remain on operators to operate the aircraft appropriately and to demonstrate an improved safety performance."*

In August 2016, CAA commissioned an industry-wide Helicopter Safety Survey. A total of 596 responses were received. In response to the question "How frequently did respondents think helicopter performance limitations were exceeded; 13% of respondents thought 'Frequently' and 49% of respondents thought 'Sometimes'¹⁹.

Transport Accident Investigation Commission (New Zealand)

The Commission's role is to determine the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future. (www.taic.org.nz).

Excerpts from TAIC website: [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.

Part of the problem is that the available evidence has not allowed the circumstances and causes of all of these 'mast bumping' accidents to be fully determined.

...a significant proportion have been found to have occurred in "low-G" flight 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."

¹⁹ [http://www.aia.org.nz/site/aianz/2016%20New%20Zealand%20Helicopter%20Survey%20Results%20\(1\).pdf](http://www.aia.org.nz/site/aianz/2016%20New%20Zealand%20Helicopter%20Survey%20Results%20(1).pdf)

What is the TAIC Watchlist?

According to its website, the Watchlist highlights the Commission's most pressing concerns²⁰. Items make the Watchlist because they represent:

- ⊙ High social, economic, or environmental risk,
- ⊙ They highlight systemic issues affecting transport safety, or
- ⊙ It is an issue the Commission has raised as a result of an enquiry, but little has happened as a result, and we (TAIC) believe we are likely to see a repeat occurrence.

When we see the same issue re-appearing and the lessons we have identified not being addressed, then we will try to raise awareness of our recommendations by adding them to our Watchlist.

"The commission is not a regulator, policy-maker or transport operator. It can only try to influence those that are."

(Media briefing notes: Commissioner Stephen Davies Howard, Watchlist 2016).

On 27 October 2016, TAIC added matters regarding the safety of the Robinson helicopter to its Watchlist saying:

- *Since 1996 TAIC and the CAA have investigated 14 mast bumping accidents involving Robinson helicopters costing the lives of 18 people.*
 - **[Note:** Following release of the Kahurangi R44 accident report [A2014-006] this number is now 15 accidents costing the lives of 19 people].
- *The rate of Robinson helicopter in-flight break-up accidents in New Zealand had not been significantly reduced by the adoption of US FAA measures intended to help prevent such accidents.*
- *"Four of our earlier recommendations made as a result of Robinson mast bump accidents have yet to be actioned. We therefore remain concerned that there is real risk that we will see more of this type of accident."*

(Commissioner Stephen Davies Howard, Watchlist 2016).

TAIC, in its report **AO 2013-003 R66 IHU** para 1.7 states:

"It is likely that mast bump accidents with Robinson helicopters will continue to happen unless the dynamic behaviour of the main rotor preceding such a catastrophe is fully understood."

TAIC recommendation 015/16²¹ [Status – Open]

On 27th July 2016, the Commission made a recommendation for the need for cockpit video recorders and/or other forms of data capture in the cockpits of certain classes of helicopter to address this safety issue.

²⁰ <http://www.taic.org.nz/Watchlist2016/TwoMorePressingConcernsWatchlist2016/tabid/298/language/en-US/Default.aspx>

²¹ <http://www.taic.org.nz/OutstandingSafetyRecs/tabid/95/Page/1/Mode/null/Recipient/null/ImplementationStatus/Open/Keywords/null/IssuedDateOffset/0/language/en-US/Default.aspx>

CAA responded that it is prepared to accept the recommendation. It will conduct a safety and cost benefit exercise of installing flight data and/or cockpit video in certain classes of helicopters. Given the timeframe of such a study is likely to be lengthy; the Director cannot provide a completion date at this stage.

While the installation of data capture technology would be a valuable aid to any post-accident investigation and subsequent prevention, this recommendation does not hold much significance in the context of this report. Installation of data capture technology such as cockpit cameras would not eliminate or minimise the risk of an accident occurring. Although such data may well provide insight into the circumstances on-board that preceded a mast-bump initiated in-flight break-up.

US National Transportation Safety Bureau (NTSB)

Much the same as the NZ TAIC, the NTSB is charged with determining the probable cause of transportation accidents and promoting transportation safety (www.nts.gov).

Excerpts from a **Special Investigation Report into Robinson Loss of Main Rotor Control Accidents April 1996**: Notation 6405B, with respect to testing and certification of the rotor-head design, in part states:

“The Safety Board is concerned that adequate testing may not have been accomplished during certification to resolve possible adverse aerodynamic characteristics of the rotor and flight control systems of both the R22 and the R44”.

“The Safety Board is specifically concerned that the unique design of the R22 and R44 rotor system may result in flight characteristics that are not adequately addressed by 14 CFR Part 27 certification standards; Anomalies in the main rotor system or cyclic control in the cockpit may have gone undetected during the original certification process”.

“The Safety Board is concerned that the stability of the R44 and R22 main rotor blades may be compromised by an inherent rotor system design deficiency that may allow loss of control of the rotor system when operating the helicopter within the currently defined flight envelope and in a manner that would seem normal in other light helicopters”.

Note: This NTSB Safety Board report does not include reference to Robinson’s more recent model, the turbine powered R66, as this model was introduced 15 years later in 2011. However, the rotor-head design of the R66 is a growth variant of the design of the R22 and R44.

All three Robinson types have two-bladed, semi-rigid teetering main rotors. The blades have independent coning hinges, a feature unique to Robinson [TAIC AO 2014-006 R44 HBQ Kahurangi para 3.3.4 pg. 6].

Summary

The following points are summarised in bullet point format for readability. No significance should be attached to the order in which they are written.

- DOC's suspension of the carriage of DOC employees, contractors and volunteers in Robinson helicopters is currently in place.
- DOC's notice of suspension reads that DOC would review its position as further information (from CAA) came to hand.
- At the time of this report no further information (from CAA) has come to hand
 - One Interim report from TAIC has said a mast bump event was 'very unlikely' (R44 Glenbervie accident)
 - Another final report confirmed mast bump and in-flight break did occur (R44 Kahurangi accident)
- The suspension does not affect the use of Robinson helicopters for tasks where DOC staff etc. are not carried e.g. external load ops or animal control where the shooter is not a DOC person.
- The suspension does not affect aerial spraying operations as the carriage of a passenger (DOC employee or otherwise) is not permitted by CAA Rule 137 except where operators are individually authorised in writing to do so by CAA for Wand spraying.
- Kurt Robinson, CEO Robinson Helicopters, has attributed mast bump accidents in New Zealand to 'certain training, operational culture and regulatory elements unique to New Zealand'.
- Unexplained mast bump events resulting in in-flight break-ups are not exclusive to New Zealand.
- Robinson Helicopters is of the stated opinion that the safety concerns surrounding the phenomenon of mast bumping in their helicopters is attributable to inappropriate or incorrect control inputs of inexperienced or poorly trained pilots.
- An RHC Safety Alert asserts that mast bumping accidents are entirely avoidable if the certain procedures are adhered to.
- CAA concurs with RHC in stating on its website *"CAA considers that there is enough evidence to conclude that the operation of Robinson helicopters may endanger persons or property if pilots have not been properly trained in operation of the aircraft in certain conditions."*
- CAA has accepted a TAIC recommendation to improve training for all R22 and R44 pilots in New Zealand.

- CAA has rejected a TAIC recommendation to mandate the same Robinson Safety Awareness training for pilots of R66 helicopters.
- A CAA letter to NZHA states it [CAA] believes that changes to the safety awareness training alone will not necessarily produce guaranteed or immediate results. It further states, *"The onus will remain on operators to operate the aircraft appropriately and to demonstrate an improved safety performance."*
- Out of 596 responses to a 2016 Industry-wide Helicopter Safety Survey, in response to the question "How frequently did respondents think helicopter performance limitations were exceeded; 13% of respondents thought 'Frequently' and 49% of respondents thought 'Sometimes'
- TAIC have raised concerns about the risks of flying these helicopters in the mountainous terrain and weather conditions that are common in New Zealand.
- TAIC believe part of the problem is that the available evidence has not allowed the circumstances and causes of all 'mast bumping' accidents to be fully determined.
- TAIC also state they believe that "It is likely that mast bump accidents with Robinson helicopters will continue to happen unless the dynamic behaviour of the main rotor preceding such a catastrophe is fully understood."
- Despite the renewed emphasis on training, there has been no attempt at an enduring solution that would either confirm or remove the alleged uncertainties around the helicopter's design.
- There is no evidence that, with the currently available information, TAIC are going to remove the Robinson helicopter from its Watchlist.
- The US National Transportation Safety Board, has stated its concern that *"the stability of the R44 and R22 main rotor blades may be compromised by an inherent rotor system design deficiency that may allow loss of control of the rotor system when operating the helicopter within the currently defined flight envelope and in a manner that would seem normal in other light helicopters."*
- This statement by NTSB is informative as it suggests firstly that it believes problems may be evident when operating the helicopter 'within the currently defined flight envelope', and secondly, that the same problems would not be encountered in other light helicopters
- Clearly the positions of the parties are divergent.

- DOC as a PCBU has, under the Health and Safety at Work Act 2015, obligations to ensure, so far as is reasonably practicable, the health and safety of its workers and any other workers who are influenced or directed by the business.
- As a PCBU, DOC also has an obligation to identify and understand work-related health and safety risks; particularly those that have the potential to cause people serious injury or illness.
- In this regard, DOC, as the purchaser of a service, is entitled to choose a service (or product) which it considers to best meet its needs and is fit for purpose under all conditions for which it will be used. While cost of the service or product will be a consideration, it cannot be an overriding consideration
- The reasons why some Robinson helicopters have broken up in-flight with fatal results while many pilots have operated the same helicopter types in the same geographical and environmental conditions for many years and many thousands of hours sees the helicopter manufacturer and NZ CAA with views opposed to that of the agencies tasked with determining the circumstances and causes of accidents and incidents with a view to avoiding similar occurrences in the future.
- RHC Safety Notices and Safety Alert advise that a pilot must be 100% focussed on flying its helicopters. Pilots must minimise distractions such as reading charts, programming avionics, or attending to passengers (SN 41) and slow down when re-tuning radios or having a conversation with passengers (RHC Safety Alert). In fact, SN 41 suggests that any avionics programming that takes 'more than a few seconds' should be done while on the ground.
- While, during many flight profiles for which the Robinson helicopter was designed and intended, it may be possible to comply with the Safety Alert and Safety Notice recommendations, the same might not be so during a typical DOC operation flight profile.

Recommendations

The terms of reference for this report do not require it to make recommendations.

John Fogden

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