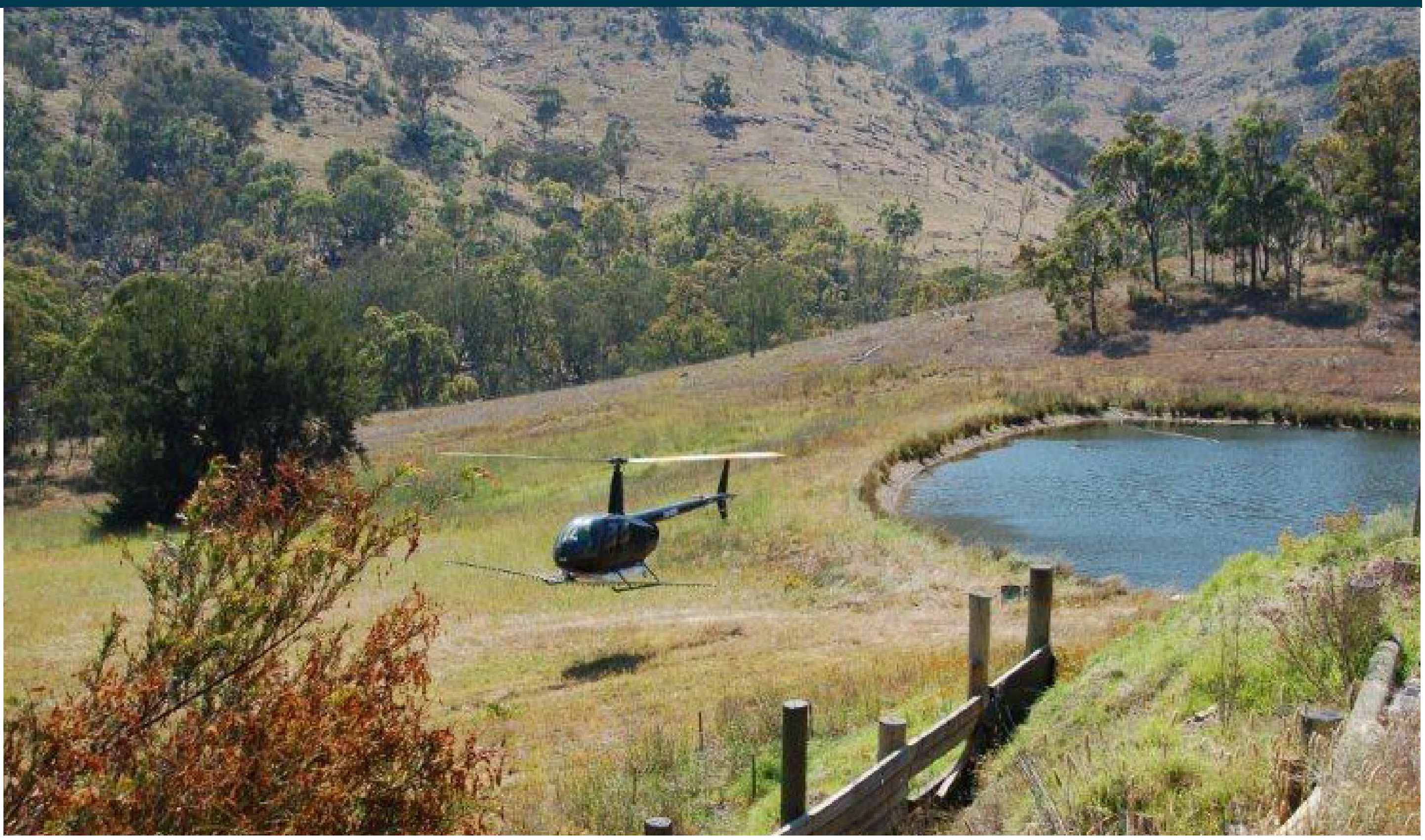
Australian Government
Australian Transport Safety Bureau

Loss of control involving Robinson R44, VH-WOH

20 km south-west of Mudgee, New South Wales | 9 December 2012



Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2012-165
Final – 26 September 2013

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

Publishing information

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Addendum

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Safety summary

What happened

On 9 December 2012, the pilot of a Robinson R44 Raven I helicopter, registered VH-WOH, was conducting aerial spraying activities on a property near Mudgee, New South Wales. Following the completion of a number of spray runs, the helicopter failed to return to the refilling station, and a search was commenced. The helicopter was found about 450 m up a hill from the refilling station, having collided steeply with terrain. The pilot was fatally injured.

Helicopter wreckage

Source: NSW Police

What the ATSB found

Analysis of the recovered global positioning system data identified that immediately before the accident the helicopter was climbing up a hill when the speed decreased below about 10 kt (19 km/h). The ATSB found that at the time of the accident the helicopter was over its maximum allowable weight, was too heavy to hover out-of-ground effect and as the speed decreased, the power required exceeded that available from the engine resulting in a probable reduction in main rotor RPM (overpitch) and a descent. The time between this point and the first contact with a tree was insufficient for the pilot to complete a recovery action. The ATSB also found that the spray system on the helicopter had not been installed by an approved aircraft maintenance engineer.

Safety message

This accident highlights the dangers of operating helicopters overweight, especially when performance is critical, such as when low flying or conducting aerial spraying operations. The use of manufacturer's performance data will assist pilots in avoiding the circumstances associated with this accident.

Contents

The occurrence

At about 0800 Eastern Daylight-saving Time[1] on 9 December 2012, a pilot commenced weed spraying operations on a property 20 km south-west of Mudgee, New South Wales in a Robinson R44 Raven I helicopter, registered VH-WOH (WOH). The intention was to conduct spraying activities on the property followed by further spraying on a neighbouring property. The operation required a loader to remain at a refilling station established at a dam on the property to mix the required chemical prior to loading it into the helicopter (Figure 1). The owner from a neighbouring property was also located at the dam.

The pilot completed seven spray runs around the property, reloading with 240 L of chemical mix each time. At about 0945, having refuelled and reloaded with chemical, the pilot departed on what was reported to be the final run prior to moving operations to the neighbouring property.

Figure 1: Helicopter landing at the refilling station

Source: Property owner

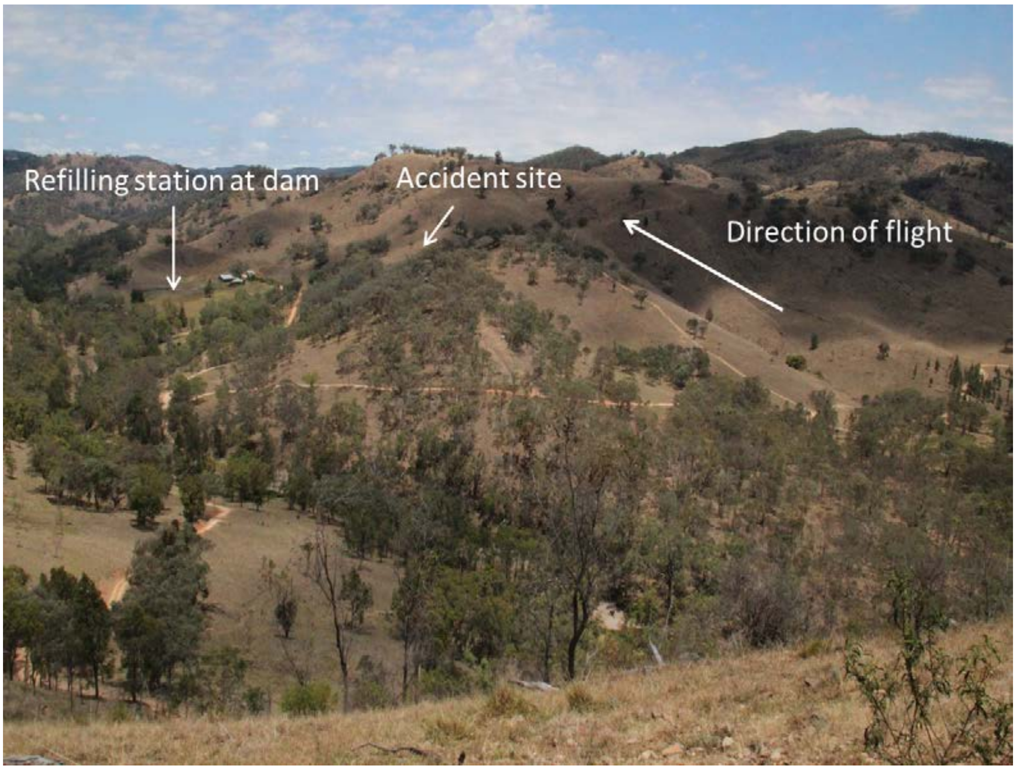
Data recovered from an onboard global positioning system (GPS) receiver that was being used by the pilot during the spraying operations showed that the occurrence flight was about 3 minutes in duration. The property owner, who was located in a nearby building, reported hearing a noise he described as a 'solid thud' consistent with something 'cutting a tree' at about 0950.

At about 1015 the loader and neighbouring property owner became concerned that the helicopter had not returned and, along with the property owner, initiated a search. At about 1100, the helicopter was found on steep terrain about 450 m from the refilling station. The damage to the helicopter and disturbance of the surrounding area indicated that the helicopter contacted a tree before impacting the ground in a steep nose-down attitude with the right skid low (Figure 2, 3 and 4). The pilot was fatally injured and the helicopter seriously damaged.[2] There was no fire.

1 Eastern Daylight-saving Time was Coordinated Universal Time +11 hours.

2 The Australian Transport Safety Regulations 2003 definition of 'serious damage' includes the destruction of the transport vehicle.

Figure 2: Overview of the property and accident site

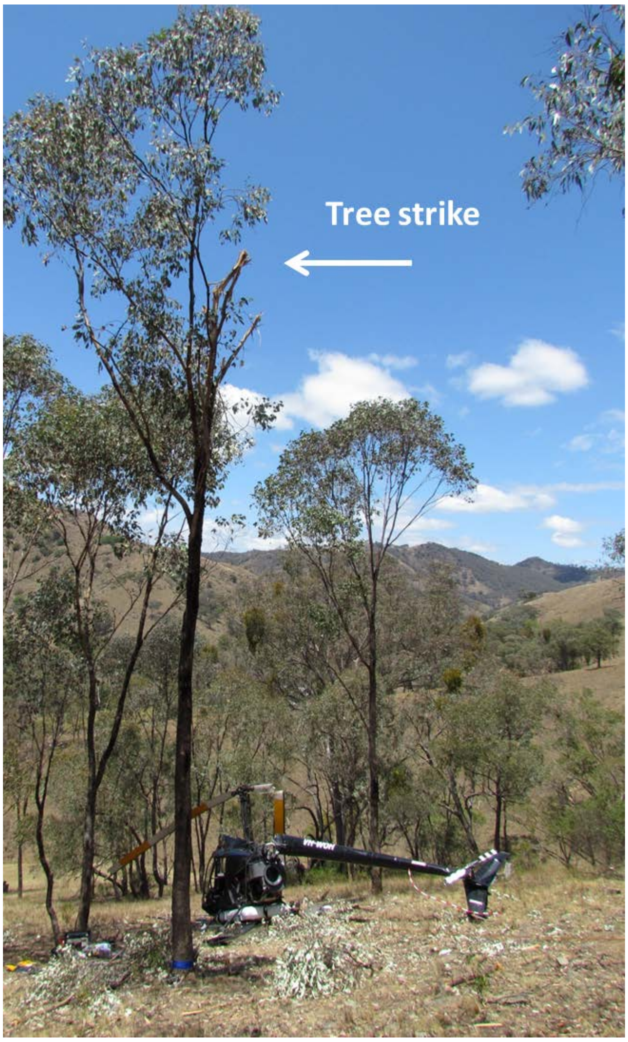


Source: ATSB

Figure 3: Accident site showing the helicopter's position at ground impact

Source: NSW Police

Figure 4: Tree strike and uprighted helicopter position, next to the ground impact point



Source: ATSB

Context

Pilot information

The pilot was appropriately qualified for the flight; holding a Commercial Pilot (Helicopter) Licence issued in 2000 and a Grade 1 Agricultural Rating (Helicopter) issued in 2009. According to the pilot's logbook, his total aeronautical experience was about 3,200 hours, with the majority of these hours accumulated conducting agricultural flying activities.

The pilot was endorsed on the R44 in 2008 and did not log flying on the type again until June 2012 when he flew with an instructor on a re-familiarisation flight of 0.5 hours duration. The pilot then operated WOH on aerial spraying activities for a further 18 hours up to the day of the accident. The ATSB calculated that the pilot had a total of 22 hours on the R44 type.

The pilot's most recent proficiency check was conducted on 28 April 2012 in the form of helicopter conversion training for the issue of a Hughes 269 helicopter endorsement. This did not assess the pilot's agricultural application skills and was not required to do so.

A review of the pilot's spraying records showed he had not conducted agricultural spraying activities on this property previously; however, it was reported that the pilot was familiar with the area and had conducted most of his agricultural spraying activities over similar terrain.

Operations

The pilot was the owner and operator of an agricultural spraying business that operated a Bell 206 helicopter and had recently purchased WOH with the aim of expanding spraying operations. Along with these helicopters, the business also had a truck and trailer for supplying, mixing and loading the chemical, and two fuel tanks to refuel the helicopters. The loader reported that the fuel tank on the truck was filled in the week prior to the accident and had been used to refuel WOH during operations the day before and on the day of the accident.

Helicopter information

General information

The pilot purchased the helicopter and spray equipment from the previous owner about 3 weeks prior to the accident. Prior to being purchased, the helicopter was primarily used as a training and charter helicopter at a flying school. It was reported to have been occasionally used for agricultural activities during this time.

The aircraft was maintained in accordance with the manufacturer's maintenance schedule. As at the morning of the accident, the airframe and engine had accumulated a total of 832.8 flying hours. The last 100-hourly inspection was carried out on 27 September 2012, at a total of 786.4 flying hours. No significant maintenance items were noted during this inspection and there were no outstanding items on the maintenance release. There were no significant engine maintenance items recorded in the engine logbook.

Spray equipment

The spray equipment fitted to the helicopter was an 'R44 Helipod III Spray System' comprising a belly tank with a jettison door, a carbon fibre and stainless steel spray boom, a chemical pump and an internal, pilot-controlled system to activate the spray valves, pump RPM, pump stop and jettison. The tank was connected to hardpoints on the helicopter by four quick-release pins. The hardpoints were provided as part of the spray equipment and were secured at the skid-landing gear attach points on the airframe. The spray boom fitted to WOH extended out to 80 per cent of the 10 m main rotor diameter. The spray system was started and set before flight. Spraying was commenced by pilot selection as required in flight.

The maximum load of the system, as displayed on the placard on the side of the tank, was 285 L. The flight manual supplement covering the Helipod III spray system stated that the helicopter's climb performance would be reduced by 240 ft/min with the equipment installed. This required the application of more power in order to achieve comparable climb performance to an R44 without the spray gear fitted.

The previous owner reported that the spray system in WOH had not been installed or certified by a licensed aircraft maintenance engineer as required by the spray system manufacturer and the Civil Aviation Regulations. Whereas the previous owner reported installing the spray system himself, information from the Civil Aviation Safety Authority (CASA) identified that he did not hold the required aircraft maintenance qualifications to do so.

The loader reported seeing the pilot test the chemical jettison door the day before the accident while cleaning the tank and that it operated normally. The manufacturer of the spray system advised that about 5 seconds was required to jettison the load down to about one quarter of the capacity of the belly tank. The loader also stated that the pilot was happy with the overall performance of the spray system.

Weight and balance

The helicopter was carrying about 85 L in the main (left) fuel tank for the flight, which was less than full fuel, and about 240 L[3] of chemical load in the spray tank. The pilot was reported to have recognised that carrying the full load of 285 L would have exceeded the operating limits of the helicopter. It was reported that the pilot had calculated 240 L of chemical as being enough to cover a set area for spraying purposes. The pilot was reported to have then filled the tank with 240 L of water to simulate carriage of the chemical before taking off to assess the resulting performance of the helicopter.

The loader reported that this test occurred on a hot day (about 35 °C) and the pilot was satisfied that if the helicopter was capable of lifting the load in those conditions, it would be suitable for most spraying activities as temperature was a limiting factor in aerial spraying. From the loader's description of the testing, it is probable that the helicopter remained in-ground effect (IGE) during the test, which required less engine power than that required to maintain an out-of-ground effect (OGE)[4] hover in similar conditions.

Based on an analysis of the GPS data, and the probable time available to the pilot to jettison the chemical (see the sections titled *Examination of the GPS data* and *Pilot response times*), it was considered likely that the majority of the 240 L chemical load remained on board at the time of the accident. Calculations by the ATSB using the probable fuel and chemical load and the weight of the pilot and onboard equipment, established that the estimated weight of WOH at the time of the accident was about 1,122 kg.

The published maximum allowable weight of the helicopter was 1,089 kg, meaning that, at the time of the accident, the helicopter was about 33 kg above that weight. Application of meteorological data from the Bureau of Meteorology (BoM) and the elevation of the accident site to the hover performance charts in the R44 Pilot's Operating Handbook (POH) identified that the helicopter was about 64 kg too heavy to hover OGE.

Low RPM warning

The R44 helicopter is equipped with a warning horn and light that activate at 97 per cent main rotor RPM to alert the pilot of a low main rotor RPM condition. A governor is fitted to the engine of the helicopter that normally maintains the main rotor RPM between 101-102 per cent.

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3 240L equated to 243 kg of chemical load, which was itself a combination of water and chemical.

4 Helicopters require more power to hover out-of-ground effect due to the absence of a cushioning effect created by the main rotor downwash striking the ground. The distance is usually defined as more than one main rotor diameter above the surface.

In response to the activation of the low rotor RPM warnings, the POH stated that:

> To restore RPM, immediately roll throttle on, lower collective and, in forward flight[5], apply aft cyclic.

Meteorological information

Witnesses described the conditions as being calm, with two witnesses noting the wind increased in strength, but not significantly, close to the time of the accident. Data analysis provided by the BoM indicated likely conditions at the time of the accident, including a north-westerly wind at less than 10-12 kt (19-22 km/h) and no significant weather. That wind direction was consistent with reports from two of the witnesses, with a third witness indicating the wind was coming from the east. The BoM data analysis indicated a temperature range from around 17 °C at 0700 to around 27 °C at the time of the accident.

Wreckage and impact information

The wreckage of the helicopter was situated on steep terrain that was inclined at a slope of about 23°. The damage to the helicopter and a nearby tree were consistent with the main rotor blades contacting tree branches before the helicopter collided steeply with terrain (Figure 5).

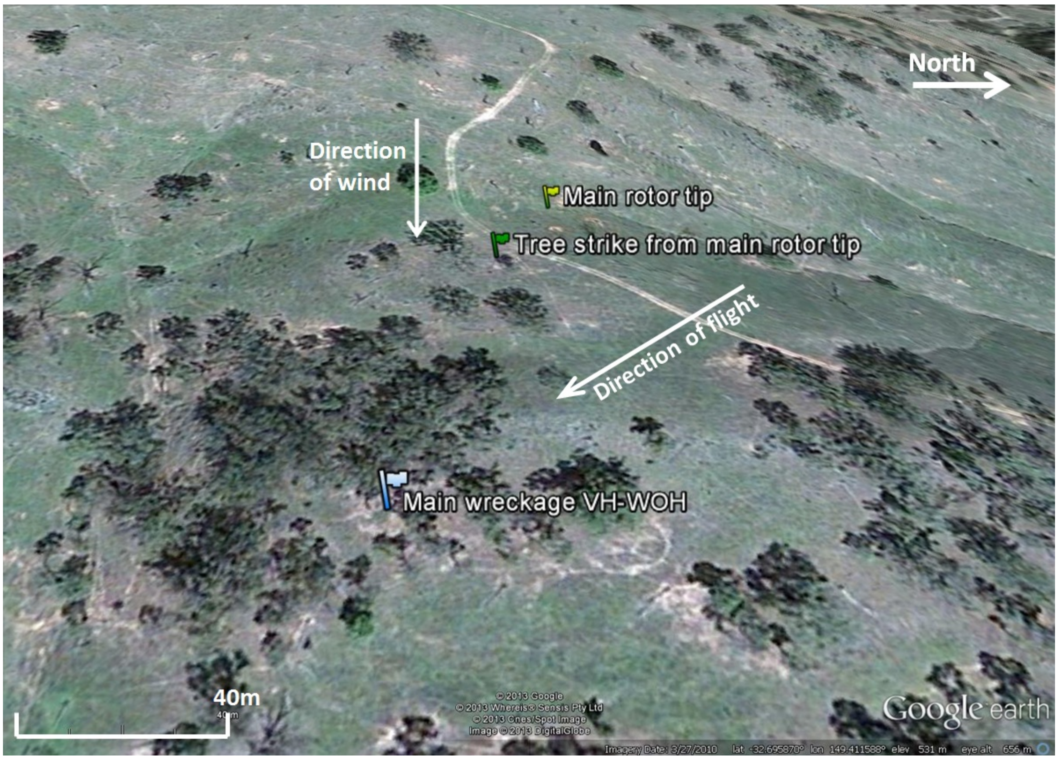
Figure 5: WOH (uprighted) showing the damage to the surrounding branches and helicopter's spray tank

Source: ATSB

The fuselage and tail, including the tail rotor assembly, and most of the main rotor blades were contained within the impact site. One main rotor blade tip was found about 162 m from the accident site, on the other side of the hill. Damage to a tree in that area was consistent with the main rotor blade tip detaching from near the accident site and travelling up the hill, before striking the tree. The main rotor tip then came to rest on the other side of the hill (Figure 6).

5 Sufficient airspeed to enable the application of aft cyclic to result in an increase in rotor RPM. This 'flare' effect lessens with decreasing speed until having no effect in a nil wind hover.

Figure 6: Location of the detached main rotor blade tip and tree damage



Source: Google earth

All of the helicopter's flight controls were accounted for at the main wreckage and flight control continuity verified. Examination of the main rotor blades identified that they were bent or coned[6] upwards, consistent with operation at low rotor RPM. There was no evidence of blade delamination; however, there was impact damage to the blades, including the skin.

The engine was removed from the site by the ATSB for functional testing. When tested, the engine was assessed as being capable of normal operation.

A witness who was the first to arrive at the accident site reported seeing fuel running down the main rotor mast and pooling on the ground below, before dissipating down the slope. This was consistent with the fuel draining through the fuel tank vent lines, which vented into the mast fairing assembly.

The fuel tanks fitted to WOH were the original all-aluminium tanks. Examination identified that neither of the fuel tanks ruptured during the accident.

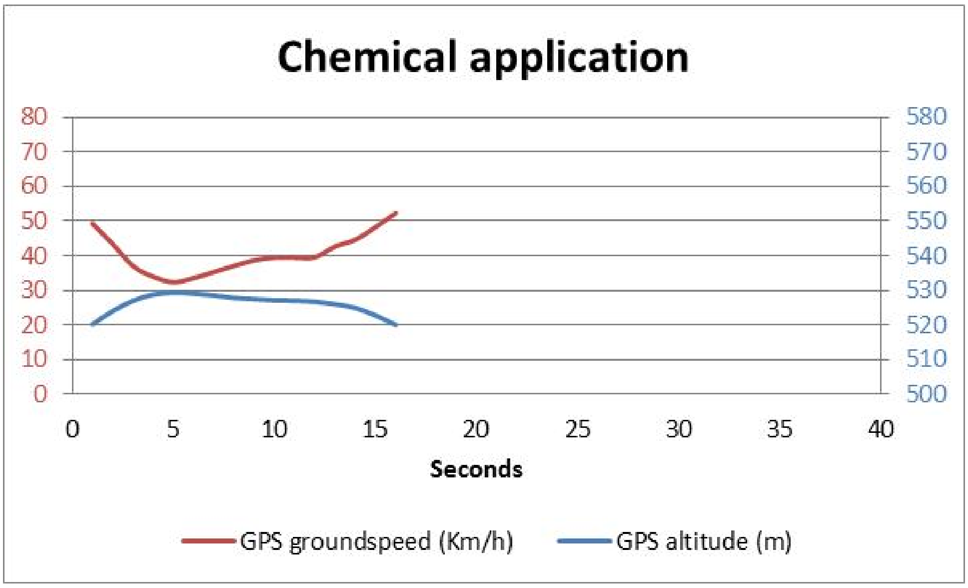
The front right corner of the spray tank was ruptured during the impact sequence and the witness reported that on arrival at the accident site, there was no chemical load remaining in the tank and no evidence of chemical in the vicinity. This apparent contrast with the ATSB's assessment that the majority of chemical was on board at the time of the accident (see the previous section titled *Helicopter information*), was probably explained by the combination of the time between the accident occurring and the witness arriving at the scene, the rupture to the spray tank and the nature of the terrain. This would have allowed any chemical to drain from the tank and down the hill.

6 Coning in this context is the upwards movement of the main rotor blades while they are rotating. This is usually in response to an increase in aerodynamic force as a result of a control input from the pilot. It is more pronounced at high weights and/or low main rotor speed.

Examination of the GPS data

Analysis of the GPS data identified the typical operating profile for the helicopter during aerial spraying activities in the days prior to the accident and the spray runs conducted on the day. These profiles were consistent and showed the pilot operating at speeds as low as 9 kt (17 km/h) in the turns during chemical application. The GPS data also recorded those times when the chemical was dispersed. Examination of this data indicated that on the final spray run the majority of the 240 L of chemical was still on board. The data also showed that while at low speed, the pilot manoeuvred to trade speed for height and vice versa. That is, as the helicopter's speed dropped off in the turn, it was climbing before, at the top of the climb, the pilot would complete the turn and regain speed (Figure 7). Speed is increased in a helicopter by lowering the nose and applying power as required. Of note, during the accident spray run, the speed did not decrease below effective translational lift (ETL)[7] until commencement of the final, sustained, climb (Figure 8).

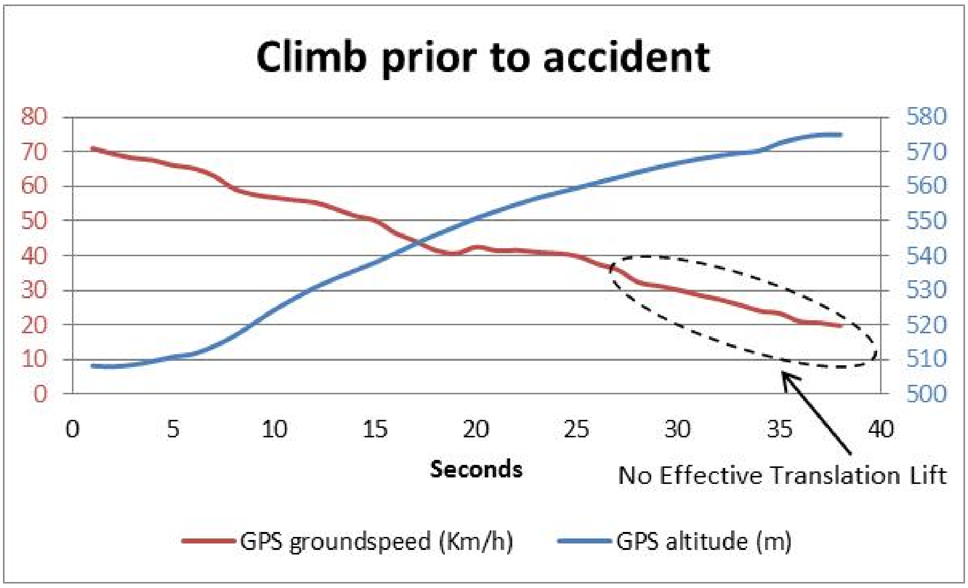
Figure 7: Speed and height variation during chemical application



The final segment of GPS data identified that the helicopter was not conducting spray activities at that time. During the final manoeuvring the helicopter climbed for about 35 seconds while the groundspeed reduced to about 10 kt (19 km/h), which, based on the BoM assessment of the likely wind, meant the helicopter's airspeed was probably at or less than the recorded groundspeed. In this case, the helicopter was no longer above ETL, increasing the engine power required for the manoeuvre. Based on the final groundspeed of about 10 kt (19 km/h), the helicopter would have taken about 6 seconds to cover the 33 m from the last recorded GPS position to the accident site.

[7] Any airflow over the main rotor acts to reduce the effect of the main rotor downwash, making the rotor more efficient and resulting in less power required to maintain altitude. This beneficial effect is known as effective translational lift (ETL).

Figure 8: Sustained climb immediately prior to the accident



During analysis of the GPS data, a vertical offset of the recorded altitude data was identified. Based on discussions with the GPS manufacturer and witness reports of the helicopter's departure profile, it was established that this step was erroneous and could be excluded from the data. In addition, the GPS stopped recording data at a point about 33 m before the accident site. This is consistent with the most recent data being lost once power was removed from the unit as part of the accident sequence.

Consideration of the groundspeed and altitude of the final data point with reference to the underlying sloping terrain identified that the helicopter was effectively in an OGE hover at that time.

Medical and pathological information

The pilot held a current Class 1 Medical Certificate issued by CASA with no restrictions. A general review of the pilot's CASA medical records, and the post-mortem examination conducted by the relevant State authorities, did not reveal any preconditions that would have affected his ability to operate the helicopter. Toxicology results did not detect the presence of any substances that may have impaired his performance.

Witnesses reported that the pilot appeared well-rested and in good spirits in the period before the flight.

Survival aspects

The post-mortem examination identified that the pilot succumbed to head injuries sustained in the accident. The accident site characteristics suggested the aircraft impacted terrain with a low forward speed, but at a high angle relative to the slope of the terrain. The pilot was wearing a flying helmet and was restrained by a three point harness; however, the helicopter impact angle and force of the impact reduced the available survivable space in the cockpit.

Additional information

Helicopter performance

Helicopter hover performance is determined by the difference between engine power available and engine power required. The main factors affecting engine power required in a hover are helicopter weight, the air density, the effect of any wind and the helicopter's proximity to the ground (ground effect).

To maintain a steady hover or climb, an increase in the helicopter's operating weight requires more main rotor thrust (effectively lift), which in turn requires more engine power. The effect of any wind can vary, depending on a number of factors. In general, if the helicopter can hover into wind, there is a performance benefit.

An increase in altitude and/or temperature decreases air density, with the effect that a normally-aspirated engine produces less power. Additionally, if the same amount of main rotor thrust is needed, the rotor blades need a higher angle of attack, which creates more drag and requires more engine power.

When a helicopter is hovering IGE, the performance of the main rotor is assisted by ground effect. That is, a helicopter hovering IGE requires less engine power to hover than a helicopter hovering OGE.

At an airspeed of about 55 kt (102 km/h), the engine power required by an R44 helicopter is at its minimum. Any reduction in airspeed will result in an increase in the engine power required. There is a further increase in the engine power required when a helicopter slows to below effective translational lift (see the section titled *Examination of the GPS data*). At this speed, which is usually about 12 kt (22 km/h), the main rotor becomes less aerodynamically efficient.

At the helicopter's estimated operating weight, it was about 64 kg too heavy to hover OGE within the available de-rated engine power limits.[8] The helicopter manufacturer advised that, based on the estimated weight and environmental conditions, the power required to hover OGE exceeded the available (non-de-rated) power of the engine by at least 5 horsepower and the engine would have been operating at full power. No more throttle would have been available to the pilot.

As a consequence, a reduction in airspeed below about 12 kt (22 km/h) would have resulted in the power required exceeding that available from the engine. In this circumstance, if the collective position was not lowered, there would be a reduction in main rotor RPM.

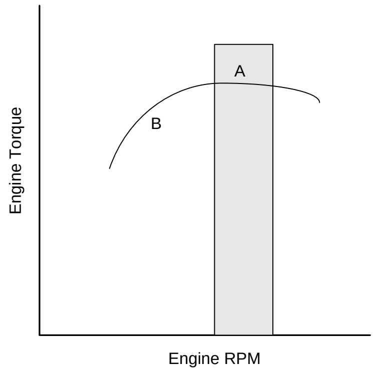
Piston-engine helicopters - general

The operation of a piston-engine helicopter within the engine's normal RPM range, shaded region 'A' in Figure 9, results in minimal variation in the available engine torque. However, as the engine RPM reduces below that operating range and into region 'B', there is an increasingly significant reduction in the available engine torque and power available to drive the rotor. In consequence, there can be an additional reduction in main rotor RPM.

As a result of a reduction in main rotor RPM, there is a corresponding reduction in the lift available to counteract the helicopter's weight and, without action by the pilot, the helicopter will descend. Any action by the pilot to increase the pitch on the main rotor blades to re-establish the required lift will also increase the drag on the rotor blades, requiring increased engine power to recover/maintain rotor RPM.

8 De-rating involves limiting the allowable amount of power to less than that which the engine can deliver, primarily to improve high-altitude performance.

Figure 9: Typical piston engine torque - RPM characteristics[9]



Overpitching occurs when the main rotor RPM reduces to the point that the engine cannot produce sufficient power to overcome the increased drag on the rotor as a result of the pilot acting to maintain height. Once overpitching occurs, the decreased main rotor RPM results in increased coning and a decrease in rotor thrust. A descent will usually follow. If the pilot increases the collective to compensate, the situation rapidly deteriorates, resulting in a further reduction of main rotor RPM, increased coning of the main rotor blades, less lift and an increasing descent rate.

Recovery from overpitching requires the simultaneous application of more throttle (if there is more throttle available) and lowering of the collective control. This action decreases the blade pitch angle and reduces blade drag while maximising engine power in an effort to increase main rotor RPM. This may be counter intuitive to the pilot of a descending helicopter at low altitude.

If a pilot does not correctly diagnose a condition of overpitching and take corrective action in a timely manner, main rotor RPM can reduce to low levels very quickly resulting in the blades stalling. Once the blades are stalled, in-flight recovery is almost impossible.

Pilot response times

The UK Civil Aviation Authority commissioned a study in a helicopter simulator to examine reaction times to various emergencies. While overpitching was not one of the emergencies covered, a total power loss situation, which also requires the pilot to lower the collective control, was examined.

The results showed the average reaction time to lower the collective in response to a total power loss was 2-4 seconds in total, with 4-6 seconds being typical of a longer, but still reasonable, reaction time. The authors of the study recommended that 6 seconds should be used for future design and certification purposes in the case of a total power loss as it covered most of the population. The study also noted that some pilots reacted to the situation by inputting the reverse (incorrect) control inputs, or hesitating, both of which were enough on their own to prevent successful recovery.

Reaction time in this study included detection and response times.

Related occurrences

ATSB investigation 200600979

On 21 February 2006, a Robinson Helicopter Company R44 Astro helicopter, registered VH-HBS, was being operated on a series of aerial survey flights from Gunpowder airstrip, about 100 km to the north of Mt Isa, Queensland. The pilot departed for a survey flight with three passengers. The helicopter did not return and the burnt wreckage of the helicopter was found the next day. The four occupants were fatally injured.

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[9] From Coyle, S (2002) - see references.

The helicopter had impacted the ground with significant force in a nose-down, fuselage-level attitude. The main rotor displayed evidence of low rotational energy and coning. Other than impact and fire damage, there were no identified mechanical defects or abnormalities. There was evidence that the engine was rotating at impact, but the amount of engine power being developed was not able to be established.

The previous aerial survey flights were reported to have included low speed flight and occasional hovering. At the estimated helicopter weight and the prevailing air density, the helicopter did not have the performance to hover OGE.

The ATSB found that the helicopter probably descended contrary to the pilot's intentions, possibly influenced by a partial engine power loss or downdraft, resulting in the pilot applying collective, which developed into overpitching and ultimately main rotor stall.

ATSB investigation AO-2008-062

On 14 September 2008, a Robinson Helicopter Company R44 Raven helicopter, registered VH-RIO, was being operated on a series of scenic flights in the Bungle Bungle ranges area of the Purnululu National Park, about 250 km south of Kununurra, Western Australia. The helicopter departed the Purnululu Aircraft Landing Area for an 18-minute scenic flight with the pilot and three passengers. When the helicopter did not return by the nominated time, a search was initiated. Shortly after, the burnt wreckage of the helicopter was located. The four occupants were fatally injured.

The pilot had deviated from the regular scenic flight track, speed and profile to operate OGE in close proximity to the terrain at a low airspeed or at the hover. The helicopter's estimated OGE hover performance was marginal. It is likely that the high level of engine power required to sustain a hover in the local conditions was not available, or not fully utilised by the pilot, resulting in an uncommanded descent, overpitching of the main rotor as a result of the pilot's attempts to arrest that descent, and a main rotor RPM decay that significantly increased the rate of descent.

Safety analysis

The Australian Transport Safety Bureau (ATSB) found no evidence of any mechanical defect or failure within the helicopter or engine that may have contributed to the accident. A review of the pilot's medical records and post-mortem results indicated that it was unlikely that the pilot had become incapacitated during the flight.

Development of the accident

The ATSB identified that at the time of the accident, the helicopter was above its maximum allowable weight and, more significantly in terms of the development of this accident, was unable to hover out-of-ground effect (OGE). That is, the combination of the operating weight and environmental conditions meant that more power was required to hover OGE than the engine could provide. Analysis of the recorded data from the onboard global positioning system (GPS) receiver showed that, immediately prior to the accident, the helicopter was conducting a sustained climb over a hill and was not applying chemical. With the spray system fitted, the power required to climb would have been increased.

The GPS analysis further identified that during the climb, the groundspeed of the helicopter decreased to about 10 kt (19 km/h). Given the available performance of the helicopter at its operating weight, as it slowed below effective translational lift (ETL), the power required would have exceeded that available, probably resulting in the main rotor RPM decreasing as the engine was unable to provide the required torque. The resulting overpitch would have led to an unintended descent. The bending, or coning, seen on the main rotor blades was consistent with operation below normal main rotor RPM.

Research into pilot reaction times indicated that a reasonable reaction time to lower the collective control in response to a total power loss for most of the population tested was about 5-6 seconds. While it is acknowledged that VH-WOH did not have an engine power loss, the required pilot recovery action in the case of the overpitching also includes lowering the collective. Application of the GPS-derived speed to the distance from the end of the GPS recording to the initial tree impact indicated a time between the probable overpitch and the impact with the tree of about 6 seconds. Based on this analysis, from the point that the speed decreased and the low main rotor RPM warning likely activated, there was probably insufficient time for the pilot to complete the appropriate recovery actions before contacting the tree. In addition any distraction, hesitation or incorrect control input would have exacerbated the situation. Furthermore, the time required to jettison the chemical meant that there was little prospect of reducing the weight of the helicopter prior to contacting the tree. Finally, there may have been insufficient height for the pilot to recover, irrespective of how quickly he might have initiated any recovery action.

The ATSB considered whether the pilot's relative inexperience in the R44 may have influenced the development of the accident. However, there was insufficient evidence to conclude that pilot experience in the R44 was a factor in the development of the accident.

The GPS data also showed that the operating profile for the helicopter during aerial spraying activities in the days prior to the accident, and the spray runs conducted on the accident day, were consistent and involved trading speed for height and vice versa. This speed-height energy trade, combined with cooler temperatures on the previous spray runs, probably explains why the helicopter did not enter an overpitching situation prior to this flight, in spite of the helicopter's marginal OGE performance, and the pilot at times operating at speeds less than ETL during those runs. In addition, the accident flight was likely the first time the helicopter was operated above its maximum allowable weight that day, as it was the first spray run since refuelling.

While the pilot had developed and then applied his own means to assess the helicopter's performance, it seems unlikely that either a formal weight and balance check or check of its performance were carried in accordance with the hover performance charts in the manufacturer's

Pilot's Operating Handbook. The use of 'trial flights' as the primary method of predicting performance does not take into account an aircraft's maximum weight limits or provide any assurance of an aircraft's flying qualities and performance. By contrast, use of the manufacturer's hover charts provides an effective means of assessing the likely performance of the helicopter and enhances a pilot's ability to avoid the circumstances associated with this accident.

This accident highlights the dangers of operating helicopters overweight, especially when performance is critical, such as when low flying or conducting aerial spraying operations.

Installation of the spray system

The installation of the Helipod III spray system by an unqualified person was considered in relation to the possible effect on the accident. Operation of the jettison system had the potential to improve the helicopter's hover performance, once the pilot realised there was a problem. As the loader reported seeing the pilot test the jettison door the day before the accident, the ATSB concluded that it was probably capable of operation on the day. Despite this, the short period of time available to the pilot to respond to the overpitch made it unlikely that he would have been able to jettison the chemical load before the impact with the tree.

Fitment of the spray system required the installer to interact with the helicopter's systems, including the electrical system. The ATSB considers that installation by an unqualified person increases the risk that the system, including the jettison function, would not work correctly.

Findings

From the evidence available, the following findings are made with respect to the collision with terrain involving Robinson R44 helicopter, registered VH-WOH, which occurred 20 km south-west of Mudgee, New South Wales on 9 December 2012. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- The operation of the helicopter out-of-ground effect at slow speed while above its maximum allowable weight probably resulted in overpitching and the subsequent collision with terrain.
- The approximate 6-second period between the likely overpitch and the collision with the tree was probably insufficient for the pilot to complete the appropriate recovery actions.

Other factors that increase risk

- The installation of the Helipod spray system was not conducted by a qualified aircraft engineer, increasing the risk that the system, including the jettison function, would not work correctly.

General details

Occurrence details

Date and time:	9 December 2012 – 0947 ESuT	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	20 km south-west of Mudgee, New South Wales	
	Latitude: 32° 41.77’ S	Longitude: 149° 24.72’ E

Aircraft details

Manufacturer and model:	Robinson Helicopter Company R44 Raven I	
Registration:	VH-WOH	
Serial number:	1807	
Manufactured	2007 in the United States	
Registered	2008 in Australia	
Type of operation:	Aerial work	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 1 (Fatal)	Passengers – 0
Damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- data recovered from the onboard global positioning system (GPS) receiver
- witness interviews
- helicopter manufacturer
- spray equipment manufacturer
- GPS manufacturer
- Civil Aviation Safety Authority (CASA)
- Bureau of Meteorology
- New South Wales Police.

References

Chappelow, JW, Smith, PR (1999) *CAA Paper 99001, Pilot Intervention Times in Helicopter Emergencies*. Civil Aviation Authority, London.

Coyle, S. (2002) *Cyclic and Collective: More Art and Science of Flying Helicopters*. Mojave, CA p93.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the witnesses, the helicopter manufacturer, the spray equipment manufacturer, CASA, the United States National Transportation Safety Board and New Zealand Transport Accident Investigation Commission (TAIC).

Submissions were received from the spray equipment manufacturer, the loader, CASA and TAIC. Those submissions were reviewed and where considered appropriate, the text of the draft report was amended accordingly.

Australian Transport Safety Bureau

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; 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 fare-paying passenger operations.

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.

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the 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.

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
Loss of control involving Robinson R44, VH-WOF
20 km south-west of Mudgee NSW, 9 December 2012

AO-2012-165
Final – 26 September 2013