Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Aviation Occurrence Investigation AO-2007-026

Final

Rotor Strike – Maryfield Station, NT
24 July 2007
VH-VHQ
Robinson Helicopter Company R22 Beta

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Abstract

On 24 July 2007, at 1500 Central Standard Time, a Robinson R22 Beta helicopter, registered VH-VHQ, with the pilot as the sole occupant, departed from a helipad at Maryfield Station, NT, in order to recommence cattle mustering activities. Visitors to the station, who had recently participated in a number of short local flights, were still in the general area of the helipad during the departure.

The pilot reported that, during the initial climb after takeoff, and at a height not above the tops of the surrounding trees, the helicopter was struck by a gust of wind that resulted in height loss and activation of the helicopter's 'low RPM' warning horn. During the recovery manoeuvre by the pilot, one of the visitors was struck in the head by the helicopter's main rotor and fatally injured.

This accident highlighted the hazards associated with conducting helicopter operations in close proximity to people and the need for positive coordination and control of those people at all times.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal bureau within the Australian Government Department of Infrastructure, Transport, Regional Development and Local Government. ATSB investigations are independent of regulatory, operator or other external bodies.

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 enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, 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.

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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 proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

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About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au.

FACTUAL INFORMATION

History of the flight

On 24 July 2007, at 1500 Central Standard Time[1], the sole occupant pilot of a Robinson R22 Beta helicopter, registered VH-VHQ, departed from a helicopter landing pad (helipad) at Maryfield Station, NT, in order to recommence cattle mustering activities. Visitors to the station, who had recently participated in a number of short local flights in the helicopter, were still in the general area of the helipad during the departure.

The pilot reported that during the initial climb after takeoff, and when 'nearly [at] tree height', the helicopter was struck by a gust of wind that resulted in height loss and activation of the helicopter's 'low RPM'[2] warning horn. The pilot stated that, during the emergency recovery of the main rotor RPM, one of the visitors was struck in the head by the helicopter's main rotor.

Following the rotor strike, the pilot turned the helicopter to the right into wind and landed (Figure 1). The visitor subsequently died from her injuries.

Figure 1: Position of the helicopter after landing. The helipad and hangar/shed are in the background.[3]

1 The 24-hour clock is used in this report to describe the local time of day, Central Standard Time (CST), as particular events occurred. Central Standard Time is Coordinated Universal Time (UTC) + 9.5 hours.

2 RPM refers to the revolutions per minute or speed of the main rotor.

3 The quad-bike in Figure 1 was not at the location shown at the time of the accident. The person fatally injured was positioned immediately beyond the location of the bike in the photograph.

That morning, the pilot had conducted about 6 hours of mustering operations in the accident helicopter. A second and more experienced pilot in another R22 helicopter also participated in those mustering operations. During lunch at the homestead, the pilot of the accident helicopter was unexpectedly asked by one of the station owners[4] if he would give some relations, who were visiting Maryfield Station for the first time, a short local flight in the vicinity of the homestead. None of the visitors were familiar with helicopter operations.

The pilot then conducted five such flights in the vicinity of the helipad, each of about 2 to 3 minutes duration. The visitors (four adults and two children) and the station owner waited inside the hangar/shed during that time. The pilot reported that he did not converse with the visitors as some could not speak English.

The pilot stated that he normally departed from the helipad tracking and climbing virtually due east and/or turning slightly left towards the east-north-east (see Appendix A). An alternative, but less commonly used take-off profile, involved turning left after becoming airborne and tracking north along the road that was adjacent to the hangar/shed.

During the first local flight, the pilot contacted the second station owner by radio[5] to find out the progress of the current mustering operation. During that radio conversation, the station owner advised the pilot that the affected cattle had to move a further 3 to 4 km before the helicopter would be required. As a result of the reported position of the cattle, and in consideration of the experience level of the workers conducting the muster, the pilot assessed that the helicopter would soon be required to support the mustering task.

Following the local flights, the pilot left the controls of the helicopter with the engine running[6] and rotors turning and refuelled the aircraft from drum stock positioned beside the helicopter.[7] The visitors were due to depart the station shortly after the local flights. There was little, if any, further conversation between the pilot and the group (visitors and station owner) and no discussion or coordination of his intended departure to recommence mustering.

One of the visitors and the station owner commenced walking south towards the homestead in preparation for the visitors' departure and another adult and the two children mounted a quad-bike near the corner of the hangar/shed. The remaining two adults assisted the children getting onto the quad-bike and then commenced walking towards the homestead.

The pilot reported that shortly prior to entering the helicopter for takeoff, he saw the latter two adults (one man and one woman) walking slowly from left to right in front of the helicopter, and between the helicopter and the road (Figure 2). The

4 The station was owned in partnership.

5 The second station owner was located about 15 km away from the homestead (about 12 min flying time in the R22 helicopter).

6 That contrasted with a caution in the *Robinson R22 Pilot's Operating Handbook* that pilots should not leave the helicopter's flight controls unattended while the engine was running.

7 Refuelling an aircraft with its engine or engines running is known as 'hot refuelling'. That activity is permitted in accordance with Civil Aviation Order (CAO) 20.10.

adult and children on the quad-bike had not moved from their original position and the other two adults were some distance from the helipad at that time.

Figure 2: View of take-off area from the helipad (note the two largest trees immediately to the left of the parked quad-bike).

The pilot stated that he intended to manoeuvre the aircraft forward and to his right (south-east), away from the children and between the two groups of adults. He then intended to turn the helicopter left into the wind and to fly away in a north-easterly direction. The pilot reported that he was very conscious of remaining clear of the children and, after rechecking their position, he departed directly from the helipad (without hovering). He then noticed that the man and woman closest to the helicopter had walked further to the right than he had expected.

The pilot continued his planned take-off profile, but now had to manoeuvre the aircraft further right than initially intended. He reported that after passing in front of the man and woman, he banked the helicopter left to avoid two large trees (Figure 2) and re-intercept his departure profile. He advised that as he approached the tops of the trees (heading approximately north), the helicopter was struck by a gust of wind and began to lose height. Shortly after, the helicopter's low RPM warning horn activated.

In response to the warning horn, the pilot reported that he:

- opened the throttle, with the effect of over-riding the engine RPM governor[8]
- lowered the collective lever[9]
- pushed forward on the cyclic stick[10].

8 The RPM governor maintains engine RPM, and therefore rotor RPM, within the normal operating range (see *The implications of low rotor rpm* section of this report for further detail).

9 Lowering the collective lever reduces the pitch of the main rotor blades, reducing drag and facilitating increased rotor RPM. The action of lowering the collective lever also reduces the main rotor thrust (effectively lift) produced by the main rotor blades.

10 Pushing forward on the cyclic tilts the main rotor disk forward and lowers the nose of the helicopter.

The pilot stated that the low RPM resulted in a loss of altitude and airspeed before he was able to recover control of the aircraft. He reported that, just as he regained control of the helicopter, he heard and felt the main rotor blade strike something, and saw the woman fall forward and to his left-front relative to the helicopter. The pilot then turned the helicopter right through about 130 degrees before landing into the wind and shutting down the helicopter.

The man walking with the fatally-injured woman reported that they had been talking about the local flights and, although he noticed the increasing noise from the helicopter, they did not take any notice of it as it was behind them and to their right. He described suddenly noticing 'more wind', before turning his head to the right to see that the helicopter's skids were at his shoulder height and about 3 m away. He instinctively bent forward and noticed the helicopter move in front of him from right to left and descending. He then heard the rotor strike the woman who was on his left, and noticed her on the ground.

The investigation was unable to conclusively determine the airspeed and orientation of the helicopter at the time of the accident.

Conduct of the local flights

The local flights were conducted with both of the helicopter's doors removed and all passenger changeovers between those flights were conducted with the engine and rotors turning. The visitors remained in the adjacent hangar/shed and the pilot motioned for them to approach the helicopter in turn for each flight. The visitors stated that the pilot supervised their operation of the available lap sash seat belt and headset.

The pilot reported having limited experience in the carriage of passengers. He stated that, while willing to conduct the local flights, he did not want to delay the recommencement of the mustering task.

The majority of the local flights were recorded on video camera by the visitors who remained at the hangar/shed. That video recording was examined and showed the operation of the helicopter in the vicinity of the helipad, including flight below 500 ft above ground level (AGL) that was not related to the takeoffs or landings.[11] In addition, the woman who was struck by the helicopter was shown to be no taller than the height of the helicopter's cabin roof.

The last recorded local flight included an impromptu request for the pilot to carry a 3 year old child who was seated on the lap of an adult passenger. The seat belt was fastened around both passengers for that flight.[12]

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11 There was no evidence that the operator held a low flying permit issued by the Civil Aviation Safety Authority in accordance with Civil Aviation Regulation (CAR) 157 that authorised the conduct of the local flights below 500 ft AGL.

12 CAO 20.16.3 only permitted passengers who had not reached their third birthday to be carried on the lap of an adult passenger. Additionally, Civil Aviation Advisory Publication (CAAP) 235-2(1) *Carriage and restraint of small children in aircraft* advised that an adult seat belt should not be fastened around both adult and child as load transfer during an emergency landing sequence may cause serious or potentially fatal injuries to the child.

Pilot information

Flight training

The pilot had worked at the station for about 7 years and, at the time of the accident, was employed as the station manager. He was awarded his Commercial Pilot (Helicopter) Licence in 2003, including an endorsement on the R22 helicopter and an aerial stock mustering approval. That approval allowed the pilot to undertake mustering operations.[13] In addition, the pilot had completed low flying training.

At the time of the accident, he had accrued 1,100.4 hours flight time, of which 1,032.8 hours were in R22 helicopters. Nearly all of his R22 hours were flown in the accident helicopter at Maryfield Station.

The pilot's most recent flight review was conducted on 15 March 2007. He had no previous experience in tourist or scenic flight operations.

The pilot held a valid medical certificate without restrictions.

Recent history

The station commenced the season's mustering operations 5 days prior to the accident. According to the maintenance release that was completed by the pilot at the end of each day's flying, and the engine hour meter, the pilot's flight hours in the days prior to the accident were as follows:

Date	Flight hours	Comments
20 July 2007	8.0	
21 July 2007	Nil	Day off
22 July 2007	5.9	
23 July 2007	Nil	
24 July 2007	6.5	Date of the accident

The pilot reported that he had no known health or medical issues that would have affected him on the day of the accident. He did not wear, nor was he required to wear, corrective lenses.

13 CAO 29.10 defined aerial stock mustering as 'the use of an aircraft to locate, direct and concentrate livestock while the aircraft is flying below 500 feet above ground level and for related training operations.'

Aircraft information

Aircraft specifications

The aircraft was an R22 Beta helicopter, serial number 1890, and was manufactured in 1991 in the US by the Robinson Helicopter Company. The helicopter was registered to the current owner on 5 May 2003.

The helicopter had one main rotor, comprising two main rotor blades, and a tail rotor. It was fitted with a Textron Lycoming 0-320-B2C engine, serial number L-16873-39A. There were two seats, one on the right for the pilot and another on the left for a passenger. There was one set of flight controls fitted on the pilot's side of the cockpit. The dimensions of the R22 helicopter are at Appendix B.

The helicopter had a maintenance release issued in the private operational category that was valid until 4 June 2008 or 2,904.3 hours in service.

At the time of the accident, the helicopter had accumulated a total of 2,833.9 hours service since new.

Recent maintenance history

The helicopter completed its 2,200 hour servicing on 5 June 2007. That servicing included the replacement of significant flight control and main and tail rotor drive components, and the non-destructive inspection of flight control and structural components.

The main rotor blades were replaced on 19 December 2006 and the new blades had accumulated 321.4 hours since that time.

The engine was installed in the helicopter on 21 December 2004 and had accumulated 517.8 hours since that time.

There were three routine maintenance items that were 4.6 hours overdue at the time of the accident. Those items consisted of a number of inspections and a requirement to replace the engine oil.

The pilot reported that, before the local flights, he had changed six of the helicopter engine's eight spark plugs. That was due to a rough running engine that was encountered during the previous mustering flight. After the spark plugs were changed, the second pilot conducted a short flight in the helicopter and found that the apparent problem had been rectified.

Aircraft weight and performance

Weight and balance calculations indicated that the helicopter was being operated below its maximum allowable gross weight and within the centre of gravity limits at the time of the accident.

The manufacturer’s performance data indicated that, at the time of the accident, the helicopter was capable of hovering out of ground effect[14] in zero wind conditions, with a significant power margin.

Meteorological information

Bureau of Meteorology analysis

There were no direct observations of the weather conditions at Maryfield Station. However, a Bureau of Meteorology (BoM) analysis described the general prevailing weather conditions on the afternoon of the accident as including clear skies, wind from the east to north-east at 10 to 20 km/h and a temperature of about 30º C.

Observations at Daly Waters (about 47km south of the station) indicated a change of wind direction from the north-east to the south-east at the approximate time of the accident. The BoM analysis stated that a wind gust could have been produced at Maryfield Station as a result of a change in wind direction similar to that observed at Daly Waters. Had that been the case, it could have accounted for the wind gust that was reported by the pilot. The BoM analysis also stated:

> In addition to the possible wind change at Maryfield Station at the time of the incident, given a temperature of around 30º C, dust devils[15] cannot be excluded as the source of the gust as dust devils are only visible if loose material is lifted.

Observations at Maryfield Station

The two pilots that were operating at the station reported that, following a still and foggy early morning, there was some wind during that morning’s mustering, with varying wind gusts from the south-east. There was no wind-sock at the station, so the pilots estimated the wind strength and direction by the movement in the trees.

The visitors and station owner described the day as being fine with a slight breeze. That was consistent with the ambient conditions as recorded on the video camera shortly before the accident.

The second mustering pilot, who was in the general area of the helipad at the time of the accident, described seeing dust in the area at the time of the accident. He associated that dust with gusting winds.

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14 Helicopters require less power to hover close to the ground due to a cushioning effect created by the main rotor downwash striking the ground. Under those conditions, the helicopter is operating ‘in ground effect’. The US Federal Aviation Administration’s *Rotorcraft Flying Handbook*[18] stated that flight in ground effect usually occurs at less than one rotor diameter above the surface (25 feet for an R22 helicopter). Operations above that height are defined as being conducted ‘out of ground effect’.

15 Dust devil (also known as a willy-willy) – A revolving mass of air resulting from local atmospheric instability, such as that caused by intense heating of the ground by the sun on a hot summer day.

Maryfield Station helipad information

Maryfield Station was located about 200 km south-east of Katherine, NT. The terrain was generally flat and lightly vegetated. The elevation of the bitumen helipad was about 650 ft above mean sea level (AMSL).

The hangar was at the southern end of a 12 m by 30 m farm shed, with a roller door and a concrete floor that extended onto the helipad (see Appendix A).

There were various trees and other buildings located in the vicinity of the landing area. In addition, there were a number of disused or rarely used farming implements in the areas of long grass near the landing area.

Helicopter examination

The helicopter was intact and capable of landing after the main rotor struck the woman. An on-site examination of its structure, engine and flight control systems found nothing that would have contributed to the accident.

The engine governor switch was found in the 'ON' position.

An engine run was conducted using the fuel that was remaining in the helicopter at the time of the accident. During that engine run, the engine and engine control system operated normally and in accordance with the manufacturer's specifications.

The governor system was tested to the extent possible on the ground and found to operate normally. The low RPM warning horn was also tested and activated correctly at 97 %.

The remaining fuel was examined and found to be free of any obvious water or contamination. The helicopter had sufficient fuel for flight.

Damage to one of the main rotor blades, including tip distortion and indentation of the metal skin (Figure 3), was consistent with that blade having contacted the woman during its operation.

Figure 3: Damage to main rotor blade

Tests and research

Two samples of fuel were retained for laboratory examination. One sample was drawn from the drum stock used to refuel the helicopter immediately prior to the accident. The second sample was drawn from the helicopter gascolator[16].

Laboratory examination of the second sample identified the presence of particulate matter. Both samples were found to exhibit the characteristics of Avgas 100/130, a fuel approved for use in the R22. The laboratory test report concluded that any particulate matter would normally be removed by the helicopter fuel filter and was therefore unlikely to have adversely affected the operation of the engine.

Additional information

Helicopter landing site

The requirements for an aircraft take-off and landing area, and pilot responsibilities when operating to/from those areas were defined in Civil Aviation Regulation (CAR) 92 (1). Aside from specifying the need for a pilot to consider the prevailing weather conditions, the CAR relied on a pilot in command to determine all other relevant circumstances affecting a takeoff or landing. In some instances, that consideration could be shared with an aircraft operator.

Civil Aviation Advisory Publication (CAAP) 92-2 (1) *Guidelines for the establishment and use of helicopter landing sites (HLS)* provided pilots and operators with guidance when determining the suitability of a helicopter take-off and landing area. A note to the CAAP explained that:

> The information contained in this publication is advisory only. There is no legal requirement to observe the details as set out. The Civil Aviation Regulations detail the legal requirements that must be complied with in relation to use of areas for take-off and landings by a helicopter. While there may be a number of methods of ensuring that the requirements of the Civil Aviation Regulations are met, this CAAP sets out criteria which ensures compliance with the Regulations. The CAAP must be read in conjunction with the Civil Aviation Regulations.

A definition of the suggested physical and structural specifications applying to a ‘Basic HLS’[17] was provided by the CAAP, together with guidance of the suitable conditions for use of that category of HLS. An application of the requirements of the CAAP to the Maryfield helipad suggested that, given the conditions on the day of the accident, it satisfied the requirements for it to be considered a ‘Basic HLS’.

In addition, CAAP 92-2 (1) provided the following guidance applicable to all HLSs, including a ‘Basic HLS’:

> The pilot of a helicopter operating to, from or at an HLS should ensure that:

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16 The gascolator is a screen filter and sediment trap located between the fuel tank and carburettor.

17 A ‘Basic HLS’ means a place that may be used as an aerodrome for infrequent, opportunity and short term basis for all types of operations, other than Regular Public Transport (RPT), by day under helicopter visual meteorological conditions (VMC).

> the HLS is clear of all…persons, other than persons essential to the helicopter operation…
>
> no person outside the helicopter, other than a person essential to the operation is within 30 metres of the helicopter…

Manufacturer's recommended take-off procedure

The Normal Procedures section of the *Robinson R22 Pilot's Operating Handbook* (POH) included the following recommended take-off procedure:

1. Verify governor on, RPM stabilized at 102-104 %.
2. Clear area. Slowly raise collective until aircraft is light on skids. Reposition cyclic as required for equilibrium, then gently lift aircraft into a hover.
3. Check that gages are in the green, lower nose and accelerate to climb speed following profile shown by the height-velocity diagram in Section 5[18]. If RPM drops below 102 %, lower collective.

The POH stated that the climb airspeed for safe operation was 60 kts indicated airspeed (KIAS). An examination of the manufacturer's recommended take-off profile (see Appendix C) suggested that, if following that profile, a pilot should not climb above 10 ft AGL until reaching about 30 KIAS.

Gaining additional height before accelerating to the recommended climb speed was possible, given sufficient power to hover out of ground effect. However, to do so increased the operational risk in the event of a loss of engine power.[19]

The implications of low rotor RPM

Piston-engine helicopters - general

The operation of a piston-engine helicopter within the normal RPM range (shaded region 'A' in Figure 4) results in a minimal variation in the available engine torque. However, as the 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 a reduction in rotor RPM.

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

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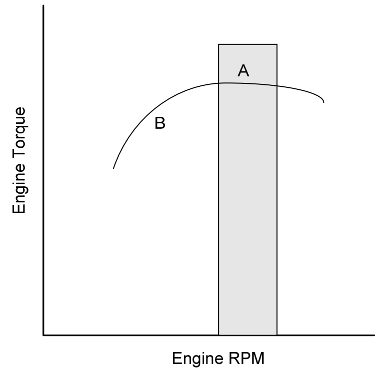
18 See Appendix C for the height-velocity diagram from Section 5 of the *Robinson R22 Pilot's Operating Handbook*.

19 Federal Aviation Administration (2000). *Rotorcraft Flying Handbook*. (Report no. FAA-H-8083-21). Washington, DC: Federal Aviation Administration.

Figure 4: Typical piston engine torque vs. RPM characteristics[20]



Overpitching occurs when the 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. The effect is a further reduction in RPM, and a subsequent loss of height.

R22 helicopter

The normal engine and rotor RPM operating range in the R22 helicopter was between 101 % and 104 %.[21] An RPM governor sensed engine RPM changes and applied corrective inputs to open or close the throttle to ensure that the engine and rotor RPM remained within that operating range. If the main rotor RPM reduced to 97% or below, a 'low RPM' horn sounded and an associated cockpit caution light illuminated.

In response to the activation of the low rotor RPM warnings, the POH required pilots:

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

The POH noted that, although the RPM governor was designed to assist the pilot in controlling the rotor RPM within the normal operating range, it may not be able to maintain the rotor RPM within that range in all circumstances.

In response to a request for an interpretation of the available performance data, and of the potential for overpitching to have been a factor in the development of the accident, the manufacturer stated that:

> The "throttle correlator" (the gearing between the collective control and the throttle arm at the carburettor) and fast response of the engine ensures minimal RPM variation with normal collective movement. It is possible, however, to demand more power than available by "over pitching" the rotor. The relatively low inertia of the R22 main rotor leads to a rapid reduction in RPM as power demand exceeds power available.

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20 Shawn Coyle (2002). *Cyclic and Collective More Art and Science of Flying Helicopters* (page 93). Mojave, CA: Helobooks, a Division of Mojave Books Limited.

21 The helicopter was installed with a later model tachometer. In helicopters with an earlier model tachometer, the normal engine and rotor RPM operating range was between 97 % and 104 %.

> With the large power margin…the RPM droop was likely caused by…over-pitching the main rotor (applying excessive collective control input). This may have been as a consequence of attempting to achieve a rate of climb exceeding the performance capabilities of the aircraft, possibly in combination with a high bank angle and in response to an altitude loss when encountering a downwind condition.

In addition, in regard to the potential for 'altitude loss when encountering a downwind condition' to result in a loss of rotor RPM, the manufacturer stated that:

> There is … more power required in a steady hover than in slow forward flight (effective translational lift, ETL[22]). With the aircraft in slow forward flight, a tail wind [downwind] gust is capable of transitioning the helicopter back to hover from ETL. This may result in an altitude loss if the pilot does not correct by adding power. The RPM will only droop if the available power is less than the power required to correct for the change from ETL to hover. I.e. this is only significant in situations where the hover power required is close to full throttle power.

At the time of the accident, the available full-throttle power was significantly greater than the power required to hover. (see Aircraft weight and performance at page 12 of this report).

During its consideration of whether overpitching might have been a factor in the development of the accident, the manufacturer advised of a secondary effect of lowering the collective, such as during the recovery from a low RPM situation. The manufacturer described the tendency for the nose of the helicopter to drop, inhibiting the recovery of rotor RPM and advised that the application of aft cyclic in response to a low rotor RPM warning was primarily intended to counter that nose drop. Depending on the airspeed of the helicopter at that time, the application of aft cyclic may also directly assist the recovery of main rotor RPM.

In that context, any application of forward cyclic during the recovery from low rotor RPM would delay the restoration of that RPM, and result in greater height loss during recovery.

The manufacturer's discussion concluded with an examination of the utility of the available forward airspeed when recovering from low rotor RPM. The power required to maintain the height of an R22 helicopter during takeoff decreases to a minimum at about 53 KIAS (about 98 km/h). The level acceleration of the helicopter from the hover towards that airspeed maximised the available power margin to restore any loss of RPM during takeoff. The validity of the use by a pilot of any increased power margin by diving to increase the speed of the helicopter would depend on the availability of sufficient height to conduct the manoeuvre.

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22 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).

ANALYSIS

The on-site examination of the helicopter, its engine and flight control systems found nothing that would have contributed to the development of the accident. The results obtained during the ground test of the engine and its associated systems, suggested that the non-completion of the overdue routine maintenance items had similarly not contributed to the accident.

In that case, the investigation considered the operational factors with the potential to have contributed to the development of the accident. The following analysis examines those factors.

Departure procedure

The action by the pilot to contact the station owner by radio during the initial local flight to discuss the remainder of the day's mustering operation suggested that the pilot's focus may have already been moving towards that activity. The pilot's assessment that the helicopter would soon be required for the afternoon's mustering contributed to a degree of perceived pressure to expedite the remaining flights, before refuelling and returning to assist with the mustering as soon as possible. That perceived timing pressure may have influenced the decision by the pilot to 'hot refuel' the helicopter and to depart the helipad while people, who were unfamiliar with helicopter operations, were in the vicinity.

The application by the pilot of relevant elements of Civil Aviation Advisory Publication (CAAP) 92-2 (1) *Guidelines for the establishment and use of helicopter landing sites (HLS)* (see Helicopter landing site section in Factual Information), or other similar procedures, would have mitigated the risk to the people in the vicinity of the helipad from the departing helicopter. In addition, the potential for the pilot to be distracted during the takeoff would have been minimised, allowing him to concentrate solely on the departure and on any unexpected developments, such as the activation of the low RPM warning and temporary loss of control of the helicopter.

The lack of coordination between the group of people on the ground and the pilot prior to the departure meant that neither party was aware of the other's intention, and no positive separation plan existed. That resulted in the adoption of a departure plan by the pilot that was based on the expected behaviour of the visitors. In that case, the pilot's initial focus on the children was perhaps understandable, however, it appeared to have reduced the pilot's awareness of the movement of the nearby adults.

The investigation considered the apparent discrepancy between the operating height of the helicopter as described by the pilot and the visitor who was walking with the fatally-injured woman. The lack of detailed, independent information on the departure meant that the investigation was unable to explain the apparent difference. However, given the relative height of the helicopter's main rotor head and the woman's stature, the helicopter must have been either pitched nose down, banked left, or a combination of both, when the woman was struck.

The short-notice alteration of the departure profile by the pilot to accommodate the unexpected position of the adults before resuming the original departure plan, resulted in the surrounding trees becoming significant obstacles. The loss of height during the turn was probably a result of overpitching; possibly because of the departure profile, the manoeuvre by the pilot in response to the reported wind gust, or a combination of both. The application of forward cyclic by the pilot in response to the low rotor RPM warning would have adversely affected the recovery of that RPM, and probably increased the height loss during the recovery manoeuvre.

In any event, the choice of departure profile did not ensure the safety of the people on the ground during the departure and subsequent temporary loss of control of the helicopter.

FINDINGS

From the evidence available, the following findings are made with respect to the Rotor Strike that occurred at Maryfield Station, NT on 24 July 2007 and involved Robinson Helicopter Company R22 Beta, registration VH-VHQ. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The pilot perceived a degree of pressure to expedite the local flights before returning to assist with the afternoon's cattle mustering.
- There was no plan for positive control of the people in the vicinity of the departing helicopter.
- The pilot elected to depart while people, who were unfamiliar with helicopter operations, were in the vicinity.
- The pilot's concern for the children probably influenced his departure profile and reduced his awareness of the movement of the nearby adults.
- The choice of departure profile did not ensure the safety of the people on the ground during that departure.
- The alteration of the departure profile by the pilot to comply with the original departure plan resulted in the surrounding trees becoming significant obstacles.
- The loss of height during the turn was probably a result of overpitching; possibly because of the departure profile, the manoeuvre by the pilot in response to the reported wind gust, or a combination of both.

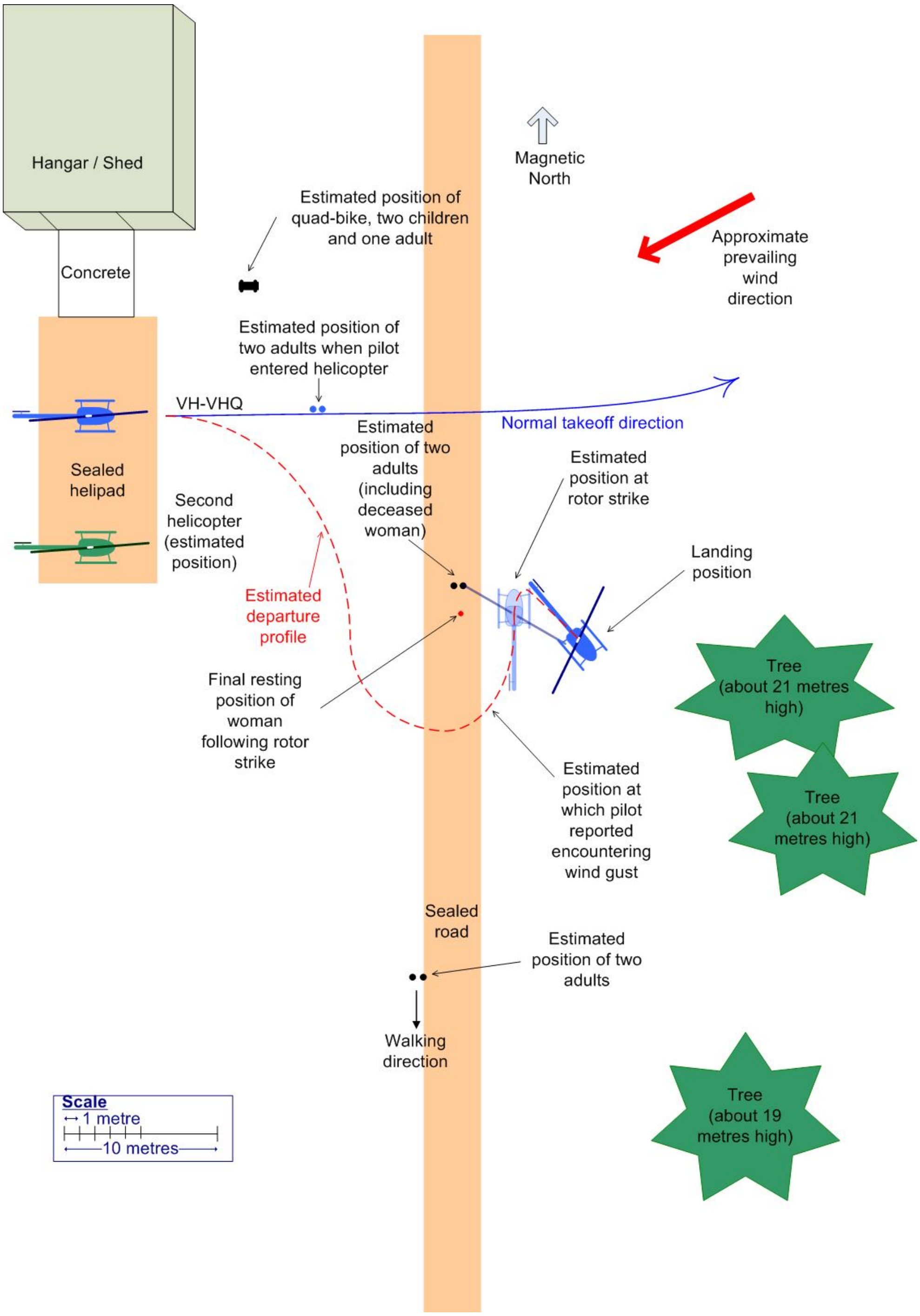
Other safety factors

- The application of forward cyclic by the pilot in response to the low rotor RPM warning would have adversely affected the recovery of that RPM, and probably increased the height loss during the recovery manoeuvre.

Other key findings

- The on-site examination of the helicopter, its engine and flight control systems, found nothing that would have contributed to the development of the accident.
- The results obtained during the ground test of the engine and associated systems suggested that the non-completion of the overdue routine maintenance items did not contribute to the development of the accident.
- The engine governor switch was probably in the 'ON' position for the flight.

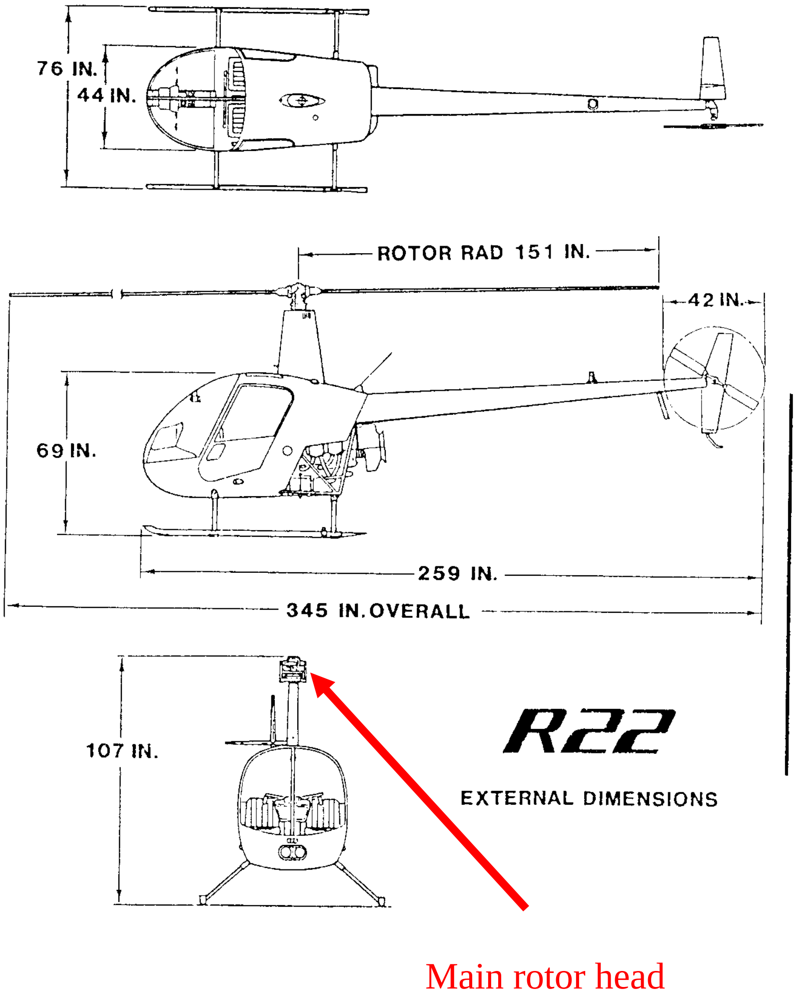
APPENDIX A: SCALE DIAGRAM OF THE HELIPAD, TAKE-OFF AREA AND ACCIDENT SITE



APPENDIX B: R22 HELICOPTER DIMENSIONS

ROBINSON
MODEL R22

SECTION 1
GENERAL



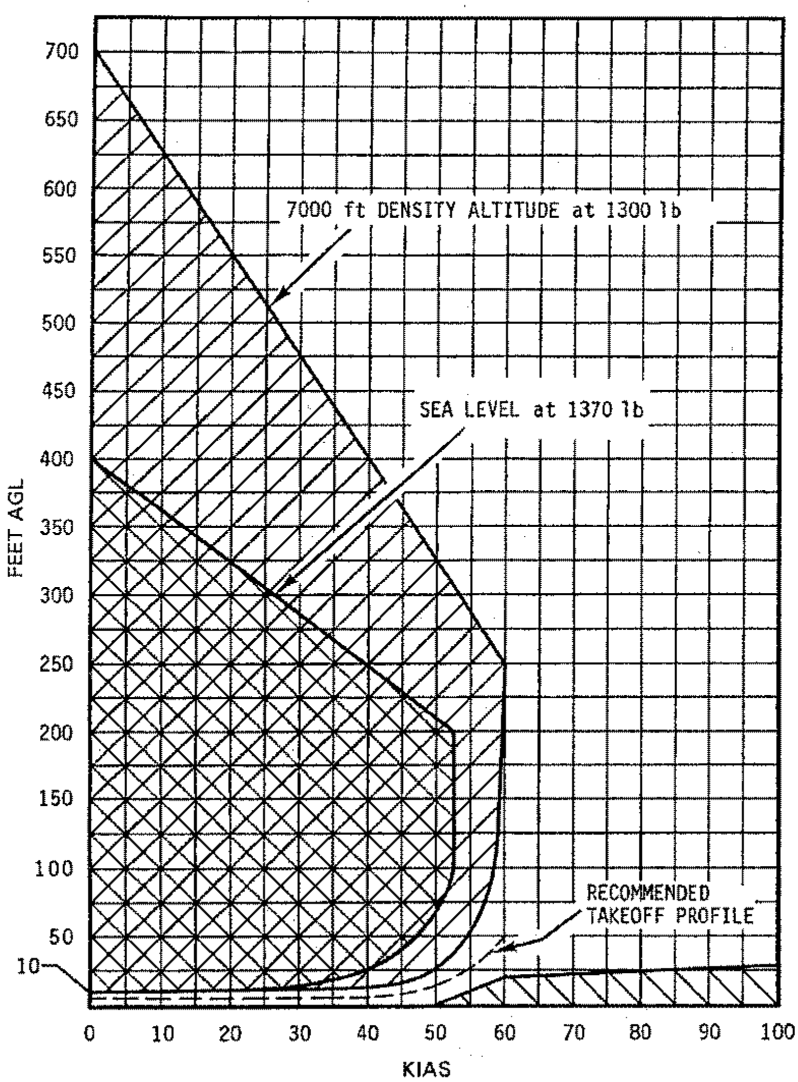
THREE-VIEW OF R22 HELICOPTER

REVISED: 6 JULY 1995 1-3

APPENDIX C: R22 HEIGHT-VELOCITY DIAGRAM

DEMONSTRATED CONDITIONS:
SMOOTH HARD SURFACE
WIND CALM
103-104% RPM

AVOID OPERATION IN SHADED AREAS



HEIGHT - VELOCITY DIAGRAM

Note: KIAS refers to ‘knots indicated airspeed’.

APPENDIX D: SOURCES AND SUBMISSIONS

Sources of information

The sources of information during the investigation included:

- the pilot
- the station owners
- a number of the visitors to Maryfield Station
- the second, more experienced pilot
- the helicopter manufacturer's *Pilot's Operating Handbook*
- recorded video footage of the short scenic flights
- helicopter maintenance documentation
- the Bureau of Meteorology
- the US Federal Aviation Administration's *Rotorcraft Flying Handbook*
- Civil Aviation Advisory Publication (CAAP) 92-2 (1) *Guidelines for the establishment and use of helicopter landing sites (HLS)*
- Shawn Coyle (2002). *Cyclic and Collective More Art and Science of Flying Helicopters.* Mojave, CA: Helobooks, a Division of Mojave Books Limited
- the helicopter manufacturer.

Submissions

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

A copy of the draft report was provided to:

- the Civil Aviation Safety Authority (CASA)
- the station owners
- the manufacturer of the helicopter
- the pilot
- the US National Transportation Safety Board
- the helicopter maintenance organisation
- a number of the visitors to the station
- the NT Coroner's Office.

Submissions were received from CASA, the helicopter manufacturer, the pilot and a number of the visitors to the station. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.