CIVIL AVIATION AUTHORITY
OF NEW ZEALAND

# AIRCRAFT ACCIDENT REPORT

## OCCURRENCE NUMBER 06/633

## ROBINSON HELICOPTER R22 BETA II

## ZK–HLC

## 22 NM North-West of WANAKA

## 5 MARCH 2006

# 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. 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.

# Contents

**Glossary of abbreviations used in this report**

| | |
|---|---|
| AD | Airworthiness Directive |
| AMSL | above mean sea level |
| CAA | Civil Aviation Authority |
| EASA | European Aviation Safety Agency |
| ELT | Emergency Locator Transmitter |
| mm | millimetre(s) |
| nm | nautical mile(s) |
| NW | north-west |
| NZ | New Zealand |
| NZDT | New Zealand Daylight Time |
| PPL(H) | Private Pilot Licence (Helicopter) |
| P/N | part number |
| RPM | revolutions per minute |
| STC | Supplemental Type Certificate |
| UK | United Kingdom |
| USA | United States of America |
| WGS 84 | World Geodetic System 1984 |

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OF NEW ZEALAND

# AIRCRAFT ACCIDENT REPORT

## CAA OCCURRENCE No. 06/633

| | |
|---|---|
| **Aircraft type, serial number and registration:** | Robinson R22 Beta II, 3803, ZK-HLC |
| **Number and type of engines:** | 1 Lycoming O-360-J2A |
| **Year of manufacture:** | 2005 |
| **Date and time:** | 5 March 2006, 0855 hours[1] |
| **Location:** | Latitude[2]: S 44º 28.34'<br>Longitude: E 168º 46.58'<br>Altitude: 5082 feet AMSL |
| **Type of flight:** | Private |
| **Persons on board:** | Crew: 1<br>Passenger: 1 |
| **Injuries:** | Crew: 1 Fatal<br>Passenger: 1 Fatal |
| **Nature of damage:** | Aircraft destroyed |
| **Pilot's licence:** | Private Pilot Licence (Helicopter) |
| **Pilot's age:** | 29 years |
| **Pilot's total flying experience:** | 96.6 hours,<br>91.9 hours on type |
| **Information sources:** | Civil Aviation Authority field investigation |
| **Investigator in Charge:** | Mr T P McCready |

[1] All times are NZDT (UTC + 13 hours).

[2] WGS 84 co-ordinates.

## Synopsis

The Civil Aviation Authority (CAA) was notified at 1000 hours on Sunday 5 March 2006 that a Robinson R22 helicopter registered as ZK-HLC had been involved in a fatal accident. The Transport Accident Investigation Commission were also notified, however they declined to investigate. A CAA field investigation was commenced the following day.

The helicopter had departed Wanaka Aerodrome at approximately 0815 hours with two persons on board. The intended flight was a one hour private scenic flight including the Homestead Peak area and then return to Wanaka Aerodrome.

At 0900 hours that morning a fire was reported at Homestead Peak. A helicopter equipped with fire fighting equipment was despatched. On arrival at the scene the pilot established that the fire had been caused as a result of a helicopter accident. Subsequent attendance at the accident scene by emergency services personnel determined that there were no survivors.

Helicopter wreckage was found scattered down the steep mountain face. The helicopter's left cabin door and a section of main rotor blade were located some distance from the accident site. An inflight break up had occurred initiated by an undetermined event.

# 1. Factual information

## 1.1 History of the flight

1.1.1 The pilot, who worked as a barman at a local hotel, had first met the passenger in the hotel bar at about 2300 hours the night before the accident. The pair arranged to complete a scenic helicopter flight the following morning. The pilot was scheduled to work at the hotel at 1000 hours on the day of the accident. This placed a tight time frame in which to complete the flight.

1.1.2 On the morning of the accident, at 0711hours, the pilot arranged by telephone to hire the helicopter. He arrived at the aerodrome at approximately 0745 hours in preparation for the planned 0815 hours departure.

1.1.3 Due to the tight time frame, the Duty Instructor at the Flying School assisted the pilot to pre-flight the helicopter.

1.1.4 The passenger arrived at approximately 0800 hours and the helicopter departed at 0815 hours as intended.

1.1.5 At approximately 0900 hours the owner of Mt Aspiring Station reported to emergency services that a fire was burning on the side of Homestead Peak. A helicopter was despatched from Wanaka Aerodrome to investigate and to extinguish the fire.

1.1.6 The accident helicopter was due to return by 0915 hours. When this time had passed the Duty Instructor, already aware of the recent fire call, initiated an overdue aircraft action in accordance with company procedures. Another helicopter was then dispatched and started searching for the overdue helicopter. Concurrently the pilot of the helicopter attending the fire reported finding helicopter wreckage.

1.1.7 The accident occurred in daylight, at approximately 0855 hours, at Homestead Peak, at an altitude of 5082 feet AMSL. Latitude: S 44° 28.34', Longitude: E 168° 46.58'.

## 1.2 Injuries to persons

| *Injuries* | *Crew* | *Passengers* | *Other* |
|---|---|---|---|
| Fatal | 1 | 1 | 0 |
| Serious | 0 | 0 | 0 |
| Minor/None | 0 | 0 | |

Table 1: Injuries to persons

## 1.3 Damage to aircraft

1.3.1. The helicopter was destroyed.

## 1.4 Other damage

1.4.1 A fire occurred which burnt an area of approximately one hectare of light vegetation.

## 1.5 Personnel information

1.5.1 The pilot, aged 29, was a Canadian citizen carrying out his helicopter training in New Zealand. He held a helicopter Private Pilot's Licence (PPL(H)) and also a Medical Certificate (Class 1) which was valid until 4 May 2006. This Medical Certificate was appropriate for his pilot's licence, and also for a Commercial Pilot's Licence which he was training towards.

1.5.2 The pilot had gained his PPL(H) on 17 August 2005. His last Pilot's Logbook entry on the 28 February 2006 showed that he had a total of 96.6 flying hours, which included 91.9 hours on the Robinson R22 helicopter type.

1.5.3 The passenger was an American citizen who was visiting New Zealand as a tourist.

## 1.6 Aircraft information

1.6.1 The Robinson R22 Beta II helicopter, ZK-HLC, serial number 3803, was manufactured in the USA in 2005 and had recorded 495 flight hours at the time of the accident. The most recent maintenance activity was a 500 hour inspection carried out on 17 February 2006.

1.6.2 The helicopter was purchased new by the Flying School, and had been utilised for pilot training as well as occasional commercial work.

1.6.3 The helicopter had a Standard Category Non-Terminating Airworthiness Certificate issued on 12 May 2005. It was fitted with a Lycoming O-360-J2A engine, serial number L-39948-36A, which had recorded a total of 495 operating hours at the time of the accident.

## 1.7 Meteorological information

1.7.1 A pilot in the local area reported that at the time of the accident he experienced moderate to severe turbulence at an altitude of 11,000 feet, but it was an otherwise fine morning.

1.7.2 The owner of Mt Aspiring Station, who reported the smoke from the fire caused by the accident, stated that the smoke appeared to be rising straight up indicating no sign of wind or turbulence at the accident site.

1.7.3 The pilot of the helicopter tasked with extinguishing the fire reported encountering moderate turbulence about one hour after the accident during the fire fighting operation.

## 1.8 Aids to navigation

1.8.1 Nil.

## 1.9 Communications

1.9.1 The accident pilot's last received radio transmission was a standard position report made to the east of Bonar Glacier at what was thought to be 7,000 feet. This report was heard by a pilot flying at 11,000 feet. The position report was unremarkable and there was no indication from the radio transmission that anything was abnormal.

## 1.10 Aerodrome information

1.10.1 Not applicable.

## 1.11 Flight recorders

1.11.1 Not applicable.

## 1.12 Wreckage and impact information

1.12.1 The accident site was located on the side of a steep mountain ridge approximately 22 nm north-west of Wanaka Aerodrome. To the right of the helicopter's flight path was Homestead Peak and to the left the ground fell away steeply to the river flats of the Matukituki Valley. Steep cliff faces ran down each side of the ridge.

1.12.2 The helicopter impacted at an altitude of 5082 feet on a ridge extending from Homestead Peak. The impact created a crater 2.5 metres in circumference and 0.3 metres deep on the ridge. A rock face adjacent to the crater, which was within the normal main rotor blade disc dimension, showed no signs of any impact marks from the main rotor blades. This indicates that the main rotor blades where not revolving in the normal plane of rotation at the time of impact.

1.12.3 After the initial impact the helicopter bounced backwards from the crater, before tumbling 150 metres down the side of the steep ridge face.

1.12.4 The wreckage was scattered down the ridge face covering an area approximately 25 metres wide by 150 metres long. The helicopter's cabin, complete with the engine, mast, and rotor head, travelled the furthest distance. The tail boom, landing skids, and fuel tanks lay between the initial point of impact and the helicopter's cabin.

1.12.5 The mid-section of one of the two main rotor blades was located on steep terrain 1000 feet below and half a nautical mile from the accident site (see Figure 1). The left cabin door was located in close proximity to the mid section of the rotor blade. Approximately a quarter of the distance between the location of the mid section of main rotor blade and the impact site were small sections of Perspex.

1.12.6 The left cabin door suffered impact damage to its window frame consistent with being struck by a main rotor blade. The main rotor blade mid-section had strike marks matching the impact damage on the left cabin door (see Figure 2). Similar strike marks were also evident on the other main rotor blade.

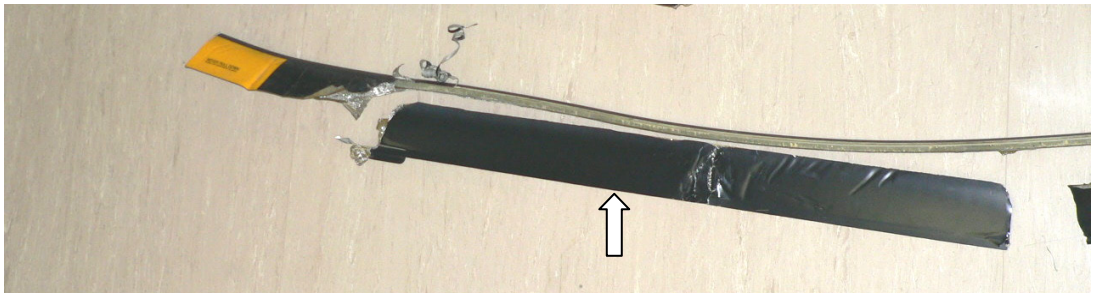

Figure 1

Recovered main rotor blade mid-section (arrowed).

Figure 2

Marks on the main rotor blade caused by contact with the left cabin door.

1.12.7 The upper airframe hinge bracket for the left cabin door was found twisted and broken (see Figure 3).

1.12.8 The lower airframe hinge bracket showed no signs of deformation. The left cabin door fitted neatly into the hinge when reassembled (see Figure 4).

Figure 3

Twisted upper hinge bracket.

Figure 4

Undamaged lower hinge (reassembled).

## 1.13 Medical and pathological information

1.13.1 Toxicological tests conducted on the pilot disclosed no evidence of medicinal or recreational drugs.

1.13.2 No analysis could be carried out for the presence of alcohol as no preserved body fluid was available.

1.13.3 During the collection of the passenger's personal effects from his accommodation, the Police found a number of bottles of prescription medication. The medication was identified as that required to control high blood pressure. Contact was made with his regular Doctor who confirmed that for his age of 61 years, the passenger was in "good medical condition".

## 1.14 Fire

1.14.1 Fire consumed the cabin of the helicopter and burnt approximately one hectare of surrounding light vegetation.

## 1.15 Survival aspects

1.15.1 The accident was not survivable due to the impact forces.

1.15.2 The helicopter was fitted with a Pointer Incorporated 3000-10 emergency locator transmitter (ELT) which when activated, transmits on 121.5 Mhz. No ELT signal was detected from the accident site as the ELT was separated from the helicopter and the airframe mounted antenna during the impact sequence.

## 1.16 Tests and research

1.16.1 The engine was disassembled and inspected at an engine overhaul facility to determine whether any pre-impact mechanical failure had occurred. No evidence of mechanical failure was found during the engine inspection.

1.16.2 Both main rotor blades and the left cabin door were examined by a metallurgy specialist. Impact marks on the main rotor blades were matched with corresponding marks on the left cabin door.

1.16.3 Research into previous Robinson R22 door failures established that, while it is a very rare occurrence for cabin doors to separate in-flight, there have been previous documented reports of cabin doors detaching in-flight in the USA and UK.

## 1.17 Organisational and management information

1.17.1 Not applicable.

## 1.18 Additional information

1.18.1 The airframes for Robinson R22 helicopters are hand-built without the use of accurate jigs. There are consequently differences in the dimensions and clearances between door hinges on different helicopters. As a result, the cabin doors are not interchangeable, as they are custom built to fit the airframe.

1.18.2 Robinson R22 helicopters have been operating in New Zealand since the early 1980's. The cabin doors on early model Robinson R22 helicopters were only secured to the aircraft by a cotter pin fitted to the upper hinge, as there was no provision for a cotter pin on the lower hinge. The clevis pins on the lower door hinges were originally only 0.25 inches long.

1.18.2 A design change to the lower door hinge, known as Revision H, was introduced by the helicopter manufacturer in November 1994. All new helicopters, and those which underwent an overhaul after this date, were fitted with a more secure lower door hinge. This was accomplished by lengthening the lower hinge clevis pin from 0.25 inches to 0.45 inches, and adding a hole to enable the insertion of a cotter pin (see Figure 5).

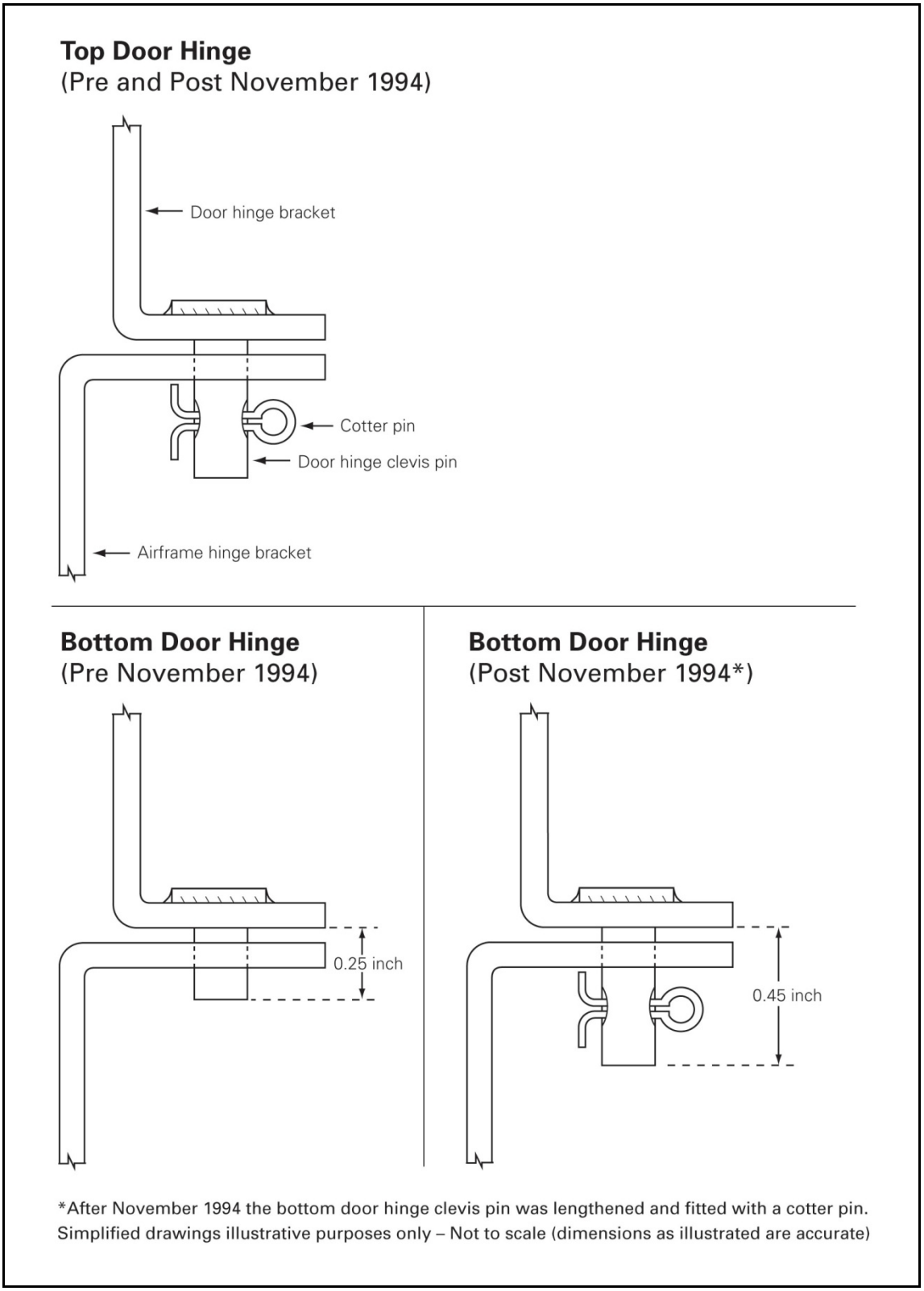


Figure 5

Illustration of upper and lower Robinson R22 cabin door hinge design change.

1.18.3 In late 1994 the UK CAA issued an Airworthiness Directive (Robinson 002-10-94) which required all UK registered Robinson R22 helicopters to be fitted with door

hinges that are compliant with Revision H. The Airworthiness Directive instructions required the change to the door hinges to be completed by 31 January 1995. This Airworthiness Directive was prompted following an in-flight cabin door separation on a UK registered Robinson R22 helicopter. This was deemed by the UK CAA as a serious flight safety issue. The Airworthiness Directive was only applicable to UK registered Robinson R22 helicopters and wasn't reported to other national regulatory authorities.

1.18.4 The first indication from the helicopter manufacturer of the design change to the lower cabin door hinges was made in an amendment to the R22 Pilot Operating Handbook (POH)[3] issued in October 2000. The information in the POH in part states:

*'Both cabin doors may be removed and installed by maintenance personnel or pilots. To remove a door, remove cotter pins in upper and lower hinges, then open and lift door to disengage hinges. (Older doors may only have provisions for upper cotter pin). To install, use reverse procedure'.*

1.18.5 The design change to the lower cabin door hinge was later published in the Robinson Illustrated Parts Catalogue[4] in March 2004. This publication, used primarily by helicopter maintenance personnel, showed the requirement for cotter pins to be fitted to the upper and lower cabin door hinges. A cotter 'ring' P/N B427-1 was also specified in the catalogue as an alternative to the cotter pin.

1.18.6 On 14 June 2006 the UK Airworthiness Directive (Robinson 002-10-94) was republished by the European Aviation Safety Agency (EASA) as Airworthiness Directive No. 2006-0167. This was principally a regulatory administration change brought about by EASA becoming the aviation regulatory authority for the European Union.

1.18.7 As a result of the knowledge learnt from this accident and after further discussions with the helicopter manufacturer, the NZ CAA issued Airworthiness Directive DCA/R22/45 on 27 March 2008. This Airworthiness Directive requires all New Zealand registered Robinson R22 helicopters to have the door hinges regularly inspected to ensure that cotter pins are fitted to the cabin door upper and lower hinges.

1.18.8 On 30 April 2010 the helicopter manufacturer issued Service Bulletin SB-101 which required Robinson R22 helicopter cabin door hinges to be replaced and secured by cotter pins. The NZ CAA followed this up by issuing an amendment to Airworthiness Directive DCA/R22/45C which mandates the compliance with the helicopter manufacturer's Service Bulletin.

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[3] Refer to Section 7 *Systems Description*, Page 7-1.

[4] Refer to Figure 2-21 *Door Assembly*.

### 1.19 Useful or effective investigation techniques

1.19.1 Not applicable.

## 2. Analysis

2.1 The pilot was familiar with the area, having trained with the operator based in Wanaka, and the flight conditions were suitable for his experience level. The flight was also correctly authorised by the Duty Instructor. The flight was therefore conducted in compliance with civil aviation requirements.

2.2 A clear flat area in a valley floor was within the range of the helicopter had the pilot wished to carry out an emergency auto-rotation landing. The fact that the helicopter appears to have been positioning towards the Homestead Peak ridge rather than the valley floor, supports the supposition that control of the helicopter was lost unexpectedly and before the pilot had time to make any deliberate manoeuvres.

2.3 The discovery of the missing main rotor blade mid-section, the left cabin door and pieces of Perspex some distance from the main wreckage area, indicates that an in-flight break up occurred at least half a nautical mile before the impact point.

2.4 As the left cabin door and main rotor blade mid-section were located 1000 feet below the ground impact point on a steep ridge face, they are likely to have fallen at least 1500 feet given the probable descent rate and angle of the helicopter after the door separation.

2.5 Both main rotor blades exhibited witness markings consistent with being struck by the departing left cabin door. The large mid-section of one main rotor blade (approximately 33% of the blade surface area) most likely separated from the main rotor blade when it was struck by the door.

2.6 The safety investigation could not conclusively establish the event that caused the cabin door to detach from the airframe.

2.7 The loss of the mid-section of the main rotor blade would have made control of the helicopter impossible.

2.8 The absence of any main rotor blade strike marks on the rock face adjacent to the initial impact point, which is within the normal rotor disc dimension, suggests that the main rotor blades were at a high angle and out of the normal plane of rotation. It is therefore likely that there was little or no rotor RPM at the time of impact.

2.9 The cabin door upper hinge was severely twisted indicating that the upper hinge clevis pin was most likely secured correctly by a cotter pin. This cotter pin would have retained the door on the hinge long enough for the door to twist about the hinge before the hinge failed in overload (see Figure 3).

2.10 The lower hinge, by comparison, showed no signs of distortion. This indicates that the cabin door had most likely freely detached from the lower hinge as it wasn't secured with a cotter pin, even though there was provision for one (see Figure 4).

2.11 The helicopter most likely had the original factory fitted cabin doors still installed due to its recent manufacture in 2005.

2.12 Helicopter cabin doors are routinely removed and refitted. The doors are removed for certain flights, particularly during the summer months, for jobs such as sheep mustering, photography or lifting operations using a cargo hook. The doors are usually refitted by the pilots after the task is completed.

2.13 Cabin doors are also routinely removed by aircraft engineers during maintenance work to provide ease of repeated entry into the cabin, then refitted at the conclusion of the maintenance.

2.14 Prior to this accident and the release of the NZ CAA's Airworthiness Directive, the importance to safety of ensuring that the helicopter's cabin doors are secured adequately by correctly fitted cotter pins does not appear to have been appreciated by the aviation industry. An inspection programme just after the accident, initiated by the CAA, identified that most Robinson R22 helicopters had incorrectly secured cabin doors.

2.15 The helicopter manufacturer appears to have relied on a series of amendments to the helicopter's operational and airworthiness manuals to create awareness of the importance of fitting cotter pins to the helicopter's upper and lower cabin door hinges. It is expected that these publications would be routinely referred to during operational, training, and maintenance activities, however, in reality this is not always the case.

2.16 It would have been prudent, given the significance of this safety issue, for the helicopter manufacturer to have issued a mandatory service letter or bulletin notifying the need to secure the cabin door hinges with cotter pins. The national aviation regulating agency for the country of design and manufacturing would then normally have issued an associated Airworthiness Directive. This did not happen, most likely because the significance to safety of fitting the cotter pins wasn't necessarily fully appreciated.

2.17 Following the issue of the NZ CAA Airworthiness Directive DCA/R22/45C, a survey of New Zealand Robinson R22 helicopters conducted by NZ CAA showed that the cabin doors were being secured correctly with cotter pins.

## 3. Conclusions

3.1 The helicopter was on a private scenic flight operating over mountainous terrain. The pilot was qualified, authorised and considered competent to conduct the flight.

3.2 The reason for the initiation of the accident sequence could not be conclusively determined. During the accident sequence it appears the left cabin door detached from the airframe and struck the main rotor blades.

3.3 The helicopter's left cabin door was most likely not secured correctly with a cotter pin in the lower hinge. At the time, the importance to safety of fitting the cotter pins to the cabin door hinges was not generally appreciated or widely complied with in the aviation industry.

3.4 The mid-section, from one main rotor blade then separated causing the rotor blades to go out of their normal plane of rotation. This would have made the helicopter impossible to control, resulting in a loss of lift and main rotor RPM.

3.5 The helicopter struck the side of a mountain ridge with a high descent angle and rate, and as a result, both occupants of the helicopter suffered fatal injuries.

3.6 Since this accident, the subsequent publishing of the helicopter manufacturer's Service Bulletin SB-101 and NZ CAA's Airworthiness Directive DCA/R22/45C have formally required all New Zealand registered Robinson R22 helicopters to have cotter pins fitted correctly to secure the cabin doors.

## 4. Safety actions

4.1 The CAA issued Airworthiness Directive DCA/R22/45 as a result of this accident (effective from 27 March 2008) to ensure that R22 helicopter cabin doors are secured using cotter pins in the upper and lower hinges of each cabin door.

4.2 Robinson Helicopter Company issued R22 Service Bulletin SB-101 on 30 April 2010 requiring both hinges to be secured by cotter pins and hinge hardware to be replaced. This Service Bulletin is to be embodied within the next 150 flight hours or by 31 July 2010 whichever occurs first.

4.3 The CAA issued Airworthiness Directive DCA/R22/45C, effective on 27 May 2010, to introduce and mandate the requirements of R22 Service Bulletin SB-101 for NZ registered Robinson R22 helicopters.

Authorised by:

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05 July 2011

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