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Publication Date: 12 April 2012

ISBN 978-1-74251-253-2

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

TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2011-087
Final

Collision with terrain, VH-YOL 14 km north-west of Fitzroy Crossing Western Australia 27 July 2011

Abstract

On the evening of 27 July 2011, the owner-pilot of a Robinson Helicopter Co. R22 helicopter, registered VH-YOL, was conducting a local flight from Big Rock Dam to Brooking Springs homestead near Fitzroy Crossing, Western Australia. The pilot was reported missing and the wreckage of the helicopter was located the following day, 14 km north-west of Fitzroy Crossing township. The helicopter was seriously damaged and the pilot sustained fatal injuries.

The pilot was attempting to fly visually at low level on a dark night in an area that did not contain any local ground lighting. About halfway into the flight, the pilot inadvertently allowed the helicopter to develop a high rate of descent, resulting in a collision with terrain.

The investigation found that the pilot was operating at night without the appropriate training or qualification in a helicopter that was not suitably equipped. An examination of the helicopter found no evidence of any pre-existent defects or anomalies.

No organisational or systemic issues were identified that might adversely affect the future safety of aviation operations. However, the accident highlighted the significant risk to non-night-qualified pilots of spatial disorientation and subsequent collision with terrain when attempting visual operations at night.

FACTUAL INFORMATION

Sequence of events

On 27 July 2011, the owner-pilot (pilot) of a Robinson Helicopter Co. R22 helicopter, registered VH-YOL, was repositioning the helicopter from the Big Rock Dam stockyards to Brooking Springs homestead near Fitzroy Crossing, Western Australia.

Station hands who were at the yards reported that the helicopter departed at about sunset. One of the station hands recalled observing the pilot preparing the helicopter for the flight and, although he didn't see it take off, he stated that it 'sounded OK'.

Information recovered from the helicopter's global positioning system (GPS) equipment indicated that the helicopter departed Big Rock Dam at about 1755 Western Standard Time[1] (about half an hour after sunset and 10 minutes after last light[2]) in a south-easterly direction. The flight was initially conducted at an altitude of about 150 ft above ground level (AGL) and airspeed of 90 kts.

1 Western Standard Time (WST) was Coordinated Universal Time (UTC) + 8 hours.

2 Last light is when the centre of the sun is at an angle of 6° below the horizon following sunset. At this time the horizon is clearly defined but terrestrial objects are no longer distinct.

Over the next 10 minutes, the helicopter's flightpath was predominantly to the south-east with occasional variations towards the south. During this period, the helicopter's groundspeed progressively reduced to about 65 kts. At 1807, the helicopter orbited overhead a dirt track that was located near a dam before accelerating to about 60 kts in the direction of Fitzroy Crossing.

Between 1816 and 1824, by which time it was dark, the helicopter continued in the general direction of Fitzroy Crossing, while the groundspeed oscillated between 5 kts and 30 kts. During this period, the helicopter's altitude varied between 50 ft and 150 ft AGL.

At 1825, the helicopter entered a climb to about 600 ft AGL. On reaching that height, the helicopter turned towards Brooking Springs and the groundspeed increased from 10 kts to about 95 kts.

During the turn towards Brooking Springs, the helicopter developed a high rate of descent that resulted in a collision with terrain. The pilot, the sole occupant, was fatally injured and the helicopter sustained serious damage.

Pilot information

The pilot held a Private Pilot (Aeroplane) Licence and a Private Pilot (Helicopter) Licence that were both issued in 1980. All of the pilot's subsequent flying experience was in helicopters; initially in the Hughes 300 type, then predominantly in the R22.

An aerial stock mustering approval was issued to the pilot in 1998 and most of the pilot's estimated 3,478 hours total flying experience was related to cattle station activities. The pilot conducted 4.1 and 10.4 hours of mustering in the helicopter on the 2 days prior to accident respectively.

The pilot's licence was not endorsed for flight under the night visual flight rules (VFR) and there was no evidence that the pilot had received any night flying training. There were anecdotal reports that the pilot had flown R22 helicopters at night while returning to Brooking Springs.

The pilot's last flight review was conducted in an R22 in November 2009, with no difficulties reported by the instructor.

Aircraft information

General

The helicopter, serial No 4463, was manufactured in the United States in 2010 and was registered in Australia that year. The helicopter's total time in service (TTIS) was 254 hours.

The aircraft's Log Book Statement indicated that the helicopter was being maintained in accordance with the requirements of the manufacturer's maintenance manual. The last recorded maintenance was a 100-hourly inspection that was completed on 12 May 2010 at 207 hours TTIS. A maintenance release[3] was issued coincident with the 100-hourly that specified the helicopter's operational capability as 'VFR Day'.

There were no defects or overdue maintenance requirements recorded on the maintenance release.

Engine governor

An engine RPM governor was installed in the helicopter as standard equipment. During normal operations, the governor was required to be switched ON to automatically maintain engine RPM within the specified range.

In the event of RPM oscillations due to a governor malfunction, the pilot was required to grip the throttle firmly to override any effect of the governor, and switch the governor OFF. The pilot would then be required to control the engine RPM manually for the rest of the flight. When the governor switch was in the OFF position, a governor-off caution light illuminated on the instrument panel. The caution and warning lights were not dimmable for night operations.

About 5 days prior to the occurrence, the pilot contacted the maintenance provider for advice regarding the intermittent or non-operation of the governor. Two days prior to the occurrence, the

3 Official document, issued by an authorised person, that is required to be carried on an aircraft as an ongoing record of its time in service (TIS) and airworthiness status. Subject to conditions, a maintenance release is valid for a set period, nominally 100 hours TIS or 12 months from issue.

pilot confirmed that the governor was 'still playing up' and indicated that care was needed when operating the helicopter. On the day of the occurrence, the pilot questioned the maintainer whether throttle stickiness might be contributing to the erratic operation of the governor.

Helicopter equipment

The helicopter was equipped with the external and internal lighting required for night VFR operation. That lighting included two landing lights and dimmable instrument panel postlights. However, the helicopter was not equipped with an attitude indicator, a heading indicator or a turn/slip indicator. Those instruments were stipulated in aviation regulations for flight at night under the VFR.

A Garmin 495 GPS receiver was installed on top of the instrument panel. It had moving map, horizontal situation indicator and terrain database display/alerting functions. The functions selected at the time of the accident could not be determined.

Meteorological and other environmental information

The area forecast (ARFOR)[4] applicable to the flight predicted the wind to be from the east at 15 kts. There was no significant cloud and the visibility was forecast to be 8,000 m in areas of smoke. Station hands associated with the muster reported that there was no smoke in the vicinity of Big Rock Dam or Brooking Springs on the day of the accident.

The aerodrome forecast (TAF)[5] for Fitzroy Crossing that was valid at the time of the occurrence predicted the wind to be from the east at 10 kts and CAVOK[6] conditions.

The 1800 and 1900 routine weather reports (METAR)[7] for Fitzroy Crossing recorded wind from the south-east at 5 kts. The recorded temperatures were 24 ˚C and 22 ˚C respectively, with a dew point[8] of about 6 ˚C.

Last light at the accident site occurred at 1745 and nautical twilight[9] occurred at 1812. Moonrise and moonset occurred at 0243 and 1402 respectively. Consequently, for the duration of the flight, the moon would have been well below the horizon.

The Fitzroy Crossing township comprised several distinct communities that were orientated generally in a north-south direction over a distance of about 4 km. In addition to street lighting, the town's oval was equipped with lighting that was reported to be in use at the time of the accident. The area between the accident site and township was uninhabited and unlit.

Wreckage and impact information

The accident site was situated on a flat, black-soil plain vegetated with thick grass and occasional small shrubs or trees at an approximate elevation of 420 ft. Similar terrain extended eastward to the outskirts of the Fitzroy Crossing Airport (370 ft elevation) and township, an average distance of about 14 km.

4 An area forecast is issued for the purposes of providing aviation weather forecasts to pilots. Australia is subdivided into a number of forecast areas.

5 Aerodrome forecasts are a statement of meteorological conditions expected for a specific period of time, in the airspace within a radius of 5 NM (9 km) of the aerodrome.

6 Ceiling and visibility OK, meaning that visibility, cloud and present weather better than prescribed conditions. For an aerodrome weather report, those conditions are visibility 10 km or more, no significant cloud below 5,000 ft or cumulonimbus cloud and no other significant weather within 9 km the aerodrome.

7 Routine aerodrome weather report issued at fixed times, hourly or half-hourly.

8 Dewpoint is the temperature at which water vapour in the air starts to condense as the air cools. It is used among other things to monitor the risk of aircraft carburettor icing or likelihood of fog at an aerodrome.

9 Nautical twilight is when the centre of the sun is at an angle of 12° below the horizon following sunset. At this time, in the absence of moonlight, artificial lighting or adverse atmospheric conditions, it is dark and the horizon is not normally visible.

Overall, the wreckage debris field was about 80 m long from the first ground scrape and an average of 15 m wide. The wreckage trail was generally oriented on an easterly heading. An incision in the ground was located about 5 m into the trail and offset 2.5 m to the right, consistent with a main rotor blade strike. Based on the angle of that incision, the helicopter was banked about 25° to the right at that time.

Figure 1: Wreckage field overview (main wreckage circled)

Forward of the initial scrape mark, which was about 26 m long, were various parts from the aircraft's cabin area, the skids, and fragments of the main rotor blades. The tail boom had detached from the aircraft 53 m along the wreckage trail and the main wreckage came to rest an additional 14 m along the trail.

The main and auxiliary fuel tanks had detached from the fuselage and were found towards the end of the wreckage trail. They were disrupted and contained no fuel.

Figure 2: Main wreckage, looking back along the wreckage trail

On-site wreckage examination found no pre-existing defects or anomalies in the helicopter or its systems that would have contributed to the accident. The mechanical continuity of the engine was established and damage to the engine cooling fan assembly was consistent with engine rotation at impact.

The governor switch was in the OFF position and the governor-off caution light globe was the only warning/caution light that showed filament stretch, consistent with its illumination at impact.

The dimmable instrument panel lights rheostat was selected to about 2/3 scale. The postlight globe filaments were undamaged and showed no filament stretch.

The governor motor and gearbox were functionally tested by the helicopter manufacturer and found to be within serviceable limits. Due to extensive disruption, the pre-impact condition of the governor system wiring and engine throttle control system was not able to be established.

Medical and pathological information

It was reported that the pilot was affected by Leptospirosis, which is a bacterial disease that is commonly contracted through contact with infected animals, including cattle. Symptoms of the condition include fever, severe headaches and sore muscles. In severe cases, the disease can lead to kidney failure, haemorrhages and meningitis.

The pilot's partner reported that, on the day of the accident, the pilot was unwell and was experiencing muscle weakness in the arms and legs that made it difficult to for the pilot to work and/or hold objects. As a result, the pilot was

reported to have spent the majority of the morning resting. The partner recalled that the pilot had worked yarding up cattle in the afternoon, but was still lethargic and experiencing pain in her hands at that time.

The pilot's most recent medical examination was conducted in January 2010. The pilot's designated aviation medical examiner reported being unaware of any serious medical condition, and recalled that the pilot was in good health at the time of the examination. The examiner had not had any contact with the pilot since the January 2010 examination.

A post-mortem examination found '…no definitive evidence of significant natural disease.' In view of the reported history of Leptospirosis, additional histology and toxicology was performed. That testing did not show any evidence of Leptospirosis.

Organisational and management information

The Aeronautical Information Publication (AIP) required that:

> Unless the pilot in command holds a Command Instrument Rating or night VFR (NGT VFR) rating and the aircraft is appropriately equipped for flight at night, a VFR flight must not depart from an aerodrome:
>
> 1. before first light or after last light; and
>
> 2. unless the ETA [Estimated Time of Arrival] is at least 10 minutes before last light after allowing for any required holding.

Last light was interpreted by the AIP to equate to the end of civil twilight.

The AIP also placed altitude restrictions on the operation of an aircraft at night under the VFR. That included that a pilot should not:

> …operate an aircraft under those rules at a height lower than the published lowest safe altitude (LSALT) for the route, or a height that was calculated in accordance with the requirements of the AIP, except under certain prescribed circumstances.

The LSALT applicable to the flight was 1,900 ft above mean sea level (AMSL).

Additional information

Flight operations at night

In December 2006, the Civil Aviation Safety Authority published Civil Aviation Advisory Publication (CAAP) 5.13-2(0) titled *Night Visual Flight Rules Rating*. The introduction stressed the need for pilots to read the CAAP, including that:

> Night flying accidents are not as frequent as daytime accidents because less flying is done at night. However, statistics indicate that an accident at night is about two and a half times more likely to be fatal than an accident during the day. Further, accidents at night that result from controlled or uncontrolled flight into terrain (CFIT or UFIT) are very likely to be fatal accidents. Loss of control by pilots of night visual flight rules (NVFR) aircraft in dark night conditions has been a factor in a significant number of fatal accidents in this country and the purpose of this CAAP is to highlight the hazards of night flying and to provide advice to NVFR pilots and others on how to fly safe NVFR operations.

Flight at night requires a balance of visual cues as well as reference to specific flight instruments. With limited illumination provided by the moon or ground lighting, it may be difficult to see the natural horizon, as well as maintaining terrain and cloud separation, making visual flight impossible.

The CAAP also stated that:

> Loss of control of the aircraft is highly likely if a pilot attempts to fly by visual reference instead of by reference to instruments.

Visual cues should only be used in night flight as a means of ascertaining navigation fixes, as well as to help position the aircraft approaching an airport and to maintain separation from other aircraft and lighted obstacles. Visual illusions can be minimised by use of flight instruments, rather than relying on visual cues as a sole means of reference.

Australian Transport Safety Bureau (ATSB) investigation 200304282, which examined an accident involving loss of control due to spatial disorientation, detailed the risks associated with NVFR operations in an NVFR-equipped helicopter with minimal celestial lighting available to the pilot. The report discussed the potentially misleading effects of night visual illusions, and the resulting risk of pilot spatial disorientation.

The ATSB has investigated four occurrences where day VFR-equipped R22 helicopters have been operated at night. Each of those occurrences[10] resulted in the aircraft impacting terrain with fatal consequences.

Robinson Helicopter Company Safety Notices SN-18 and SN-26 warn pilots of that company's helicopters of the dangers involved in flying at night, and the resulting increased risk of a fatal accident in those conditions.

ANALYSIS

Introduction

The recovered data from the helicopter's global positioning system equipment indicated that the helicopter departed Big Rock Dam after last light and that the latter part of the flight was conducted in darkness. This analysis will examine the risks associated with the night flight and their influence in the development of the accident.

Visual flight at night

At night, the available visual references for establishing an aircraft's attitude and position are degraded or absent. A lack of visual references significantly increases the risk of pilot disorientation and consequent loss of control. The inherent instability[11] of a helicopter has the potential to further increase that risk.

To mitigate the risk of spatial disorientation at night, aircraft are required to be fitted with flight instruments that display the aircraft's attitude. In addition, pilots must undertake specific training that enables them to interpret those instruments and make the necessary flight control inputs.

In this case, the helicopter was not fitted with the necessary flight instruments and the only means of establishing the helicopter's attitude was from external visual references. Without the necessary night qualification, and in the absence of adequate visual references, the pilot would have been more susceptible to the effects of spatial disorientation.

In addition, flying visually with degraded or absent visual references requires a high degree of concentration and increases pilot workload. That would reduce the pilot's capacity to perform other tasks, such as monitoring the altimeter and vertical speed indicator.

Development of the accident

As the flight progressed, the available ambient light reduced to the point where, in the absence of any moonlight, the horizon would have no longer been visible. Without a visible horizon, it was likely that the pilot would have relied on light from the helicopter's landing lights to illuminate the ground. However, the landing lights would have only illuminated a relatively small area immediately below and forward of the helicopter, making it difficult to orientate and navigate the helicopter. Although unable to be determined, the use by the pilot of the landing lights in that endeavour might explain the airspeed and altitude oscillations that occurred between 1816 and 1824, and be symptomatic of the level of difficulty being experienced by the pilot. The climb to about 600 ft above ground level and turn to the left a short time later were consistent with the pilot having acquired the town's lights and the intention to continue the flight by reference to those lights.

The turn and acceleration towards Brooking Springs homestead was conducted in an area that did not contain any local ground lighting. In that case, any understanding of the aircraft's height above the ground would have been derived either from the pilot's local knowledge of the surrounding terrain in comparison to the altimeter reading, or from her perception of the height above the ground with reference to the lights at Fitzroy Crossing. Given that the helicopter was about 14 km (46,000 ft) from the nearest lighting, it would have been difficult for the pilot to detect the small change in the horizon's relative position in the windscreen equating to a height loss of 500 ft. In that context, the risk of disorientation and loss of control was elevated.

10 ATSB occurrence reports 199502225, 199903335, 200504925 and AO-2009-031 are available at www.atsb.gov.au

11 In general, stability is the combination of the quality of resisting disturbances from an existing condition and the tendency to restore or return to that condition once the disturbance has been removed.

Pilot workload

The position of the governor switch and filament stretch to the corresponding globe was consistent with the governor system being in the OFF position at the time of the accident. Based on the pilot's experience and exposure to the reported previous intermittent or non-operation of the governor, it is likely that the pilot was capable of, or had previously operated the helicopter by day without a serviceable governor.

However, in this case, the pilot was operating at night and without the required qualification or helicopter instrumentation. In addition, any glare from the illuminated governor-off caution light in the dark night conditions may have impaired the pilot's spatial awareness and therefore ability to fly visually. Each would have increased the pilot's workload and increased the disorientation risk.

Fitness for duty

Although the post-mortem microbiological examination found no evidence of Leptospirosis, and it was reported that the pilot had rested for the majority of the morning, the partner's observations suggest that the pilot was still unwell immediately prior to the flight. The reported muscle weakness and hand pain could have impacted on the pilot's ability to manipulate the helicopter's controls and the reported lethargy may have had a detrimental effect on the pilot's cognitive ability.

There appeared to have been several opportunities during the flight where the helicopter could have been landed in an emergency. The pilot's action to continue the flight would suggest that either the pilot was not confident in landing, or that any sickness was not debilitating to the extent that a landing was considered necessary. The relative stability of the climb and turn towards Brooking Springs was consistent with the pilot being in control of the helicopter and might suggest that the latter was the case. While recognising that the pilot was probably not totally fit, a loss of control associated with a medical event was considered unlikely.

Conclusion

The circumstances of the accident highlight the significant risk of spatial disorientation and subsequent collision with terrain associated with visual flight at night when unqualified and operating in a helicopter that is not suitably equipped. Based on the available evidence it is likely that, on a moonless night and without the required instruments or qualification, an unintentional descent developed from which the pilot had insufficient visual references to recover in sufficient time to avoid a collision with terrain.

FINDINGS

Context

From the evidence available, the following findings are made with respect to the collision with terrain that occurred near Fitzroy Crossing, Western Australia on 27 July 2011 and involved Robinson Helicopter Co. R22, registered VH-YOL. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The pilot was operating at night without the appropriate qualification in a helicopter that was not suitably equipped.
- While attempting to fly visually at low level on a dark night without local ground lighting, the pilot inadvertently allowed the helicopter to develop a high rate of descent, resulting in a collision with terrain.

SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

- recorded data from the helicopter's global positioning system equipment
- a number of station personnel
- maintenance provider
- a number of medical practitioners
- Civil Aviation Safety Authority (CASA)
- Bureau of Meteorology.

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 pilot's family, the maintenance provider, the aircraft manufacturer, the National Transportation Safety Board (NTSB) and CASA. A submission was received from a member of the pilot's family. The submission was reviewed and, where considered appropriate, the text of the report was amended accordingly.