Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT

Aviation Occurrence Investigation – AO-2007-013

Final

Engine power loss – 91 km E Hamilton Island, Qld

13 June 2007

VH-JWM

Bell Helicopter B206B

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Figure 1 courtesy of Australian Customs Service Coast Watch.

Figure 2 courtesy of Google Earth.

Figure 3 courtesy of Airclaims (Australia) Pty Ltd.

Abstract

On 13 June 2007 at about 1335 Eastern Standard Time, a Bell Helicopter B206B helicopter registered VH-JWM (JWM) departed Mackay, Qld on a charter flight to a container ship, located about 180 km offshore. The helicopter was engaged in the transfer of a marine pilot to an offshore ship. On board were the pilot and the marine pilot. The flight was operated under the visual flight rules (VFR). The pilot later reported that at about 1423, while about midway between Mackay and the ship at about 1,500 ft above mean sea level, the helicopter sustained an engine power loss. The pilot reported that the first indication was a slight yaw kick in the helicopter. He reported that he immediately lowered the collective control and configured the helicopter descent profile for an auto-rotation emergency landing. The pilot reported that he broadcast a MAYDAY on both the operator's and air traffic control radio frequencies. The pilot reported that he then reduced the forward airspeed of the helicopter, confirmed the inflation of the pop-out floats on the helicopter's skids, flared the helicopter and landed in the ocean. He reported that at this point, the helicopter was floating on the ocean and the main rotor blades had nearly stopped rotating.

The 2 to 3 m sea swells caused the helicopter to roll to its left and become inverted. The two occupants sat on the overturned helicopter until they could inflate and enter a four-person life raft.

About one and one-half hours after ditching, they recovered by another company helicopter and transported to the Mackay Base Hospital. They sustained only minor injuries. After several weeks floating, the helicopter eventually submerged and was not recovered until 26 September 2007. The damage to the wreckage prevented the investigation from obtaining any additional information in relation to the engine failure.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

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

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

The object of a safety investigation is to enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the ATSB endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why, in a fair and unbiased manner.

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

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

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

FACTUAL INFORMATION

History of flight

On 13 June 2007 at about 1335 Eastern Standard Time[1], a Bell Helicopter B206B, registered VH-JWM (JWM), departed Mackay, Qld on a charter flight to a container ship located about 180 km offshore. The helicopter was engaged in the transfer of a marine pilot to the container ship and was operating under the visual flight rules. On board was the pilot and one passenger, the marine pilot. The pilot later reported that at about 1423, while about midway between Mackay and the ship at about 1,500 ft above mean sea level, the first indication of a problem was a slight yaw[2] kick in the helicopter. He reported that he immediately lowered the collective control and configured the helicopter descent profile for an auto-rotation emergency landing. He also reported that at that time the ENGINE OUT advisory light was illuminated and that the engine N1[3] was decreasing with no audio warnings heard. The engine eventually decreased in N1 until it was no longer operating.

The pilot broadcast a MAYDAY[4] on both the operator's operations centre and air traffic control radio frequencies advising of the problem, the current location and the number of persons on board. He reported that he then 'armed' the emergency pop-out floats on the helicopter's skid gear[5]. His next action was to position the helicopter into the prevailing wind, which he estimated to be about 20 kts from the south-east. The pilot reported he then engaged the engine starter/generator in an attempt to restart the engine and that the sounds from the engine were 'not normal'. He reduced the forward airspeed of the helicopter, inflated the emergency pop-out floats and confirmed inflation. He then flared the helicopter and landed it in the sea. After the forced landing/ditching, the helicopter floated upright with the main rotor blades rotating slowly.

The sea swells at the time of the ditching were estimated to be between 2 m to 3 m. One of the swells hit the helicopter, rolling it onto its left side. Both occupants reported that they then exited the helicopter and inflated their personal floatation devices. They then sat on the underside of the now inverted floating helicopter. The pilot located and inflated the on-board four-person life raft and they entered the raft, with the pilot initially securing the raft to the helicopter skid gear. The sea swells then caused the helicopter skid gear to contact and puncture one of the raft's two floatation compartments. The occupants then floated in the partially inflated raft

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1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

2 Rotation of the aircraft about the vertical axis.

3 N1 was a measurement of engine gas producer speed in RPM with 100 % representing 51,000 RPM.

4 International call for urgent assistance.

5 The helicopter was normally flown with the floats in the 'unarmed' position until needed. Arming the floats activated the system that by pilot action fires a cartridge to release the pressurised nitrogen kept in bottles and used to inflate the floats. The floats were comprised of two floatation compartments per float.

until recovered by another company helicopter (using a rescue hoist) and were then flown to the Mackay Base Hospital (Figure 1), where they were treated for minor cuts and fuel burns. For further details regarding the recovery of the occupants, refer to Appendix A.

Figure 1: Map showing ditching and final locations

Recovery of the helicopter

Air searches were conducted the next day in the area calculated by AusSAR[6] as the most likely location of the helicopter if it was still floating[7]. These efforts were unsuccessful in locating the helicopter. An advisory was also broadcast to ships in the area to report the location of the floating helicopter if found.

6 Search and rescue services are provided by AusSAR, the national search and rescue organisation, which is part of the Australian Maritime Safety Authority (AMSA), the national safety agency responsible for maritime safety, protection of the marine environment and aviation and marine search and rescue.

7 The provided computer modelling/projection was based on prevailing tide, wind and sea information but was made difficult because of the drag component of the helicopter below the surface.

The helicopter was not equipped with an underwater acoustic beacon, nor was it required by regulations[8]. The helicopter was equipped with a 121.5 MHz emergency locator transmitter, but the unit did not activate during the ditching as there were insufficient impact forces, and these units are not designed to function when immersed in water.

On 7 July 2007, an Australian Customs Service Coastwatch aircraft overflew and photographed the semi-submerged helicopter, which was located at a position of 19º37'00" S 149º38'00" E (near Rafter Reef). The flight crew reported that one emergency pop-out float was completely deflated and that the opposite side float was partially inflated (Figure 2).

Figure 2: The helicopter when located near Rafter Reef

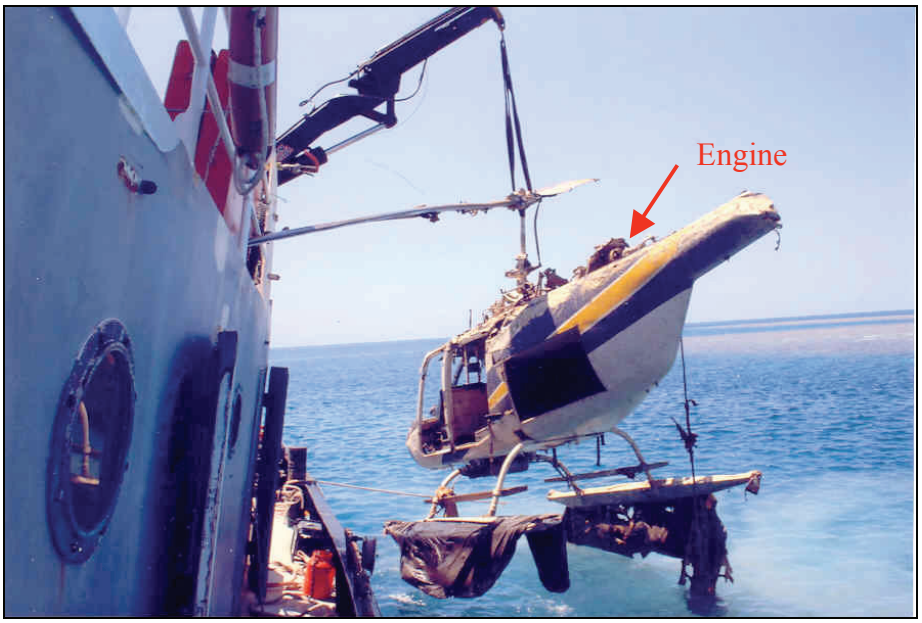
On 9 July 2007, the Australian Transport Safety Bureau (ATSB) hired a salvage vessel in an attempt to recover the helicopter. That effort was abandoned because of high winds and sea states.

On 13 July 2007, a pilot in one of the operator's aircraft located the wreckage submerged in about 5 m of water at a position of 19º37'45" S 149º38'03" E. In the 30 days since the ditching, the helicopter had floated approximately 84 km to the north-north-west.

On 26 September 2007, a salvage organisation working on behalf of the helicopter insurers salvaged the helicopter. Damage to the airframe, engine and all components was extensive because of salt-water immersion and exposure (Figure 3).

8 Underwater acoustic beacons assist with the recovery of aircraft and helicopters by emitting a signal when activated by a water switch on a frequency of 37.5 kHz for up to 30 days.

Figure 3: Recovered helicopter wreckage



Pilot information

On 20 June 2005, the pilot was endorsed on the helicopter type. On 1 November 2006, the pilot commenced employment with the operator and had been flying the occurrence helicopter for several months (Table 1).

Table 1: Pilot's qualifications

Type of licence and date issued	Private Pilot (Helicopter) Licence - issued on 24 July 2002, Commercial Pilot (Helicopter) Licence - issued on 18 September 2002
Medical certificates	Class 1 (valid, no restrictions)
Flying experience (total hours)	909.6
Hours on type	588.4
Hours flown in the last 90 days	184.0

On 6 February 2007, his most recent bi-annual flight review was successful completed. That review included emergency auto-rotation emergency landings. On 1 June 2007, the pilot's last check flight was conducted during a marine pilot transfer flight.

The pilot also had 4 years experience as an apprentice aircraft maintenance engineer.

Meteorological information

On the day of the ditching, the forecast weather for Mackay Airport was for winds of 13 kts from the south-east with good visibility. The flight crew of the operator's other helicopter reported the weather at the ditching location as scattered cloud[9] at 2,500 ft AMSL[10], winds of about 20 to 25 kts, gusting to 30 kts from the south-east and visibility of over 10 km.

Helicopter information

On 9 August 1988, the helicopter, serial number 617, was registered in Australia. At the beginning of the days flying, it had accumulated 13,487.9 hours total time in service (TTIS). The maintenance release for the helicopter was valid. The helicopter was not equipped with an engine auto-relight system[11].

The pilot later reported that prior to the occurrence flight, the helicopter had a problem with the 24-volt direct current (VDC) electrical system as the helicopter had no battery power when the battery ON/OFF switch was placed in the ON position. He then contacted a Civil Aviation Safety Authority (CASA) licensed aircraft maintenance engineer, located at the operator's facility at Hamilton Island. The engineer later reported that he told the pilot how to resolve the problem by bypassing the battery relay by removing and reinstalling the relay wiring. When questioned regarding this maintenance, the helicopter manufacturer confirmed that this was not approved maintenance, citing the inability to isolate the battery if a fault developed during flight[12].

The helicopter's maintenance release was not recovered. However, the pilot reported that he did not annotate the maintenance to the battery relay wiring completed. There was no documentation of recent maintenance to the battery relay in the helicopter's maintenance records available to the investigation.

The CASA Civil Aviation Advisory Publication (CAAP) Number 42ZC-1(0) addressed approved pilot maintenance for class B aircraft such as the helicopter. Rewiring and bypassing the helicopter's battery relay as completed was not listed as an approved pilot maintenance item.

An entry in the helicopter's maintenance documentation dated 5 January 2007 annotated that the helicopters ENGINE OUT warning horn had been disabled as per a Bell Helicopter Company Technical Bulletin. Technical Bulletins were not mandatory to comply with and were incorporated at the discretion of operators.

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9 Cloud amounts are reported in oktas. An okta is a unit of sky area equal to one-eighth of total sky visible to the celestial horizon. Few = 1 to 2 oktas, scattered = 3 to 4 oktas, broken = 5 to 7 oktas and overcast = 8 oktas.

10 Above mean sea level.

11 The auto-relight system automatically reignites the engine in the event of a 'flame out'.

12 In this configuration, an internal fault in the battery or short circuit in the 24-volt direct current electrical system could not be isolated by disconnecting battery power from the system as is normally done using the battery ON/OFF switch.

Engine information

The Rolls Royce Corporation model 250-C20B (serial number CAE 833595) turboshaft engine was installed in the helicopter on 30 January 1996, with 4,226.6 hours TTIS. The last overhaul was on 13 February 2004, at 8,869.6 hours TTIS. Recent significant maintenance to the engine is documented in Table 2 below.

Table 2: Recent significant maintenance to the engine

Date	Engine hours TTIS	Documented maintenance
24 May 2007	10,845.9	The Fuel Control Unit (FCU), Power Turbine Governor (PTG) and engine driven fuel pump were removed and replaced with overhauled units following a report of a problem with the engine overspeeding during start with only ¾ throttle input.[13]
5 January 2007	10,787.5	A 100-hourly inspection completed.[14]
6 February 2006	10,345.9	The FCU was removed and replaced to resolve a problem with the engine 'hanging' during starting.

The pilot later reported that the only anomaly of the engine apparent before the flight and since the replacement of the FCU and PTG, was momentary elevated starting temperatures of 850 to 860º C for about 6 seconds during the first start of the day. He reported that following the first start of the day, the starting temperatures were normal, as were the temperatures during normal operation. A review of the helicopter's maintenance documentation available to the investigation did not reveal an entry noting this discrepancy.

The engine manufacturer's maintenance manual defined maintenance action required when the engine operating or starting temperatures were exceeded. For starting temperatures of up to 810ºC, there were no time limits or maintenance actions required. The manual stated that for starting temperatures from 810 ºC to 927ºC of over 10 seconds in duration, an inspection of the turbine section was required. The manual included a notation under the time limitations for starting temperatures from 810 ºC to 927ºC of over 10 seconds in duration that stated:

> (5) Momentary peak temperature of 927ºC (1700ºF) is permitted for no more than one second.
>
> NOTE: With the exception of the 810-899ºC (1490-1650 ºF) temperature encountered for 6 to 12 seconds (max 3 occurrences on 250-C20B, -C20F), the time-at-temperature limits are not additive and may be repeated without restriction. The repeated intentional use of transient temperature limits can result in reduced turbine life and is not recommended.[15]

13 At the commencement of the days flying, the helicopter had accumulated about 30 hours of operation since the replacement of these components.

14 Other subsequent 100-hourly inspections were completed but not included in the table.

15 Rolls-Royce 250-C20 Series Operations and Maintenance, Table 9, note (5), July 15, 1999.

Survival equipment and training

The operator only recently acquired the helicopter and at the time of the occurrence, was initially unsure of the survival equipment carried. Both occupants were wearing personal floatation devices (PFD). The pilot's PFD included aerial distress flares, which were used to signal the over flying fixed wing search aircraft and helicopter. Both PFDs were equipped with a 121.5/243 MHz emergency position indicator beacon (EPIRB). The pilot reported that he activated his EPIRB when they entered the life raft. This signal was later detected by the rescue aircraft and helicopter.

The pilot reported that he had received training in the operation and use of the life raft as well as helicopter underwater escape training (HUET). The marine transfer pilot also reported that he had completed HUET training on several occasions. Both occupants reported that this training was invaluable during the ditching and while exiting from the inverted helicopter.

ANALYSIS

Pilot actions

The pilot's reaction to the engine power loss was to broadcast a MAYDAY[16] and then initially attempt an engine restart. When these actions were unsuccessful, he prepared the helicopter for a water ditching. The engine power loss occurred at a location too far away from the designated alternate offshore landing areas. He did not detect an audio warning of the engine in-flight shutdown as the warning horn had been disabled in compliance with the helicopter manufacturer's Technical Bulletin. The pilot completed a successful auto-rotation emergency landing and over-water ditching, thereby preventing significant injuries to the occupants and contributing to a successful exiting of the helicopter.

Engine power loss

Because of the prolonged salt-water immersion and ensuing corrosive damage to the engine and its components, the investigation was unable examine or test the engine or its ancillary components. Therefore, the investigation was unable to determine the reason for the engine power loss.

Based on reports from the occupants, the engine did not sustain a catastrophic failure, but a more subtle failure mode similar to an uncommanded in-flight shutdown. Possible engine problems related to this type of failure include:

- engine fuel starvation
- anomalies of the engine fuel control unit (FCU) or power turbine governor (PTG)
- leaking engine compressor bleed air or fuel lines.

Helicopter recovery

The prompt recovery of the helicopter, which would have possibly permitted examination and testing of the engine and its components, was hindered because the:

- helicopter did not fully submerge at the recorded position following ditching
- weather conditions and sea states in the area precluded the immediate recovery of the floating helicopter by boat
- computer modelling of the drift of the helicopter was imprecise[17].

16 His timely broadcast of a MAYDAY giving position and persons on board assisted in the speedy recovery of the occupants.

17 AusSAR computer modelling is based on objects such as small boats, persons in lift jackets, life rafts etc.

However, had the helicopter submerged immediately following the ditching, it would have been difficult for the investigation to locate as it was not equipped with an underwater acoustic beacon.

Engine starting temperatures

The report by the pilot of starting temperatures of 850 to 860º C for about 6 seconds during the initial start did not exceed the engine manufacturer's limit of 10 seconds duration and therefore did not require maintenance action.

The manufacturer's starting temperature limit of 810-899ºC for 6 to 12 seconds was permitted only for a maximum of three occurrences for the engine model. They further stated that the continued exceedance of this limit could result in reduced turbine life. As the helicopter engine had operated for 30 hours since replacement of the fuel control unit and power turbine governor when this problem was apparent, it was most likely that the three-occurrence limit was exceeded and should have been annotated with subsequent maintenance action initiated.[18] However, the investigation considered it unlikely that a failure of the turbine was contributory to the engine power loss.

Pilot and engineer maintenance actions

Although not considered contributory to the occurrence, the unapproved pre-flight maintenance completed on the helicopter by the pilot presented a potentially hazardous situation. As a result, the helicopter and occupants could have been exposed to a possible in-flight hazard, which the pilot would have been unable to isolate.

18 Average flight duration for the helicopter would have been about 2 flight hours, representing about 15 engine starts in 30 flight hours.

FINDINGS

Contributing factors

- The helicopter sustained an in-flight engine power loss of unknown origin.

Other safety factors

- Prior to the flight, the pilot completed unapproved maintenance to the helicopter under the instructions of a Civil Aviation Safety Authority licensed aircraft maintenance engineer.

Other key findings

- The reason for the in-flight engine power loss could not be determined.
- The pilot completed a successful auto-rotation emergency landing and water ditching.
- Both occupants had attended helicopter underwater escape training which assisted them during the ditching.
- Both occupants had sufficient survival equipment available that assisted in their survival and recovery.
- The operator maintained flight following of the flight.
- The operator had appropriately trained rescue crews and equipment standing by for rescue efforts.

APPENDIX

Appendix A: Rescue of the occupants

The search and rescue efforts conducted to recover the occupants following the over water ditching are outline in Table 2 below.

Table 2: Timeline of search and rescue/recovery efforts

Time	Event details
1423	The helicopter operator's operations centre (OPS centre) used for flight following received the MAYDAY broadcast and began organising the local search and rescue (SAR) team and configuring their Bell Helicopter model B222 helicopter registration VH-TOR (TOR) for the flight. AusSAR is contacted.
1429	AusSAR records a report of the helicopter ditching and reports the nearest aircraft diverting and within 8 minutes of the location.
1440	AusSAR locates the nearest vessel about 80 km away. A military Learjet 25 aircraft call sign 'Baldock14' is reportedly in the area and attempts are made to contact it.
1442	Baldock14 is in the area of the helicopter ditching and receives a partial distress signal (EPIRB) and reports to AusSAR that the sea swells and white caps are making spotting a life raft difficult.
1450	Two Royal Australian Navy vessels dispatched to the location of the ditching.
1455	One of the operator's Cessna Aircraft Company model C208 aircraft on floats, registration VH-LNI (LNI) with a pilot and an observer on board departs Hamilton Island to the area of the ditching.
1457	Helicopter TOR departs Hamilton Island Qld with two pilots, and two SAR team members on board.
1502	The OPS centre contacts AusSAR and advises of clothing, life raft and life jacket information and then advises TOR that the search area location was 20º23'29" S and 149º49'31" E.
1505	LNI advises the OPS centre and AusSAR that a flare had been sighted and a distress signal received at 20º22'52" S and 149º50'69" E.
1524	Baldock14 reports a life raft sighted about 100 m from a floating helicopter with at least one person in raft.
1551	LNI contacts the OPS centre to advise that two persons were successfully recovered by the crew of TOR.
1552	TOR contacts the operations centre and advises two persons on board and that they are enroute to Mackay Base Hospital. AusSAR advised by the OPS centre.
1631	TOR arrives at Mackay Base Hospital.