Australian Government
Australian Transport Safety Bureau

Rotor drive failure – Robinson R22 Beta II, VH-DSD

83 km NW of Julia Creek, Queensland | 9 May 2011

Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2011-060
Final

Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Aviation Occurrence Investigation

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Rotor drive failure
83 km NW of Julia Creek, Queensland
9 May 2011
VH-DSD
Robinson Helicopter Company R22 Beta II

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SAFETY SUMMARY

What happened

On 9 May 2011, the pilot of a Robinson Helicopter Company R22 Beta II helicopter, registered VH-DSD, was conducting mustering operations 83km north-west of Julia Creek, Queensland. The helicopter was operating in close proximity to the ground when drive to the rotor system was lost resulting in a high rate of descent at the point of impact. The pilot was fatally injured.

What the ATSB found

The ATSB found that the two v-belts that transfer torque from the engine to the rotor system had failed. The damage to the forward v-belt indicated that it had partially dislodged from the drive sheave, resulting in significant damage to the belt. At some point the v-belt fragmented, compromising the redundancy of the belt-drive system. Once the rear v-belt failed, all drive to the rotors was lost.

As a result of the drive failure and operating conditions at the time, the pilot was faced with the need to conduct an autorotative landing from a low altitude and at minimal speed. As a consequence, there was limited time for the pilot to recognise the condition, respond accordingly, and for the autorotation to develop. This situation resulted in a high rate of descent at the point of impact.

What has been done as a result

Although no organisational or systemic issues that might adversely affect the future of aviation operations were identified, the importance of the correct installation and maintenance of the drive system and v-belts in R22 helicopters, and their operation within the stipulated power limits was reaffirmed. ATSB safety advisory notice AO-2011-060-SAN-001, which was issued as part of the preliminary factual report into this occurrence, reinforced the need for continued vigilance by operators and maintenance organisations regarding the routine inspection of the R22 drive system.

Safety message

Pilots and operators should pay particular attention to the installation, maintenance, and inspection of R22 drive belts and other components of the helicopter’s drive system. In the event of an aircraft malfunction, pilot proficiency in emergency situations and particularly autorotations is especially important.

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THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau 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 safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

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 appropriate, or to raise general awareness of important safety information in the industry. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

TERMINOLOGY USED IN THIS REPORT

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing safety factor: a safety factor that, had it not occurred or existed at the time of an occurrence, then either: (a) the occurrence would probably not have occurred; or (b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or (c) another contributing safety factor would probably not have occurred or existed.

Other safety factor: a safety factor identified during an occurrence investigation which did not meet the definition of contributing safety factor but was still considered to be important to communicate in an investigation report in the interests of improved transport safety.

Other key finding: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.

Safety issue: a safety factor that (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operational environment at a specific point in time.

Risk level: the ATSB's assessment of the risk level associated with a safety issue is noted in the Findings section of the investigation report. It reflects the risk level as it existed at the time of the occurrence. That risk level may subsequently have been reduced as a result of safety actions taken by individuals or organisations during the course of an investigation.

Safety issues are broadly classified in terms of their level of risk as follows:

- **Critical** safety issue: associated with an intolerable level of risk and generally leading to the immediate issue of a safety recommendation unless corrective safety action has already been taken.
- **Significant** safety issue: associated with a risk level regarded as acceptable only if it is kept as low as reasonably practicable. The ATSB may issue a safety recommendation or a safety advisory notice if it assesses that further safety action may be practicable.
- **Minor** safety issue: associated with a broadly acceptable level of risk, although the ATSB may sometimes issue a safety advisory notice.

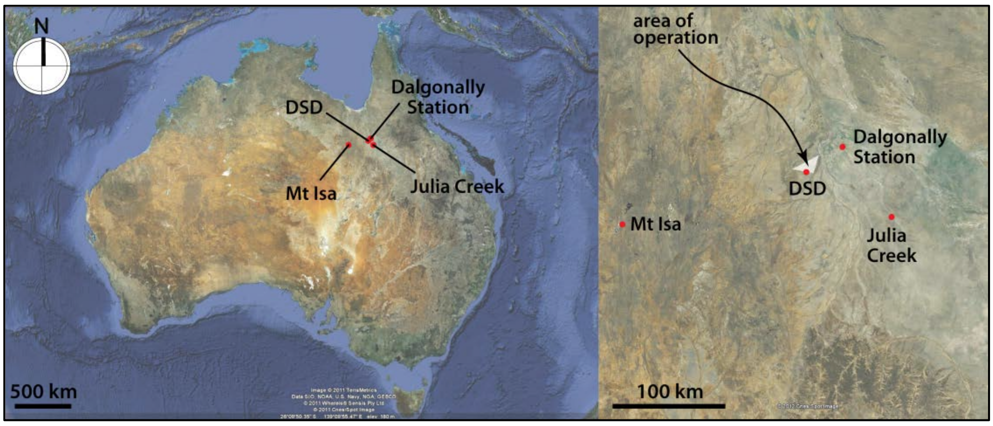
Safety action: the steps taken or proposed to be taken by a person, organisation or agency in response to a safety issue.

FACTUAL INFORMATION

History of the flight

At about 0700 Eastern Standard Time[1] on 9 May 2011, the pilot of a Robinson Helicopter Company (RHC) R22 Beta II helicopter, registered VH-DSD (DSD) took off from the Dalgonally Station homestead, about 75 km north-west of Julia Creek, Queensland (Figure 1). The pilot was engaged to conduct aerial stock mustering[2] in company with the pilot of another R22 aircraft. Weather in the area on the day of the accident was fine and dry, with clear conditions, and stable, southerly winds. At Julia Creek, the temperature at the time of the accident was 25 °C and the wind was southerly at 15 kts (28 km/h).

Figure 1: Location of the flight



Both pilots flew about 35 km to the south-west of the homestead where they began mustering cattle, continuing throughout the morning and early afternoon. During that time the pilots landed on several occasions, including twice for refreshments and to refuel the helicopters. In each instance, the helicopters' engines were left running and the rotors turning.

At about 1200, a third pilot began mustering on an adjacent property, about 15 km to the west. The three pilots talked with each other via very high frequency (VHF) radio while they worked. It was reported that, at about 1445, the pilot of DSD transmitted 'I'm going down'. He made no further transmission.

The other two pilots immediately flew to the area that the pilot of DSD had been working. After locating the helicopter wreckage they landed and established that the pilot was deceased. The helicopter sustained serious damage[3] (Figure 2).

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1 Eastern Standard Time (EST) was Coordinated Universal Time (UTC) +10 hours.

2 Civil Aviation Order 29.10 defined aerial stock mustering as '...the use of aircraft to locate, direct and concentrate livestock while the aircraft is flying below 500 ft AGL [above ground level] and for related training purposes.'

3 The *Transport Safety Investigation Regulations 2003* definition of 'seriously damaged' includes 'the destruction of the transport vehicle'.

Figure 2: Aircraft wreckage

Pilot information

The pilot of DSD held a Commercial Pilot (Helicopter) Licence and a Class 1 Medical Certificate. He was endorsed to fly R22 helicopters and held an approval to conduct aerial stock mustering operations from the Civil Aviation Safety Authority (CASA).

The last entry in the pilot's logbook was for flying on 9 April 2011 at which time the pilot had recorded a total of 5,872 hours. A notebook belonging to the pilot was recovered at the accident site and recorded flying hours for dates after the last logbook entry. However, the significance of this data could not be established.

The pilot's last recorded helicopter flight review[4] was conducted in an R22 on 6 June 2008. About a month later, the pilot was endorsed on the RHC R44 helicopter type, which also satisfied the requirements of a helicopter flight review. Given there was no evidence of a subsequent flight review or check, the pilot was overdue for a flight review by about 10 months at the time of the accident.

The pilot's post-mortem found no evidence of pre-existing medical conditions that could have been implicated in the accident. Toxicological testing returned no contributory results.

Aircraft information

General

The helicopter was manufactured in the United States in 1998 and registered in Australia in 1999. A maintenance release was issued for operations in the charter category and was valid until 28 October 2011 or 6,881.8 hours time in

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4 Civil Aviation Regulation (CAR) 5.124 stated that: '...a commercial (helicopter) pilot must not fly a helicopter as pilot in command if the pilot has not, within the period of 2 years immediately before the day of the proposed flight, satisfactorily completed a helicopter flight review.'

service (TIS). The last entry on the maintenance release was on 9 April 2011 with 6,848 hours TIS. It is likely that the helicopter was flown between 9 April 2011 and 9 May 2011, the day of the accident, but it was not possible to establish the extent of that flying. In any event, the pilot was reported to have said that at the end of the day (of the accident) he was taking the helicopter to the maintenance facility for a 100-hourly service.

The last maintenance was conducted on 16 December 2010 (at 6,823.8 hours TIS) after the pilot detected that the then Revision-Y[5] v-belts had stretched to limits and no further adjustment was available. These two drive system v-belts were replaced with a new Revision-Z v-belt set. The relevant maintenance documents indicated that all maintenance was conducted in accordance with the procedures specified by the helicopter manufacturer. This included the alignment of the drive sheave as a result of the replacement of the v-belts.

The daily inspection of the helicopter included a requirement to check the condition of the v-belts and degree of belt movement with the clutch actuator disengaged. There was no record of a daily inspection in the maintenance release for the day of the accident, but anecdotal evidence indicated that the daily inspection was carried out.

The calculation of aircraft weight and balance was complicated by a lack of information about refuelling quantities. Based on full tanks at the last refuelling and average fuel consumption, the helicopter’s weight was estimated to be in the order of 100 kg below the maximum allowable gross weight of 622 kg, and within the centre of gravity limits at the time of the accident.

The helicopter was equipped with a de-rated Lycoming O-360 four-cylinder, horizontally-opposed engine. To ensure that power limits were not exceeded, the pilot was required to determine the corresponding manifold pressure limits[6] using a cockpit placard, and to monitor the manifold pressure gauge when operating the helicopter. There was no mechanical limitation on the amount of power that could be applied.

R22 rotor drive system

On the R22 helicopter, engine power was transferred to the rotor system through a drive belt system that consisted of two rubber double v-belts running on matching multi-grooved sheaves (Figure 3). Both the upper and lower sheaves were constructed of aluminium alloy with a thermally-sprayed, metallised coating to improve wear resistance. The upper drive sheave was mounted on the clutch shaft next to a flexible coupling. The upper sheave could be moved relative to the engine-mounted drive (lower) sheave by means of an electric clutch actuator. This movement had the effect of varying the tension being applied to the v-belts (for more information on the helicopter’s drive-belt system, see the section titled *Component examination*).

The v-belts are not tensioned for engine start, allowing the engine to run without driving the rotor system. After engine start, the pilot selects the clutch switch to

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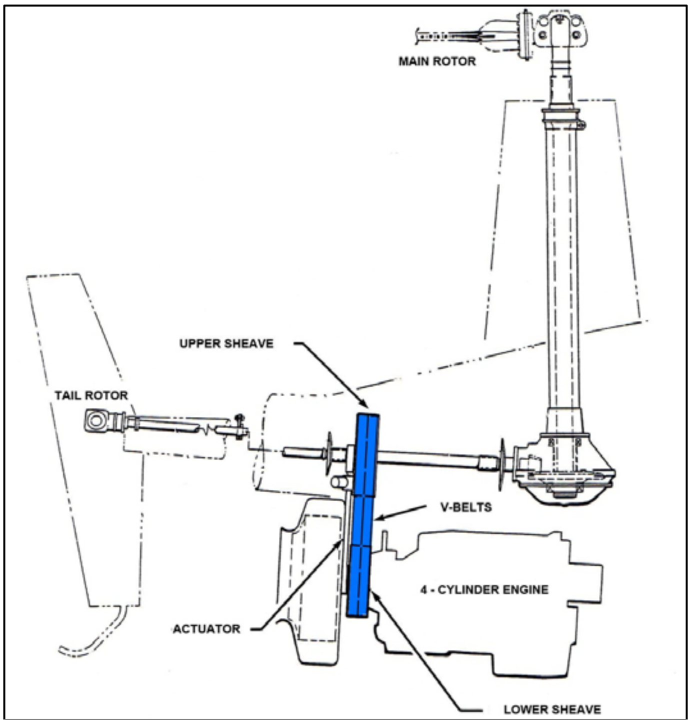
5 V-belts were manufactured to a specification; however, minor changes were annotated with a different revision status. Revision-Z was the latest belt status at the time of the accident.

6 An installed manifold pressure gauge was the only measure of engine power available to the pilot.

engage the actuator, which raises the upper sheave to the flight position and tensions the v-belts. The actuator is thereafter controlled by a load-sensing switch, which automatically maintains the correct belt tension during flight. During shutdown, the actuator lowers the top sheave to loosen the v-belts.

Power is transferred to the main rotor shaft through the main gearbox and to the tail rotor via a separate driveshaft and gearbox. The upper sheave incorporated an overrunning clutch to allow the rotor system to continue rotating in the event of engine failure and to facilitate autorotation (see the section titled *Helicopter autorotation*).

Figure 3: R22 rotor drive system



Wreckage and impact information

On-site examination

There was no post-impact fire and, although significantly damaged, the aircraft was largely intact. The wreckage was contained within the immediate vicinity of the impact site and there were no ground marks indicative of movement on contact with the ground. The skid-landing gear was splayed outward and the lower fuselage was severely distorted from the ground impact forces, indicating a high rate of descent and almost no forward speed at the time. A post-impact fuel leak was evident and emergency services reported draining about 40 L from the helicopter’s fuel system.

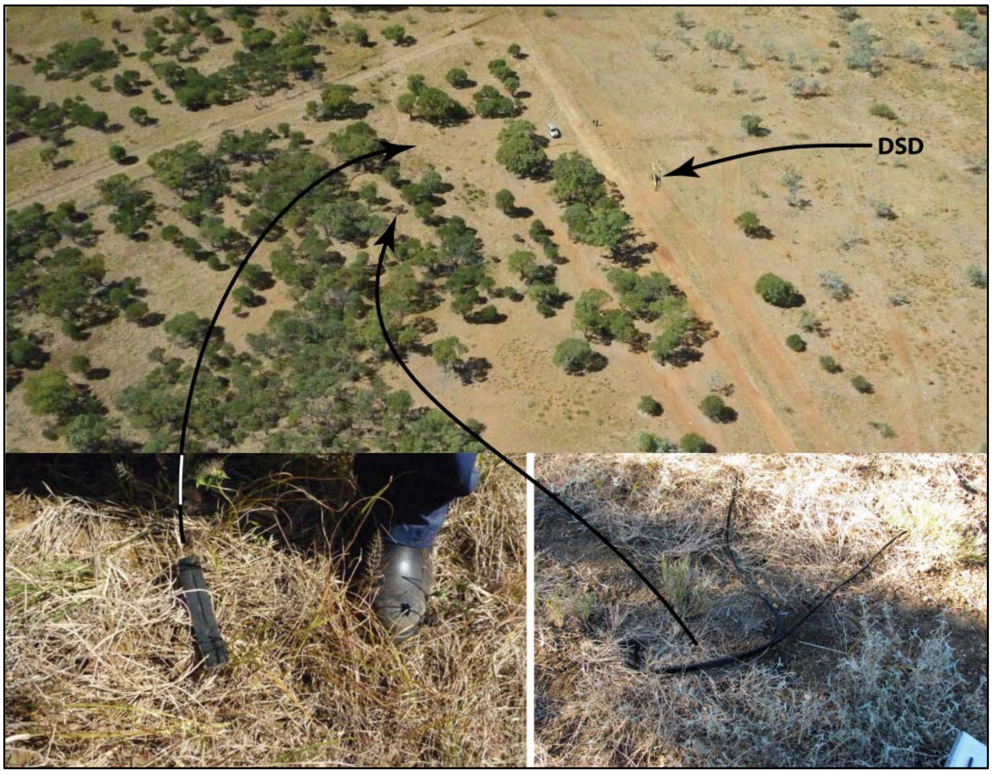
The trailing edge of one of the helicopter’s two main rotor blades was kinked in two places, but otherwise the main rotor blades were undamaged and securely attached to the main rotor hub. The tail rotor was damaged and the tail boom had been severed at a rivet seam about 1 m from the tail rotor, consistent with a main rotor blade strike. Pre-impact continuity of the flight controls was evident.

There was also evidence of pre-impact continuity of the main and tail rotor driveshafts. The main rotor gearbox rotated normally as did the overrunning clutch in the upper sheave. Drive system continuity from the upper sheave to the engine-driven lower sheave was broken due to disruption of the two v-belts.

The rear v-belt was severed and wrapped around the drive sheaves, but there was no evidence of the forward v-belt in the wreckage. Subsequently, almost all of the forward v-belt was found in two adjacent locations about 60 m from the main wreckage (Figure 4). Black rubber marks – consistent with a flailing drive belt - were found on the sides and lower surface of the engine. There were also deposits of fine rubber particles around the drive system area.

The extent of the impact damage meant that it was not possible to establish the in-service alignment of the drive sheaves. A number of components, including the engine, were recovered from the accident site for further technical examination.

Figure 4: Location of the main wreckage and v-belt fragments



Component examination

Engine

The engine was disassembled and examined at an approved engineering facility under the supervision of the Australian Transport Safety Bureau (ATSB). External damage to the engine was consistent with impact with the ground. Fragments of the shattered carburettor and dirt ingress were found in the internals of the engine, including all of the cylinders, most likely due to the engine operating at high RPM at impact.

Damage to the No. 3 cylinder rocker cover and inlet valve actuation gear was indicative of excessive engine RPM. The helicopter manufacturer advised that engine overspeed often occurs after drive v-belt failure.

There was no other condition found during the examination of the engine that would have prevented normal engine operation.

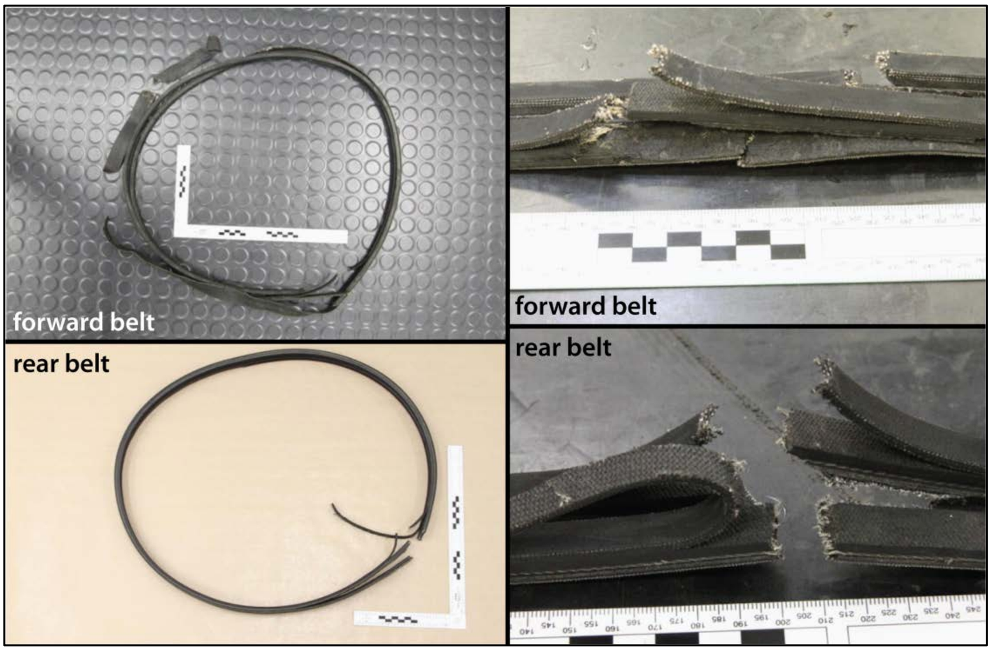
Drive system components

The v-belts fitted to the helicopter were manufactured by Mitsuboshi Belting Ltd, Japan. Identifiers on each of the v-belts indicated they were a matched pair and had undergone bench-testing and certification checks at the RHC factory prior to dispatch into service.

An initial examination of the v-belts showed that the polyester tensile cords on both belts were exposed and had pulled out of the rubber binding matrix. This indicated that both v-belts had been subjected to gross tensile overstress conditions and had been literally ‘ripped apart’. The front v-belt had a permanent ‘kink’ around its centreline, consistent with the belt having been forced forwards over the forward-most shoulder of the drive sheaves.

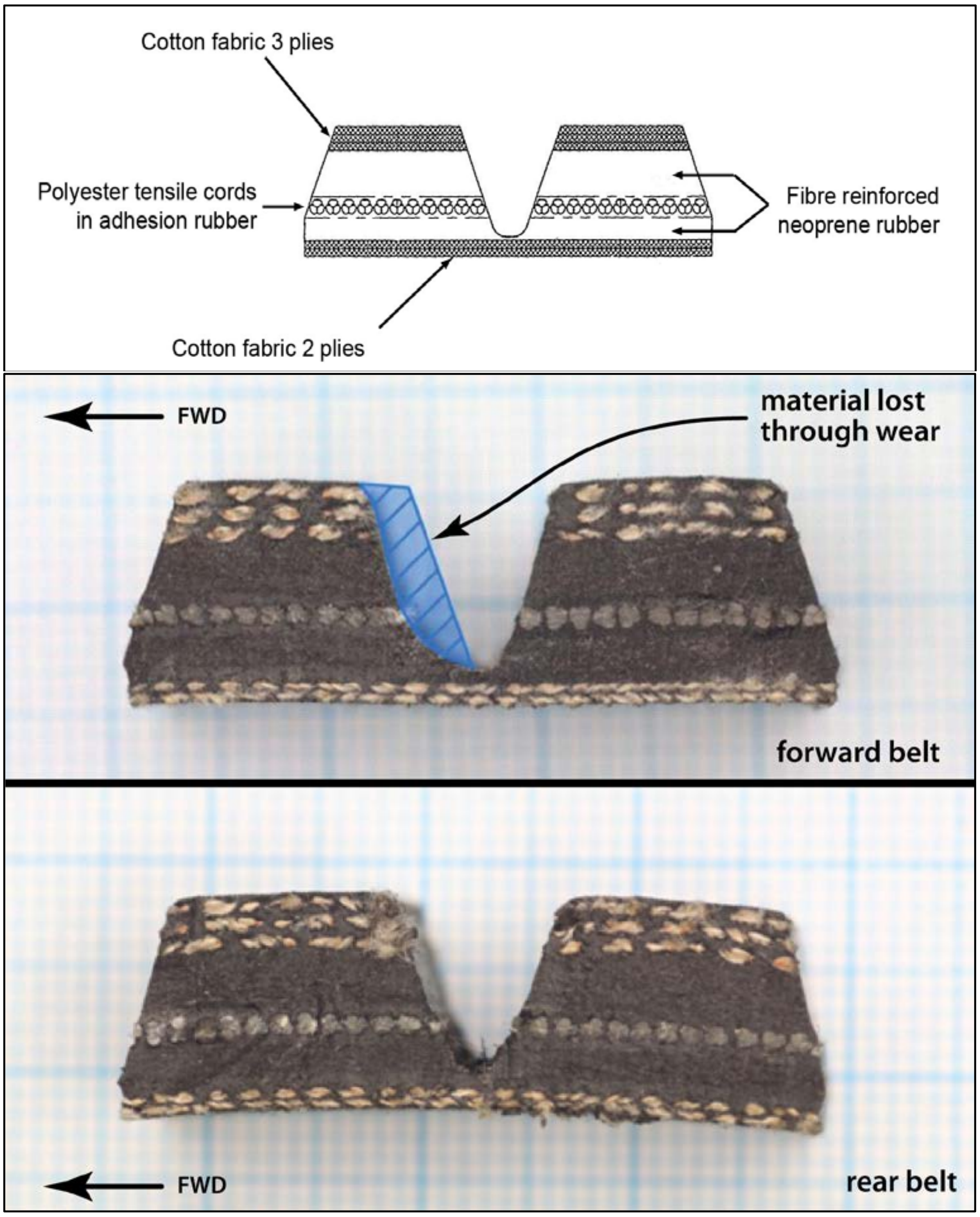
Despite the significant physical damage to each v-belt, their circumferences were measurable and each was found to be within specification (Figure 5).

Figure 5: Recovered v-belts



Both v-belts were sectioned (Figure 6). The rear v-belt displayed almost no evidence of abnormal wear. In contrast, the forward v-belt had lost a considerable amount of material where its front half had been worn away. Two of its 12 polyester tensile cords were lost, as well as a considerable quantity of the neoprene rubber that encased them.

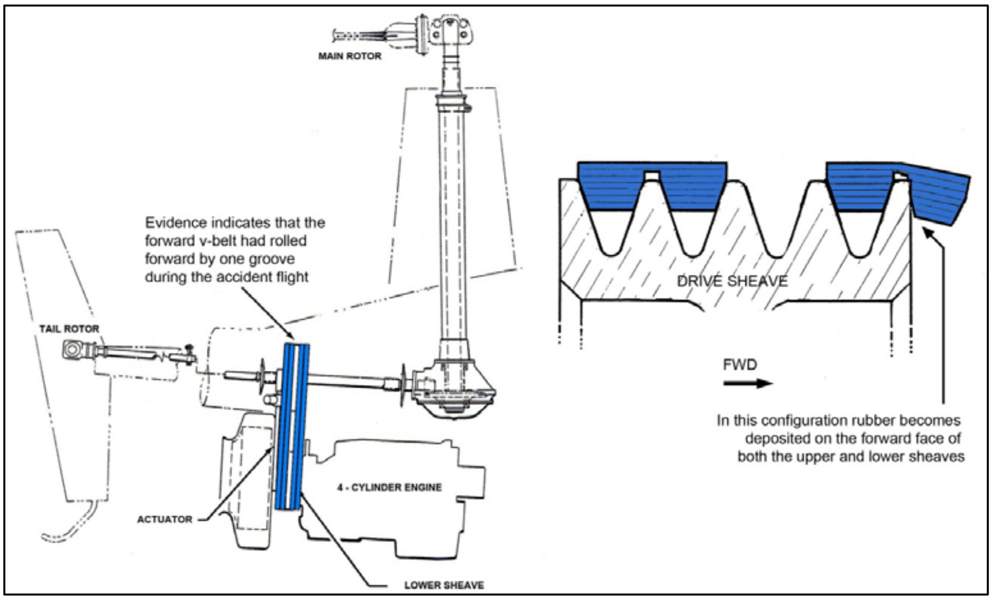
Figure 6: V-belt cross-sections



The wear to the forward v-belt showed that the belt had rolled forward at some stage during the accident flight and continued to operate while abnormally positioned on the front edge of the drive sheaves (Figure 7). Both of the sheaves were coated with black dust originating from v-belt rubber material, indicative of rapid wear to the belt.

There was no excessive wear to the sheaves' metallised coating and no sharp ridges or other damage to either sheave that might have affected the integrity of the v-belts.

Figure 7: Indicative forward displacement of the forward v-belt



Electric clutch actuator

Despite damage sustained from impact with the ground, examination of the clutch actuator found no evidence of a pre-existing condition that would have caused it to malfunction. The clutch actuator lower limit adjustment screw was fully wound in, consistent with the position set at the most recent v-belt replacement. This is reported to be typical of a Revision-Z v-belt installation due to the revision’s slightly smaller circumference and greater resistance to stretching than previous revision v-belts.

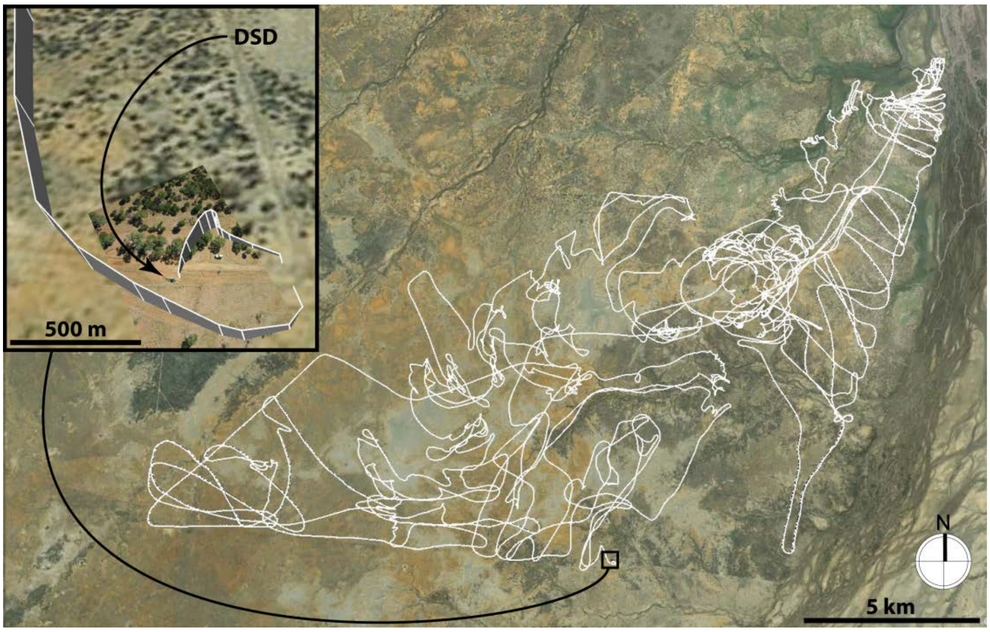
Checks of the actuator motor function and limit switches verified their operation as designed. Testing of the clutch actuator tension loads was limited due to the nature of the impact damage to the screw portion of the actuator. However, investigators were able to determine that the clutch actuator spring assemblies functioned and activated their respective microswitches.

Recorded information

A Garmin GPSmap 76CSx handheld global positioning system (GPS) unit, which was mounted on the instrument console, was found intact in the wreckage. Data was downloaded from the unit including the aircraft’s position and groundspeed during the day’s flights.

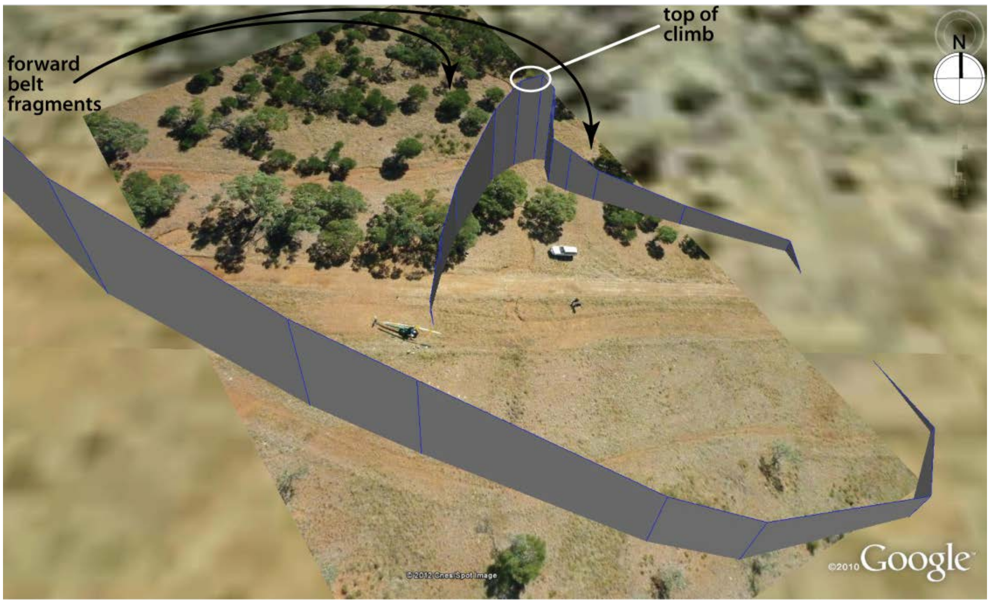
The recovered data was recorded continuously from 0730 to the time of the accident at 1441. Over that time the pilot manoeuvred the helicopter within a defined area and generally not above 500 ft, consistent with the aerial stock mustering task (Figure 8). On seven occasions, the helicopter’s position and groundspeed were static, representing landings for periods ranging from 1.5 to 6.5 minutes. Of these, two were for the pilot to refuel the helicopter.

Figure 8: GPS-recorded track



In the final 30 seconds of flight, the pilot climbed the helicopter to about 130 ft above ground level (AGL) at an average rate of 300 ft/min. At that point, when the helicopter's groundspeed was about 20 kts, the helicopter entered a steep descent to the ground (Figure 9). Based on the descent profile and the location of the forward v-belt fragments, the loss of drive occurred at or about the top of the climb.

Figure 9: Representation of the helicopter's final flightpath



Additional information

Helicopter autorotation

In the case of a complete loss of rotor drive, a pilot is required to immediately enter autorotation by lowering the collective[7] control to reduce the drag generated by the main rotor blades. Once established in autorotation, the main rotor is driven by the upward airflow generated by the descent and forward airspeed.

Nearing the ground, a pilot will progressively flare the aircraft by applying rearward cyclic[8] until the rate of descent and airspeed is sufficiently reduced, prior to the pilot levelling the helicopter for landing. Upward movement of the collective follows to cushion the landing.

Autorotative performance after drive failure is limited at the relatively low altitudes and airspeeds typically adopted during aerial stock mustering. This is due to the height that is lost before the upward airflow from the rate of descent is sufficient to maintain main rotor RPM.

Although the height and speed of the helicopter at the time of the drive failure was within the ‘avoid area’ of the R22 Height Velocity diagram (Appendix A), operation in this regime was typical of aerial stock mustering.

Factors associated with v-belt failure

An investigation by the Transportation Safety Board of Canada[9] of a Robinson R22 accident included the results of a review by the United States Federal Aviation Administration (FAA) of a number of R22 drive belt failures or dislodgements. The FAA report noted that, in most cases, these problems occurred with relatively new belts (less than 50 hours TIS) and were associated with some combination of the following factors:

- helicopter operation at high weight, or above gross weight conditions (sometimes compounded by turbulence)
- improper sheave alignment at installation, or alignment shifts caused by initial belt wear-in
- sheave surface condition (new belts mounted on worn or corroded sheaves)
- actuator tension being out of specification
- excessive belt slack at initial engagement.

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7 The collective lever varies the pitch of all main rotor blades simultaneously, irrespective of their azimuth position. It is the primary control of the helicopter’s altitude or vertical velocity.

8 The cyclic control varies the tilt angle of the main rotor disc (and total rotor thrust) by changing the pitch of each main rotor blade individually. It is the primary control of a helicopter’s direction of travel or position over the ground when in the hover. Robinson helicopters are equipped with a teetering-bar cyclic control.

9 See www.tsb.gc.ca/eng/rapports-reports/aviation/2004/a04p0314/a04p0314.asp

In response to continuing reports of R22 main rotor drive system failures, CASA issued Airworthiness Bulletin (AWB) 63-006 in 2009. The AWB identified a number of possible causes of the main rotor drive failures, and referred to applicable operational and maintenance data.

The aircraft manufacturer advised that this was the first recorded accident with Revision-Z v-belts installed, in which v-belts may have been a factor.

Flight reviews

The Civil Aviation Regulations require pilots conducting a flight to have completed a flight review (or equivalent) within the previous 2 years. Flight reviews typically include practice emergency procedures including autorotations. Once a flight review is satisfactorily completed, the person conducting the review must make a relevant entry in the pilot's personal logbook.

ANALYSIS

Introduction

The helicopter collided with terrain during mustering operations on Dalgonally Station. There were no direct witnesses to the accident, although there were two other helicopter pilots flying in the area at the time.

Examination of the pilot's medical and post-mortem results found no evidence of any pre-existing medical conditions or sudden illness that may have affected his ability to operate the helicopter. The prevailing weather conditions on the afternoon of the accident were not considered to have been a factor. Therefore, the investigation considered the possible airworthiness and operational factors that could have contributed to the accident. The following analysis examines those factors.

Airworthiness considerations

After examination of the wreckage, the Australian Transport Safety Bureau (ATSB) established that both v-belts failed prior to impact with terrain. The damage to the forward v-belt indicated that the v-belt had partially dislodged and sustained significant damage. Given the location of forward v-belt fragments away from the main wreckage, it is likely that the forward v-belt failed in flight prior to the rear v-belt, which was contained in the main wreckage. As a consequence of the forward v-belt fragmentation, the drive loads on the rear v-belt were suddenly increased with potential interference from forward v-belt fragments. In that context, the rear v-belt failed and all drive to the rotors was lost.

Loss of drive to the main rotor resulted in the engine overspeed and a sudden loss of altitude. This correlated with the high rate of descent recorded by the global positioning system (GPS) receiver just prior to impact and the damage sustained by the helicopter.

Although the Z-revision v-belts did not have a history of failure, the failure modes associated with previous revisions can still occur. Those modes include v-belt defects, sheave condition, incorrect v-belt tension, and sheave misalignment. In regard to the v-belts and sheaves, the ATSB found no pre-existing defects or anomalies and that they were therefore unlikely to have influenced the outcome.

Correct v-belt tension is important, especially at initial engagement, to avoid dislodgement. In this case there were a number of indicators of adequate v-belt tension including timely main rotor engagement and clutch actuator setting. In addition, the Z-revision belts fitted to the helicopter were known to be more resistant to stretching than previous revisions, which was consistent with the dimensional check conducted by the ATSB.

The upper and lower sheaves were disrupted during the accident sequence, precluding measurement of sheave alignment. In the absence of any other valid indicators of sheave alignment or any maintenance anomalies, the ATSB was unable to establish the existence of sheave misalignment.

Given the available evidence, the ATSB was unable to establish any airworthiness factors in the partial dislodgement of the forward v-belt. However, the ATSB concluded that the forward v-belt partially dislodged with consequent deterioration and failure of the v-belt, contributing to failure of the rear v-belt, complete loss of drive to the rotor system, and high rate of descent.

Operational considerations

A potential operational factor in the partial dislodgement of the forward v-belt was operation at high gross weight, and associated high power settings. Although the helicopter was not at a high gross weight at the time, the potential remained for high or excessive power settings, especially during mustering manoeuvres. However, engine parameters were not recorded and the recorded GPS data was insufficient to derive any power settings.

Once the v-belts failed with loss of drive to the rotors, the pilot was faced with the need to conduct an autorotative landing from a low altitude and at minimal speed. As a consequence, there was limited time for the pilot to recognise the condition, respond accordingly, and for the autorotation to develop before attempting to land. This was consistent with operation within the parameters of the helicopter's Height-Velocity diagram (or avoid curve) and resulted in a high rate of descent at the point of impact. While the manufacturer recommended minimising exposure to the avoid curve, mustering necessarily involves sustained low-level, low-speed flight.

In operations such as mustering, pilot proficiency in emergency situations and particularly autorotations is especially important. In this case, the most recent evidence of the pilot's practice of autorotations was more than 2 years prior to the accident. By not complying with the requirements for a biennial flight review, the pilot missed an opportunity to maintain the critical skills relevant to his operating environment. That increased the risk, but was not necessarily a factor in the final outcome.

FINDINGS

Context

From the evidence available, the following findings are made with respect to the rotor drive failure involving a Robinson Helicopter Company R-22 helicopter, registered VH-DSD, that occurred 83 km north-west of Julia Creek, Queensland on 9 May 2011. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factor

- The forward v-belt partially dislodged with consequent deterioration and failure of the v-belt, contributing to failure of the rear v-belt, complete loss of drive to the rotor system, and a high rate of descent that was unable to be arrested before impact with the terrain.

Other safety factor

- The pilot's lack of recency in the conduct of biennial helicopter flight reviews that include the practice of emergencies increased the risk of an inappropriate or delayed response to an aircraft malfunction.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

The investigation did not identify any organisational or systemic issues that might adversely affect the future of aviation operations. However, the importance of the correct installation and maintenance of the drive system and v-belts in R22 helicopters, and their operation within the stipulated power limits was reaffirmed. The ATSB therefore considers it prudent to again draw pilots' and operators' attention to the following safety advisory notice, which was initially published in the Preliminary Report into this occurrence.

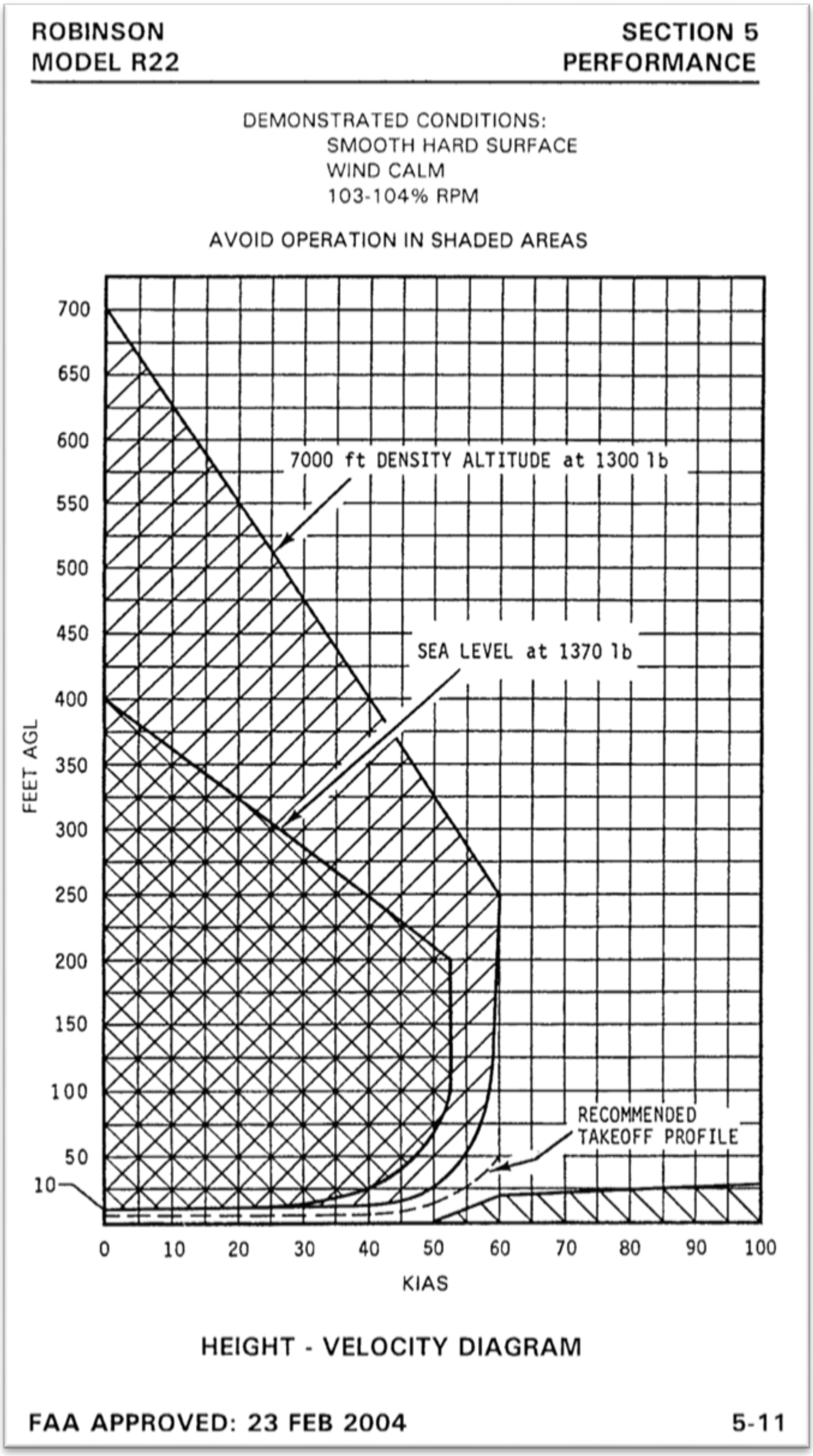
ATSB safety advisory notice AO-2011-060-SAN-001

The Australian Transport Safety Bureau encourages all operators of R22 helicopters, and organisations performing installation, inspection, and maintenance activities on the drive belts of R22 helicopters to note the circumstances detailed in this preliminary report. It is suggested that all operators and maintenance organisations consider inspecting the drive belts on R22 helicopters.

Civil Aviation Safety Authority proactive safety action

The Civil Aviation Safety Authority advised that, in response to the failure in this accident of a Mitsuboshi Belting Ltd, Japan Revision Z v-belt, they will review the content of Airworthiness Bulletin 63-006.

APPENDIX A: R22 HEIGHT-VELOCITY DIAGRAM



APPENDIX B: SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

- other pilots operating in the vicinity of the accident at the time
- the operator of DSD
- Dalgonally Station personnel
- the Bureau of Meteorology (BoM)
- the helicopter manufacturer
- the Northern Coroner's Office, Queensland.

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 operator of DSD, the helicopter maintenance organisation, the BoM, the Northern Coroner's Office, the helicopter manufacturer and the Civil Aviation Safety Authority (CASA).

Submissions were received from the operator of DSD, the helicopter manufacturer and CASA. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
Rotor drive failure - Robinson R22 Beta II, 83 km NW of Julia Creek, Queensland, 8 May 2011

AO-2011-060
Final