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ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2010-073
Final

Collision with terrain, VH-THI

170 km east of Katherine, Northern Territory

4 October 2010

Abstract

On 4 October 2010, the pilot of a Robinson Helicopter Co. R22 Beta, registered VH-THI, was conducting cattle mustering operations on a station property about 170 km east of Katherine, Northern Territory. During those operations, the helicopter collided with the ground. The pilot, the sole occupant of the helicopter, sustained fatal injuries. The helicopter was seriously damaged.

The investigation determined that the collision with terrain was probably a result of engine stoppage while operating at low altitude. The investigation also determined that the helicopter was serviceable prior to the collision with the terrain and that the engine stoppage was probably due to fuel exhaustion.

The nature of mustering operations had the potential to divert the pilot's attention away from other safety-critical tasks, such as monitoring the helicopter's fuel state. The circumstances of the accident highlight the importance of pilots and operators using a system to independently verify the fuel quantity in their aircraft's tanks.

FACTUAL INFORMATION

History of the flight

On 4 October 2010, a Robinson Helicopter Co. R22 Beta helicopter, registered VH-THI (THI), was being used for cattle mustering operations on a station property about 170 km east of Katherine, Northern Territory.

The helicopter was being operated about 8 km from the property homestead, over relatively flat but lightly-timbered terrain. The pilot's task was to spot and muster any bulls to open areas, where they could be chased and caught by ground personnel using station vehicles.

Operations commenced that morning at about 0700 Central Standard Time[1], and involved two pilots who were each qualified to muster cattle. The first pilot operated the helicopter on and off for an estimated 2 hours flying time, during which the occurrence pilot was involved in the operation of the ground vehicles.

The first pilot landed mid-morning to help load a number of bulls onto the ground transport vehicle. He reported that at that stage, the vehicle had enough room to load one or two more animals. He then handed responsibility for the flying component of the muster to the occurrence pilot, who indicated that, before commencing mustering, he would refuel THI from a 200 L fuel drum that was located a short distance away.

A station hand, who was driving one of the ground vehicles, stopped briefly at the refuelling spot and spoke to the occurrence pilot. He recalled that the helicopter was next to the fuel drum, with the engine shut down at that time. He did not actually see the pilot refuel the helicopter. Subsequently, the station hand observed THI being manoeuvred in the distance.

At about 1030, the station owner departed the nearby homestead in another R22 helicopter, with the intention of assisting with the muster. He made a radio transmission to the pilot of THI to

1 Central Standard Time (CST) was Coordinated Universal Time (UTC) + 9.5 hours.

advise of his pending arrival in the area of the muster. The pilot responded, giving his location. At that stage, the pilot was reported to have been airborne for about 30 minutes.

Subsequent radio transmissions from the pilot of THI to the ground crew gave the impression that he may have been having difficulty keeping a bull out in the open, and needed them to proceed without delay to his location. As the owner approached the area of operations, he attempted to make further radio contact with the pilot of THI, but without success. After several more attempts and without being able to sight THI, he landed where the ground vehicles were gathered, picked up the first pilot and departed in search of THI.

Several minutes later, the station owner and first pilot sighted the wreckage of THI in a dry creek bed that was surrounded by trees (Figure 1). They landed in a nearby clearing and proceeded on foot to the accident site where they found that the pilot had sustained fatal injuries.

The helicopter was seriously damaged. There was no fire.

Figure 1: Aerial view of the accident site

Personnel information

The pilot held a Commercial Pilot (Helicopter) Licence that was issued by the Civil Aviation Safety Authority (CASA) on 2 September 2005 and was endorsed on the R22. CASA issued the pilot an Operational Approval for Low Flying (Helicopter) on 15 September 2005 and an Aerial Stock Mustering Approval on 30 April 2007. The pilot held a current Class 1 Medical Certificate, with nil restrictions.

The pilot's flying logbook indicated a total aeronautical experience of 3,416 hours as of 11 May 2010. There were no further flights documented in the pilot's logbook from that time. Of the pilot's recorded hours, about 3,100 were in R22 helicopters, including about 2,500 hours in aerial stock mustering operations. The pilot's most recent flight review was conducted in an R22 on 17 September 2009.

The pilot was free of duty on the day before the accident and was reported to be well rested and in good health on the day of the accident. The pilot's colleagues described him as being a very confident and competent pilot.

Aircraft information

The helicopter, serial number 0864, was manufactured in the United States in 1988 and entered on the Australian aircraft register in September that year. The aircraft's Log Book Statement indicated that the helicopter was being maintained in accordance with the requirements of the manufacturer's maintenance manual.

An overhauled Textron Lycoming O-320-B2C engine was installed in September 2010, coincident with a 100-hour inspection. Since that inspection, the daily inspection certification and aircraft time-in-service section of the aircraft's maintenance release had not been completed. The aircraft's engine was reported to have undergone scheduled oil and oil filter changes, although they too were not recorded in the aircraft's maintenance release.

The aircraft's hour meter indicated that the helicopter had accrued 51.9 hours since its release to service following the last 100-hour inspection. The helicopter's total time in service (TTIS) was estimated to be 8,009 hours. A review of the aircraft's maintenance records indicated that all other maintenance and inspections were up to date.

The helicopter was estimated to be about 110 kg below its maximum gross weight of 622 kg and within centre of gravity limits at the time of the accident. The helicopter's flight manual indicated that, at the reported ambient temperature of 36 °C, the helicopter could hover out of ground effect[2] at its maximum gross weight in nil wind. That suggested a good performance margin for the intended muster.

The helicopter's flight manual stated that the capacity of the helicopter's main fuel tank was 75 L. The published unusable fuel was 2.3 L, which was based on a 3° nose-up pitch attitude.

Meteorological information

Persons in the vicinity of the accident site described the weather conditions at the time as being fine, with a strong easterly wind, good visibility and a temperature of about 36 °C. The Bureau of Meteorology reviewed the available weather data for the time of the accident and summarised the likely conditions as clear, with a generally easterly wind flow. The nearest observation site was at Bulman, 85 km to the north-east, where the automatic weather station recorded easterly winds at 12 to 20 kts and a temperature of 34 °C at about the time of the accident.

Those atmospheric conditions were not considered to be conducive to the formation of significant carburettor ice.

Wreckage and impact information

Wreckage examination

The wreckage of the helicopter was located on a dry creek bed that was surrounded by numerous trees about 10 m in height (Figure 2). There was evidence of slight main and tailrotor contact with the surrounding trees during the final stages of the descent. The helicopter's angle of descent was estimated to be about 45°.

The helicopter collided heavily with the creek bank in an upright attitude with a high rate of descent that collapsed the skid-landing gear. There was evidence that, at the time of the collision with the terrain, the helicopter had low forward speed. That speed could not be quantified.

The 60° upwards slope of the creek bank brought the helicopter to an abrupt stop. The impact forces deformed the cabin and cabin floor, severely compromising the survival space.

Beyond the creek in the direction of flight, there was a relatively clear area that appeared suitable for an emergency landing. The helicopter's heading on impact was 230°(M).

Figure 2: Helicopter main wreckage

The helicopter's tail boom was damaged when it collided with the creek bank during the impact sequence. The main rotor blades were intact and securely attached to the main rotor hub. The main rotor mast teeter[3] stops were undamaged. The main rotor blades were in the maximum pitch position and the pilot's collective pitch control was fully raised. There was no evidence of any coning[4] of the main rotor blades.

Pre-impact continuity of the helicopter's flight controls was established with the failures to those controls confirmed as due to impact overload. The rotor system vee-belts[5] were engaged in their respective sheaves, but were slightly out of alignment due to the engine's movement on impact.

The engine was intact and undamaged. There was impact-related abrasion to one of the engine's

2 The US Federal Aviation Administration's Rotorcraft Flying handbook defined flight at more than one rotor diameter above the surface as being 'out of ground effect'. Helicopters require more power to hover out of ground effect due to the absence of a cushioning effect created by the main rotor downwash striking the ground.

3 The teeter stops are mounted on the main rotor mast and prevent excessive teetering (or rocking) of the main rotor at low RPM.

4 Coning in this context refers to the permanent upward-bending of the main rotor blades as a result of aerodynamic loads during flight with low main rotor RPM.

5 Comprising two rubber drive belts that transfer power from the engine to the helicopter's rotor system.

ignition harnesses and the carburettor had been damaged during ground contact.

Both the main and auxiliary fuel tanks were intact. The fuel line to the carburettor had disconnected at the elbow connection to the carburettor as a result of impact damage to the carburettor body.

The on-site examination of the wreckage commenced on 6 October 2011, 2 days after the accident. At that time, there was no evidence of fuel leakage from the disconnected fuel line or from the impact-damaged carburettor. There was no smell of fuel at the site and no staining or wetting on the area adjacent to the carburettor, on the underside of the helicopter or to the soil directly beneath.

Persons at the accident site soon after the accident, and later that same day, reported no smell of fuel or obvious signs of spilt fluid at those times.

There was no fuel in the auxiliary fuel tank. A small amount of fuel, estimated to be about 800 ml, was observed in the main fuel tank. The investigation team recovered 600 ml of that fuel via the main tank drain. The recovered fuel was clear and bright and was retained for testing.

The gascolator[6] was intact and the drain tube had contacted the ground with insufficient force to compress the drain valve. No fuel stain or wetting was evident in the soil below the gascolator. The gascolator bowl was removed and contained about 5 to 10 ml of fuel.

The main wreckage and engine were transported to a CASA-approved maintenance facility for disassembly and examination under Australian Transport Safety Bureau (ATSB) supervision. During that examination, a number of fuel system components were retained for later technical examination at the ATSB's facilities in Canberra.

Examination of recovered items and components

Engine

The engine was removed from the airframe for closer examination. No contamination or debris was evident in the engine's oil strainer, sump or filter screen and all spark plugs were clean and intact with the correct gaps[7] set. The magnetos were timed correctly.

The damaged right magneto leads were replaced and a serviceable carburettor was fitted to the engine. The engine was installed in a protective test cell and a test run carried out.

The engine started at the first attempt and idled satisfactorily with all engine parameters within limits. The magneto checks were normal and the engine responded appropriately to throttle inputs. After reaching operating temperature, the engine was shut down. A compression test was performed on each cylinder and was within limits. The engine oil filters were clean and free of debris.

Fuel system

The carburettor body exhibited impact damage. No sediment was evident in the fuel feed inlet and all components were clear of any obstruction. The outside air inlet and carburettor heat ducts were free from obstruction. The carburettor-mounted air box assembly and integral air filter element were damaged on impact. The air filter element was clean and free from obstruction.

The main and auxiliary fuel tank vent lines were tested and no obstructions or restrictions were found in either line. Fuel was added to the main tank with no leaks evident. A fuel flow check was carried out and the results of that check were within the helicopter manufacturer's maintenance manual limits.

The main tank fuel gauge and associated low fuel warning light[8] were subjected to a calibration test, which determined that the warning light illuminated with about 5.5 L of useable fuel remaining. That was consistent with the requirements of the helicopter's maintenance manual.

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6 A filter located at the lowest point of a fuel system that included a drain to allow the as-required removal of water and solid particles.

7 Spark plugs are typically designed to have a gap between the central and lateral electrodes that can be adjusted to ensure fuel-efficient firing.

8 The 'low fuel' warning light was designed to illuminate with about 1 US gallon (3.8 L) of useable fuel in the main tank. It would activate if the sensor was exposed for longer than 3 seconds. That amount of fuel provided for about 5 minutes of engine operation at cruise power.

Six litres of fuel was then added to the main fuel tank, which resulted in the helicopter's fuel gauge indicating empty. That was consistent with the last recorded calibration of the helicopter's fuel gauge on 8 July 2010. Additional fuel was progressively added to the tank and the gauge readings noted. As the increasing fuel reached about 23 L of useable fuel (about ¼ full), the gauge indication jumped to about ½ full. A further 2 L was added and the gauge indication jumped to full.

As a result of those indications, and their inconsistency with the last-recorded fuel gauge calibration, the main and auxiliary fuel tank quantity sender units were removed and forwarded to the ATSB's technical facilities in Canberra for technical examination. The low fuel warning light sender was also sent to Canberra for analysis.

Fuel quality

The 600 ml of fuel that was recovered from the helicopter's main tank was tested at an accredited National Association of Testing Authorities laboratory. The test report from that laboratory stated that the sample was green in colour, clear and bright and visually free from solid matter and undissolved water at ambient temperature. The fuel sample had a high lead content and was contaminated with an additional substance that the testing agency was unable to identify.

As a result of the small sample of fuel available for testing, a distillation test was not possible. The laboratory report concluded that the fuel sample did not meet the aviation gasoline (Avgas) 100/130 specification for the parameters tested.

The fuel used for the flight was from the owner's bulk stock at a nearby property. The fuel was transferred to 200 L Avgas drums for transport to, and use during the mustering operation. It was reported that the owner's other helicopter used the remainder of the fuel from the same drum as used by the pilots of THI on the day of the accident. No operational difficulties were reported with the second helicopter.

The engine manufacturer was consulted regarding the fuel's high lead content and stated that it should not have resulted in any noticeable difference in engine operation.

Technical examination of fuel system components

The sender unit for the main tank fuel gauge comprised a wire-wound variable resistor that was attached to an arm-mounted float inside the fuel tank. The reading on the fuel gauge was derived from the measurement of electrical resistance from the sender unit.

The helicopter's logbook recorded the replacement of the sender unit on 30 March 2006 and, other than a general visual inspection at the 100 hour/annual inspection, the sender unit was not subject to any specific inspection requirement. That visual inspection would not have revealed the wear to the variable resistor (see following discussion).

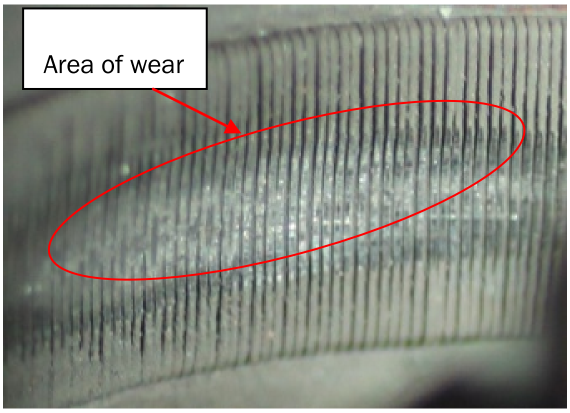
On examination, the sender unit exhibited intermittent resistance between a position that corresponded to about three quarters full, down to the empty position. The unit was dismantled and examined in an effort to understand that intermittent resistance.

Wear of the unit's wire-wound variable resistor[9] was identified (Figure 3). The location of that wear was consistent with the helicopter having regularly operated with fuel quantities of less than half full tank capacity. That would have given intermittently erroneous fuel quantity indications and was consistent with a tendency for the gauge to over read, particularly between half and the lower end of the fuel gauge scale.

There was no evidence of damage to the sender unit associated with the ground impact.

9 A wire-wound variable resistor is an electrical device that converts rotary or linear motion into a measurable change of resistance, which can be displayed as fuel contents in the cockpit.

Figure 3: Main fuel tank sender unit wire-wound resistor



The sender unit from the low fuel warning light functioned correctly when tested. Wear was noted on the float shaft, but was not considered to have affected the operation of the unit.

An examination of the globe from the low fuel warning light for any indication of its illumination at ground impact was inconclusive.

Medical and pathological information

Post-mortem examination of the pilot and toxicological testing by the relevant authorities found no pre-existing medical condition or other factors that would have affected the pilot's performance, or have incapacitated the pilot. Due to the extent of the impact forces and injuries sustained by the pilot, the accident was not survivable.

Additional information

Operational category

The owner of the helicopter also owned the station property, in which case the flights were a private category operation. Private operations did not require an Air Operator's Certificate or an operations manual, but were required to comply with various provisions of the Civil Aviation Regulations (CAR).

Fuel management

As a private category operation, there was no requirement for a formal system of fuel management. However, CAR 234 – *Fuel requirements*, required the pilot in command and the operator[10] to take reasonable steps to ensure that sufficient fuel was carried for the flight. It was reported that neither the fuel uplifted and consumed, nor the flight time was formally recorded by the station pilots. The first pilot to fly THI that day had an unclear recollection of the quantity of fuel uplifted and flight times for that portion of the muster.

In order to maximise the performance of the R22 during mustering, the station's pilots reported generally minimising the helicopter's weight by only uplifting sufficient fuel for the expected duration of the flight. Fuel uplifted was generally crosschecked with the aircraft's fuel gauge to validate the total fuel on board.

The pilots reported using a fuel consumption of 34 L/h to calculate the helicopter's endurance. The station's pilots indicated that, when the occurrence pilot refuelled the helicopter, he could have filled the main tank to capacity. They stated that it was equally possible that he added about 30 or 40 L to whatever fuel was remaining in the main tank at that time, consistent with its being sufficient for the expected flight duration.

A hand-operated rotary fuel pump was provided to fuel the station owner's aircraft from the drum stock. The ATSB arranged for a check of the pump's output, which was established at about 0.86 L per revolution. That was less than the '1 L per revolution' estimate used by many general aviation pilots to calculate fuel uplift.

Civil Aviation Advisory Publication 234-1(1) titled *Guidelines for aircraft fuel requirements* included the following advice:

> Unless assured that the aircraft tanks are completely full, or a totally reliable and accurately graduated dipstick, sight gauge, drip gauge or tank tab reading can be done, the pilot should endeavour to use the best available fuel quantity crosscheck prior to starting. The cross-check should consist of establishing the fuel on board by at least two different methods such as:
>
> a) Check of visual readings (tab, dip, drip, sight gauges) against fuel consumed indicator readings: or

10 CAR 2 defined an 'operator' as a person, organisation, or enterprise that was engaged in, or offering to engage in an aircraft operation.

b) Having regard to previous readings, a check of electrical gauge or visual readings against fuel consumed indicator readings: or

c) After refuelling and having regard to previous readings, a check of electrical gauge or visual readings against the refuelling installation readings: or

d) Where a Series of flights is undertaken by the same pilot and refuelling is not carried out at intermediate stops, cross-checks may be made by checking the quantity gauge readings against computed fuel on board and/or fuel consumed indicator readings, provided the particular system is known to be reliable.

The helicopter manufacturer did not provide or manufacture dipsticks for use in the R22. The manufacturer reported that there should not be any problems with using a dipstick in the R22, as long as it was properly calibrated.

It was common practice in Australia for owners and operators of general aviation aircraft, including the Robinson R22, to use 'home-made' calibrated dipsticks for fuel measurement. Although the investigation was unable to establish the occurrence pilot's normal fuel management practices, it was reported that station pilots did not use dipsticks to verify fuel contents.

The helicopter manufacturer alerted pilots to the serious consequences of fuel exhaustion via Safety Notice SN-15 titled *Fuel Exhaustion Can Be Fatal* (see Appendix A).

Autorotation

In the case of a complete engine power loss, a pilot is required to immediately enter autorotation by lowering the collective 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 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 an engine failure is limited at the relatively low altitudes and airspeeds typically adopted during aerial stock mustering. That limited performance is due to the height loss before sufficient upward airflow is generated from the rate of descent to maintain main rotor RPM, or to the pilot's inability to reduce airspeed before contacting the ground.

Overpitching

Overpitching refers to the situation where there is insufficient engine power available or selected to sustain the intended flight path while maintaining the required main rotor RPM. Overpitching can be induced by engine power loss, main rotor inefficiencies or by exceeding the helicopter's performance limitations. If the pilot does not immediately respond by increasing power (if available) and/or lowering the collective control, overpitching can result in a rapidly decreasing main rotor RPM and a rapidly increasing rate of descent.

The application of collective to arrest a descent in a low main rotor RPM state will result in coning of the main rotor blades. Once the main rotor RPM reaches a critically low level the main rotor will effectively stall, and rotor thrust will completely collapse with typically catastrophic consequences.

Vortex ring state

Vortex ring state (VRS) is an aerodynamic condition, also referred to as settling with power, where a helicopter may be in a high-rate vertical descent with up to maximum power applied and with little or no cyclic authority. It can develop when the helicopter has:

- low or zero airspeed
- engine power applied
- a descent rate of at least 300 ft/min.

Recovery from VRS is affected by freezing, or if possible lowering the collective control and increasing airspeed. Power is then applied to fly away.

Effect of wind on helicopter performance

The wind can have a significant effect on a helicopter's performance. Headwinds are generally more advantageous as they contribute to an increase in performance. Strong crosswinds and tailwinds may require the use of more tailrotor thrust to maintain directional control. That increased tailrotor thrust absorbs power from the engine, which means less power is available to the main rotor for the production of lift.

Task fixation

The ability to maintain situational awareness while completing individual, separate tasks is one of the most critical aspects of working in the aerial stock mustering environment. Preoccupation with one particular task can degrade the ability to detect other important information. Fixation can happen even to experienced pilots who have mastered those individual tasks.

ANALYSIS

The evidence is consistent with the pilot attempting to muster a bull out of the timbered area that surrounded the accident site. As a result, the helicopter was most likely being flown at a low height and at a low speed immediately prior to the accident. The impact with the ground in an upright attitude and with the helicopter facing toward an area relatively free of obstructions suggested the helicopter was probably under control at that time, and that the pilot was attempting to make a landing in the clear area.

For the helicopter to have avoided major contact with the surrounding trees, the angle of descent would have been steep, estimated to be about 45°. The nature of the damage to the helicopter was consistent with a high rate of descent at impact. The investigation concluded that either the landing was as a result of an in-flight emergency, or that the pilot inadvertently impacted the ground. The low forward speed at the time suggested that the latter was not the case.

An estimated 800 ml of fuel remained in the main fuel tank at the accident site, less than the published unusable fuel figure of 2.3 L. However, that unusable quantity was established for a 3°nose-up pitch attitude, whereas mustering operations generally entail flight with a degree of nose down. Such flight would move the remaining fuel toward the fuel line pickup at the front of the tank, and tend to maintain supply. Fuel remaining in the carburettor bowl may have been sufficient to maintain engine operation during any initially intermittent un-porting of the pickup.

The pilot had indicated his intention to refuel the helicopter and was observed at the refuelling drum, so it was likely that he did uplift a quantity of fuel. Refuelling to an easily identified known quantity, such as a full main tank was a good fuel management practice, but operating with a full tank was not necessarily desirable due to the need to keep the helicopter as light as possible.

It was reported that at the time of the accident, the cattle truck was close to being fully loaded and that it was possible the pilot would have added just 30 or 40 L to the main tank. That would likely have been sufficient for the remainder of the muster. Considering the variability of the refuelling pump output, and the inaccuracy of the helicopter’s fuel gauge, if the pilot had taken less than a full tank of fuel he may have thought that there was more fuel on board the helicopter than was actually the case.

The general impression of the station hands was that the pilot was not airborne for a significant time before the accident occurred; perhaps 30 minutes. However, a lack of any record of fuel use throughout the morning, and uncertainty about the previous pilot’s flight time in the helicopter, resulted in the investigation being unable to determine an accurate sequence of events.

The last line of defence against fuel exhaustion was the low-fuel warning light. Testing of that system indicated that it was most likely serviceable prior to the accident. Illumination of the low fuel warning light should have given the pilot at least 5 minutes warning of fuel exhaustion. Although it may seem doubtful that an experienced mustering pilot would not notice a red warning light, it was possible that at about that critical time, the pilot was ‘eyes out of the cockpit’, concentrating on the muster.

The investigation considered other factors with the potential to have resulted in a steep approach angle and high rate of descent on impact. The pilot was qualified for, and well experienced in aerial stock mustering in R22 helicopters. In addition, there was no evidence of physiological factors that would have affected his handling of the helicopter. Although it was calculated that the helicopter had an adequate performance margin for the muster, there was insufficient information to establish if the circumstances in the lead-up to the accident were conducive to vortex ring state or that overpitching was a factor.

The evidence from the accident site and the subsequent component inspections indicated that the helicopter and its systems were capable of normal operation prior to the collision with the ground. Based on the engine manufacturer's advice that the high lead content of the fuel should not have resulted in any noticeable difference in engine operation, and that the other helicopter had reportedly used fuel from the same drum without operational difficulty, the investigation concluded that fuel quality was not a factor in the accident. The engine operated normally when run in a test facility and there was nothing to suggest that the engine would not have run satisfactorily with an adequate supply of fuel.

The impact damage to the carburettor and resultant detachment of the main fuel line raised the possibility of post-impact fuel leakage. However, there was no observed fuel spill or smell at the accident site, either by those first on scene, or during the course of the on-site phase of the investigation. There was no evidence that fuel had leaked from the open main fuel feed line, as would be expected if there was fuel on board.

The high rate of descent and impact with terrain was most likely the result of engine stoppage due to fuel starvation at a height that was insufficient for a successful autorotation. In the case of a sudden engine stoppage, the helicopter's subsequent flightpath was determined by the lack of available energy in the main rotor blades, a situation over which the pilot had no control due to insufficient height to fully establish autorotation. As it was unlikely the pilot could have altered the descent angle to any significant degree, the impact with the creek bank was probably unavoidable.

FINDINGS

From the evidence available, the following findings are made with respect to the collision with terrain that occurred about 170 km east of Katherine, Northern Territory on 4 October 2010 and involved Robinson Helicopter Co. R22 Beta helicopter, registered VH-THI. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factor

- The quantity of fuel on board the helicopter was probably insufficient to maintain continuous engine operation, resulting in engine stoppage, a high rate of descent and collision with terrain.

SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included the:

- helicopter owner
- other pilot that flew the helicopter that day
- helicopter manufacturer.

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 helicopter owner, the other pilot that flew the helicopter that day, the helicopter maintenance organisation, the helicopter manufacturer and the Civil Aviation Safety Authority (CASA).

A submission was received from CASA. The submission was reviewed and, where considered appropriate, the text of the draft report was amended accordingly.

APPENDIX A: HELICOPTER MANUFACTURER SAFETY NOTICE SN-15

ROBINSON
HELICOPTER COMPANY

Safety Notice SN-15

Issued: Aug 83 Rev: Jun 94

FUEL EXHAUSTION CAN BE FATAL

Many pilots underestimate the seriousness of fuel exhaustion. Running out of fuel is the same as a sudden total engine or drive system failure. When that occurs, the pilot must immediately enter autorotation and prepare for a forced landing. Refer to Section 3 of the Pilot's Operating Handbook under Power Failure. If autorotation is not entered immediately, the RPM will rapidly decay, the rotor will stall, and the results will likely be fatal. Serious or fatal accidents have occurred as a result of fuel exhaustion.

To insure this does not happen to you, observe the following precautions:

1) Never rely solely on the fuel gage or the low fuel warning light. These electromechanical devices have questionable reliability in any airplane or helicopter. Always record the hourmeter reading each time the fuel tanks are filled.

2) During your preflight:

   a) Check the fuel level in the tanks visually.
   b) Be sure the fuel caps are tight.
   c) Drain a small quantity of fuel from each tank and the gascolator to check for water or other contamination.

3) Before takeoff:

   a) Insure that the fuel valve is full on.
   b) Be sure guard is placed on mixture control.
   c) Plan your next fuel stop so you will have at least 20 minutes of fuel remaining.

4) In flight:

   a) Continually check both hourmeter and fuel gages. If either indicates low fuel, LAND.
   b) Always land to refuel before the main tank fuel gage reads less than 1/4 full.
   c) NEVER allow the fuel quantity to become so low in flight that the low fuel warning light comes on.