



Australian Government

Australian Transport Safety Bureau



ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation
AO-2009-077
Final

**Visual flight into instrument
meteorological conditions
Dorrigo, NSW
9 December 2009
VH-MJO, Bell Helicopter 206L-1
LongRanger**



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Bell Helicopter Company 206L-1 LongRanger**

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Abstract

On 9 December 2009, at about 1120 Eastern Daylight-saving Time, the pilot of a Bell Helicopter Company 206L-1 LongRanger, registered VH-MJO, was conducting a visual flight rules fire-fighting support flight in the area of Dorrigo, New South Wales with one passenger on board. Shortly after takeoff, the pilot encountered reduced visibility conditions due to low cloud. Subsequently, all visual reference with the horizon and the ground was lost. The pilot attempted to land, but the helicopter impacted the ground in an uncontrolled state and with significant vertical force. The passenger was fatally injured and the pilot was seriously injured. The helicopter was seriously damaged.

The investigation found that after the pilot established the hover, the helicopter entered the rapidly fluctuating cloud. The pilot lost visual reference and became spatially disoriented and the helicopter impacted the ground in an uncontrolled state. The at times rapidly-moving fog or low cloud in the vicinity of the helicopter landing area (HLA) increased the risk of visual operations encountering instrument meteorological conditions at the HLA.

Following the accident, a full review of the operational procedures affecting the operation was conducted jointly by the then Department of Environment, Climate Change and Water; the NSW Rural Fire Service; and other NSW fire-fighting authorities. An action plan was implemented to make several safety enhancements to those operational procedures. In addition, the National Parks and Wildlife Service ceased operations at the Dorrigo helicopter landing site.

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 it appropriate. 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

On 9 December 2009, a Bell Helicopter Company 206L-1 LongRanger, registered VH-MJO, was being used to conduct fire observation, water bombing and personnel insertion duties under the visual flight rules (VFR) on behalf of the New South Wales (NSW) National Parks and Wildlife Service (NPWS). The helicopter was being operated from an area adjacent to the Dorrigo National Parks and Rainforest Centre (the Centre) in NSW, to fires located to the west-north-west.

At about 1120 Eastern Daylight-saving Time¹, during the second flight from Dorrigo that day, the pilot lost all external visual reference and the helicopter impacted the ground with significant vertical force, fatally injuring the sole passenger who occupied the front left cockpit seat, and seriously injuring² the pilot. The helicopter was seriously damaged³ (Figure 1).

Figure 1: Helicopter wreckage



The pilot reported that the helicopter was due to arrive at Dorrigo from Mudgee, NSW on the day prior to the accident, but that he had to conduct a precautionary landing en route due to deteriorating weather. When the weather improved a short time later, the pilot flew the helicopter to a landing site at Ebor, NSW and contacted a NPWS employee who was stationed at Dorrigo to ask about the local weather

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- ¹ The 24-hour clock is used in this report to describe the local time of day, Eastern Daylight-saving Time, as particular events occurred. Eastern Daylight-saving Time was Coordinated Universal Time (UTC) + 11 hours.
- ² The *Transport Safety Regulations 2003* definition of ‘serious injury’ means an injury that requires, or would require, admission to hospital within 7 days after the day when the injury was suffered.
- ³ The *Transport Safety Regulations 2003* definition of ‘serious damage’ includes the destruction of a transport vehicle.

conditions and to report on his location. The NPWS employee advised the pilot that the weather at Dorrigo ‘...was poor’. After discussions with the NPWS employee, the pilot elected to fly to Armidale and wait until the next day for the weather to improve in the Dorrigo area. The helicopter arrived at Armidale at 1849.⁴

The pilot stayed overnight at a local motel and described his sleep as being as good as could be expected when away from home. The flight departed Armidale at 0759 on the morning of the accident and landed adjacent to the Centre at 0829. The pilot noted that the weather at the time was cool and clear with a light and variable wind, with a blanket of low cloud sitting under the escarpment. The escarpment edge was about 100 m to the east of the helicopter’s landing position, which was situated on a plateau.

The helicopter was then tasked by NPWS personnel to carry out fire observation and surveillance duties on two fires that were located to the west of Dorrigo. The helicopter took off at 0839 from Dorrigo with the pilot and two NPWS personnel on board. During that flight the NPWS personnel briefed the pilot about local area hazards, such as powerlines.

After completing the fire observation and surveillance duties, the helicopter returned to Dorrigo at 0945. The pilot landed about 100 m to the west of his previous landing position due to reduced visibility conditions from low cloud that was coming over the escarpment from the east. The pilot reported that, within the 3 minutes that he took to cool the engine down in preparation for shutdown, the cloud had dissipated and he could see back to the Centre.

The pilot refuelled the helicopter with 200 L of fuel from drum stock supplied by the NPWS and also decanted 20 L from a container of fuel that he had brought with him from the operator’s base at Mudgee. He had something to eat and drink and then prepared the helicopter for the next flight.

The pilot estimated that, before takeoff for the second flight, he could see about half a nautical mile (926 m) to the west, but the visibility to the north and east was ‘not as good’. The pilot stated that, during the initial takeoff, he raised the helicopter into a low hover and conducted a pedal turn⁵ through 360° to get a better look at the weather and establish an appropriate departure direction. He said that the weather looked better in the low hover than it did on the ground, so he elected to climb to about 100 ft into a high hover. From that position, he could still see the ranger station, which was about 200 m to the east, and what looked like a person walking up the road towards the station.

The pilot reported that he looked inside the cockpit to survey his instruments for a couple of seconds and, when he looked outside again, all visual reference was lost. He recalled that cloud had blown in under the helicopter and that he could not see anything outside the helicopter. The pilot described it as similar to being in ‘whiteout conditions’⁶.

The pilot stated that he tried to maintain a neutral position in the hope of regaining adequate visibility to land, thinking that if the cloud blew in quickly, then it might

⁴ Derived from the GPS data that was downloaded from the GPS fitted to the helicopter.

⁵ Changing the heading of a hovering helicopter using tail rotor pedals only.

⁶ A loss of orientation with respect to the horizon caused by overcast sky and sunlight reflecting off snow.

also move away equally as quickly. Additionally, he was conscious of maintaining position over the ground due to the collision hazard posed by the nearby powerlines and trees. The pilot did not know how long he was in the no visibility situation or even which way the helicopter was travelling, but he recalled regaining some visibility of a spur line and some trees. At that point he believed that the helicopter was in a sideways crab motion to the left. Shortly after, he recalled looking through the helicopter's chin bubble at one or more trees. The helicopter appeared to be moving quickly over the ground at that stage.

The pilot recalled telling the passenger that the situation was not good and that he was going to land. He made a steep right banking turn to maintain visual reference with the tree(s), and then flared⁷ the helicopter at a height estimated to be 20 ft above the tree(s) to slow the helicopter down.

Following the flare, the pilot heard a loud bang and thought that the helicopter had either hit a tree or the terrain to the rear of the helicopter. He said that he thought he had lost the tail rotor, as the helicopter commenced spinning and that, in response, he reduced the engine power. He attempted to cushion the impact by raising the collective⁸; however, the helicopter impacted the ground with significant force while rotating to the right and came to rest on its right side. The pilot thought that he turned the fuel and the electric master switches to OFF after the impact.

A witness, who saw the helicopter take off, stated that he observed the helicopter moving slowly around the local area to the south for an extended period before moving to the north. He then lost sight of the helicopter due to cloud after it passed over the powerlines that were located on the side of the road. The witness heard the helicopter impact the ground a short time later. The witness contacted the Centre for assistance and then drove to where he thought the helicopter was located. He was the first person to arrive at the accident site and stated that he saw the pilot walking towards him from the direction of the helicopter. The pilot was taken to the local hospital and then airlifted to the hospital at Coffs Harbour, NSW for further treatment.

The pilot reported that there was nothing mechanically wrong with the helicopter at the time of the accident.

Personnel information

The pilot held a Commercial Pilot (Helicopter) Licence that was issued on 18 November 2003, and was endorsed on the Bell 206. He also held a Class 1 Aviation Medical Certificate without restriction. The pilot had completed low-level flying training and held an approval to conduct aerial stock mustering operations.⁹

⁷ The application of aft cyclic to arrest the vertical velocity and most of the forward velocity of the helicopter.

⁸ Raising the collective increases the pitch of the main rotor blades and increase the main rotor thrust (effectively lift) produced by the main rotor blades.

⁹ 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.'

The pilot's flying logbook indicated a total aeronautical experience as of 24 September 2009 of 4,082.3 flying hours. Of those hours, 879.1 were in Bell 206 helicopters, including 865.6 hours as pilot in command. He had also undertaken 10 hours of instrument flying training in April and May 2008 utilising a simulator and a Bell 47 helicopter as part of the requirements for the issue of a Canadian Pilot (Helicopter) Licence. He was not endorsed for flight under the instrument flight rules or night visual flight rules. The pilot's most recent flight review was conducted on 19 August 2009 in a Bell 206B.

The pilot stated that he did not consider using the flight instruments as a means of recovering from being in cloud as he was a VFR pilot and did not feel adequately trained to use them.

Helicopter information

The Bell 206L-1 LongRanger is a seven seat, light utility helicopter with two-blade main and tail rotor systems and a single turboshaft engine. The helicopter was certified for day VFR operations only and was not fitted with an autopilot. The details of the helicopter and its engine are at Tables 1 and 2 respectively.

Table 1: Airframe details

Manufacturer	Bell Helicopter Co.
Model	206L-1
Serial Number	45745
Registration	VH-MJO
Year of manufacture	1982
Certificate of airworthiness	Issued 28 August 2003
Certificate of registration	Issued 1 August 2003
Maintenance Release	Validity (hours/date): 17,095.4 / 2 December 2010
Total airframe hours	17,001.7 hrs before accident flight

Table 2: Engine details

Manufacturer	Rolls Royce / Allison
Model	250-C30P
Type	Turboshaft
Serial Number	CAE-895644
Time since overhaul	7,441.8 hours (Turbine module)
Total time in service	7,741.6 hours

Airworthiness and maintenance

The helicopter was maintained under a Civil Aviation Safety Authority (CASA)-approved system of maintenance. The current maintenance release was

found in the helicopter and there were no outstanding defects listed. A review of the aircraft's log books showed that the most recent scheduled maintenance on the helicopter was a 100-hourly airframe and 150-hourly engine inspection. Those inspections were completed on 2 December 2009, about 6 flight hours prior to the accident flight.

Weight and balance

The helicopter's weight and balance was estimated using the helicopter's load sheet, an estimate of the pilot's and passenger's weights, an estimate of the weight of the equipment onboard and the pilot's estimate of the fuel remaining at the time. Based on those weights and their position in the helicopter, the helicopter was within its weight and balance limits at the time of the accident.

Fuel

The pilot reported that there was about 320 L of fuel onboard at takeoff. The helicopter's fuel tank retained a quantity of fuel after the impact with terrain and there was also evidence of post-accident fuel leakage from the tank. The remaining fuel in the tank was tested for evidence of water contamination. No contamination was found.

Plastic fuel containers that were used by the pilot to decant fuel into the helicopter were located at the helicopter's original take-off position. Fuel remaining in some of those containers was tested for water contamination, with no contamination evident.

The majority of fuel that was onboard the helicopter was from drum stock supplied by NPWS. The drum that was used by the pilot before the flight was within its expiry date, the cap seal was reported to have been intact before the fuel was used by the pilot, and the drum's useable contents of 200 L was decanted into the helicopter just before the flight.

The remaining unusable fuel in the drum was tested for water contamination with none found.

Meteorological information

Witness reports

The weather in the area at the time was described by witnesses and the pilot as including highly variable visibility due to low cloud that was 'wiping like fingers' out of the adjacent escarpment. The wind was reported to be light and generally swinging from east to north-east, forcing the cloud over the edge of the escarpment.

A witness, who worked at the Centre, stated that low visibility occurred in the vicinity of the Centre on a regular basis. Deteriorating weather in the form of fog and or low cloud would come from the direction of the escarpment, significantly reducing the visibility in the area.

Bureau of Meteorology

A Bureau of Meteorology report for the area at the time advised the following:

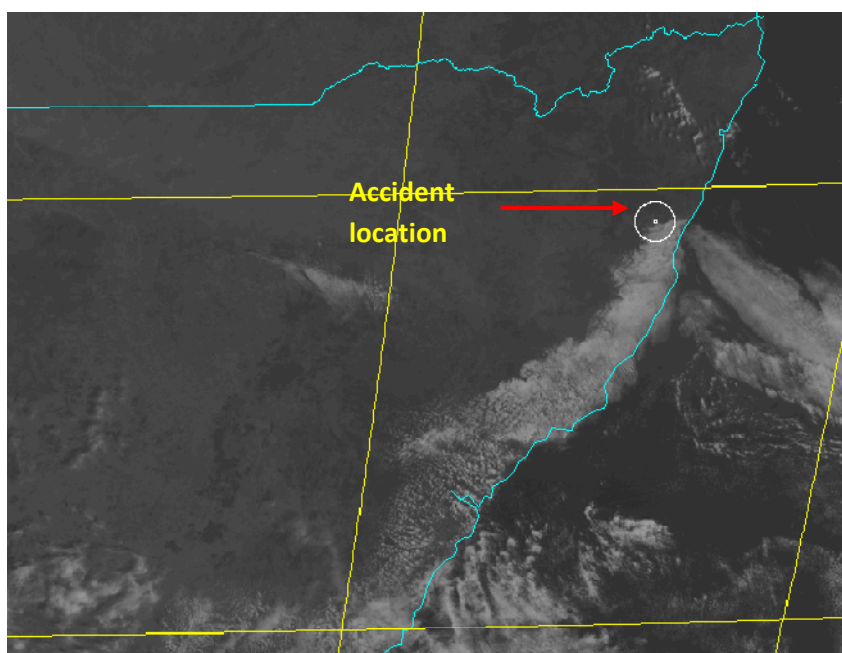
Synoptic Situation

On 09 December 2009, a broad low pressure trough was moving across the north-eastern parts of NSW and the trough axis was in the vicinity of the incident location at the time of the incident. Meanwhile, a ridge of high pressure extended over the southern parts of the state. Behind the trough, a moist southwest to southeast air stream was establishing along the NSW coast and the adjacent ranges, including in the vicinity of the incident location.

Cloud and precipitation

The moist south to southeast air stream (in the area south of the trough axis) produced widespread low cloud over the NSW coasts and the adjacent ranges prior to and at the time of the incident as indicated by the satellite image in [Figure 2]. The high-resolution visible satellite image shows the presence of a sharp boundary of cloud near the incident location. This is most likely due to the moist south to southeast air stream being advected^[10] through the valley southeast of the incident location, forming low cloud as it lifted over the ranges. As the air descends and warms on the leeward side of the ranges, the low cloud dissipated.

Figure 2: Satellite image at 1030 on 9 December 2009



¹⁰ The sideways movement of air in the lower atmosphere due to differences in air pressure (commonly called wind).

Weather in the area

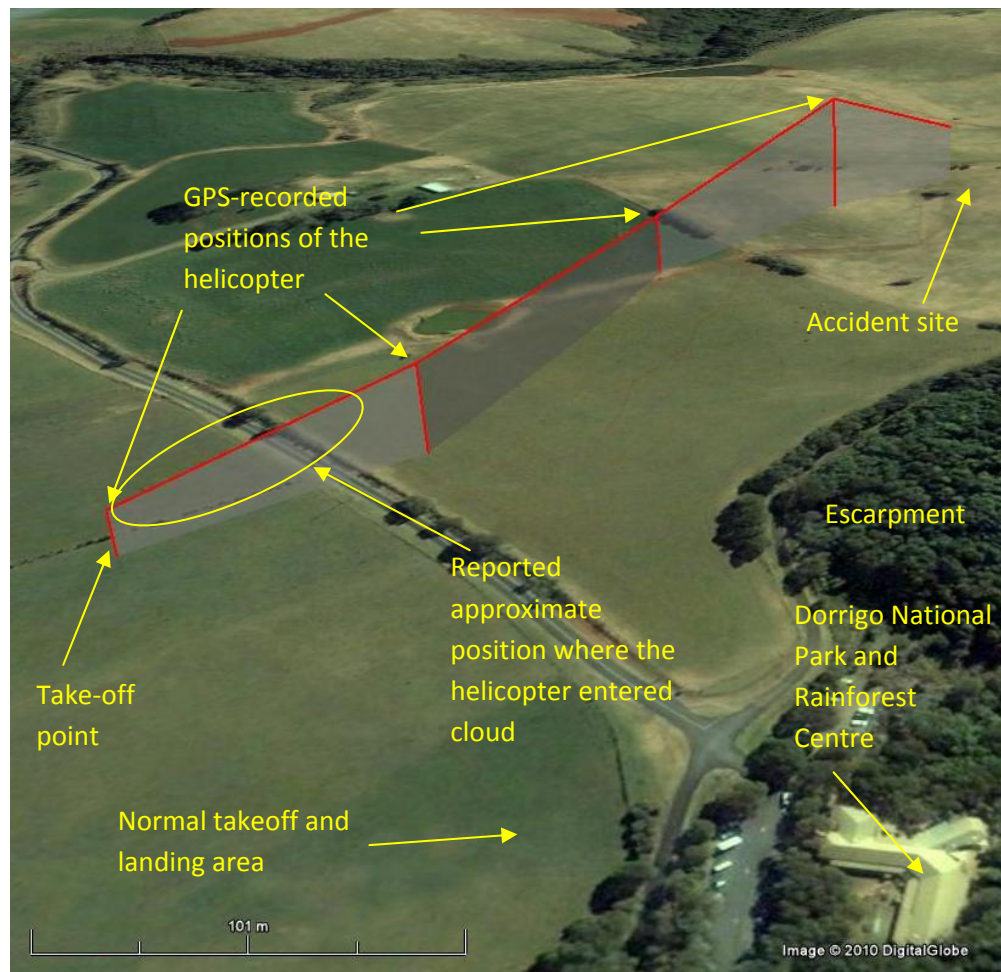
The manual weather observations were recorded at 0900 and 1500 on the day at Dorrigo which is approximately 2 km to the northwest of the accident site. Those observations indicated that at 0900, calm winds and the visibility was 12km in smoke. At 1500, the winds remained calm but the visibility reduced to 700m in fog and there were reports of overcast low cloud. Extrapolating from this data and using the high resolution satellites images suggest that a broken to overcast layer of low level cloud would have been present in the area at the time of the incident.

Recorded information

The helicopter was fitted with a Garmin GPSMAP 296 Global Positioning System (GPS). The GPS was recovered from the accident site and taken to the Australian Transport Safety Bureau (ATSB) technical facilities, where the stored data was successfully downloaded. The data showed the helicopter's movements that day, including the date and time, and the helicopter's latitude, longitude and altitude at distance intervals of about 0.1 NM (185 m).

The GPS indicated that the duration of the flight once the helicopter departed the vicinity of the take-off point was about 1 minute and 20 seconds. During that time, the helicopter travelled a distance of about 550 m. The GPS recorded five positions during the flight, which are overlaid onto a Google Earth map of the area at Figure3. The red vertical lines in the figure show the recorded positions of the helicopter during the flight. The interconnecting lines do not necessarily illustrate the actual position of the helicopter at any point between those positions.

Figure 3: Recorded GPS positions



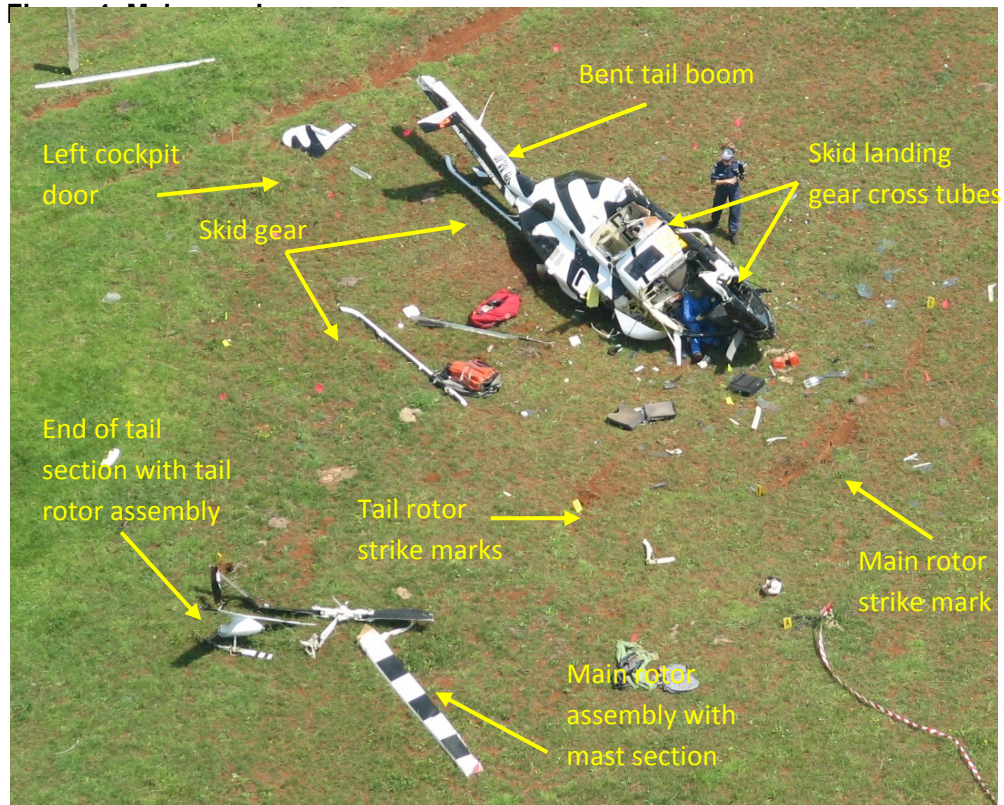
Background image courtesy of Google Earth.

Wreckage and impact information

General information

The majority of the wreckage was contained within an area of about 10 m in diameter (Figure 4). The only wreckage outside that area included one of the tail rotor blade tips, which was about 16 m from the main wreckage, and the outboard section of one main rotor blade, which was about 56 m from the main wreckage. The surrounding terrain was slightly undulating and sloped downwards to the south at about 10°.

Adjacent to the wreckage was an open grass field with a single tree. That tree did not exhibit any evidence of helicopter impact damage.



The helicopter came to rest on its right side. Both left and right landing skids had separated from the helicopter and were located parallel and adjacent to the fuselage, oriented in the opposite direction to the orientation of the main wreckage. Both forward and rear skid landing gear crosstubes were splayed and rotated forward and upwards. The tail boom was bent in a downward direction and the tail rotor assembly had separated from the boom, consistent with a ground strike. The main rotor mast had failed in overstress and separated from the transmission at the base of the mast. Two of the three hydraulic servo actuator connecting tubes had also failed in overstress. All of the helicopter components were accounted for at the accident site.

There was a crescent-shaped ground scar just forward of the fuselage that showed signs of paint transfer from the main rotor blades. A second ground scar, consisting of a smooth-edged vertical cut into the soil, was found between the fuselage and crescent-shaped main rotor ground scar. That ground scar was consistent with a tail rotor strike.

The engine was inspected, with no evidence of external damage, internal failure or foreign object damage. All engine controls were intact and continuity of the engine control runs was confirmed. The ground immediately adjacent to the engine exhaust showed evidence of light brown staining to the grass, indicative of heat damage and consistent with the engine running or winding down. The main and tail rotor drive train was inspected with no evidence of pre-accident defects.

Flight control continuity was checked and, apart from a number of overstress failures that were consistent with the ground impact sequence, all control runs were intact with no evidence of pre-impact defects.

The cockpit instruments were intact, with little damage sustained during the impact sequence. The aircraft's battery and generator switches were found in the OFF position. The fuel shutoff valve was found in the guarded OFF position. A Garmin 296 GPS was found in the cockpit and was connected to the aircraft's power supply.

The structure of the cockpit area was maintained during the initial impact. During the remainder of the accident sequence, one of the detached main rotor blades breached the left side of the cockpit, in the area of the left front seat.

The helicopter's front seats were intact, with no evidence of structural failure or buckling of the seat pans.

Medical and pathological information

The passenger's post-mortem report included injuries that were consistent with the passenger sustaining a high energy impact.

Survival aspects

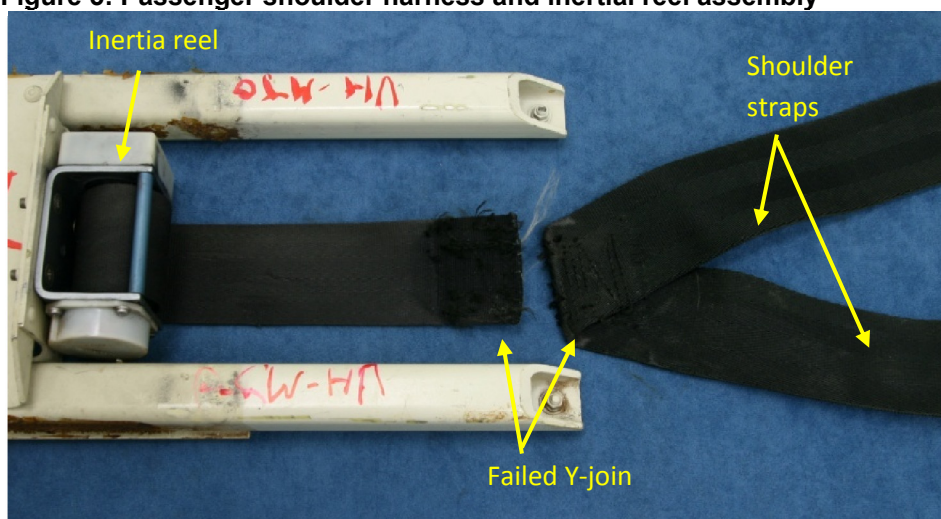
The passenger was not wearing a helmet at the time, nor was there an aviation regulatory requirement for him to do so. The helicopter manufacturer stated that, although the safety benefit of helmets for front seat occupants was recognised, the decision on their use rested with the individual helicopter operator. There was no operational requirement for the passenger to have been seated in the cockpit.

The passenger's seat belt had failed at the shoulder harness/inertia reel Y-joint stitching (Figure 5), while the pilot's seat belt was undamaged. The passenger's shoulder straps were located outside the aircraft. The pilot and passenger's seat belt assemblies were recovered from the wreckage for technical examination.

Seat belt examination and testing

An examination of the passenger's seat belt shoulder harness revealed that the harness had failed in overstress at the stitched Y-joint between the shoulder straps and the inertia reel webbing (Figure 5).

Figure 5: Passenger shoulder harness and inertial reel assembly



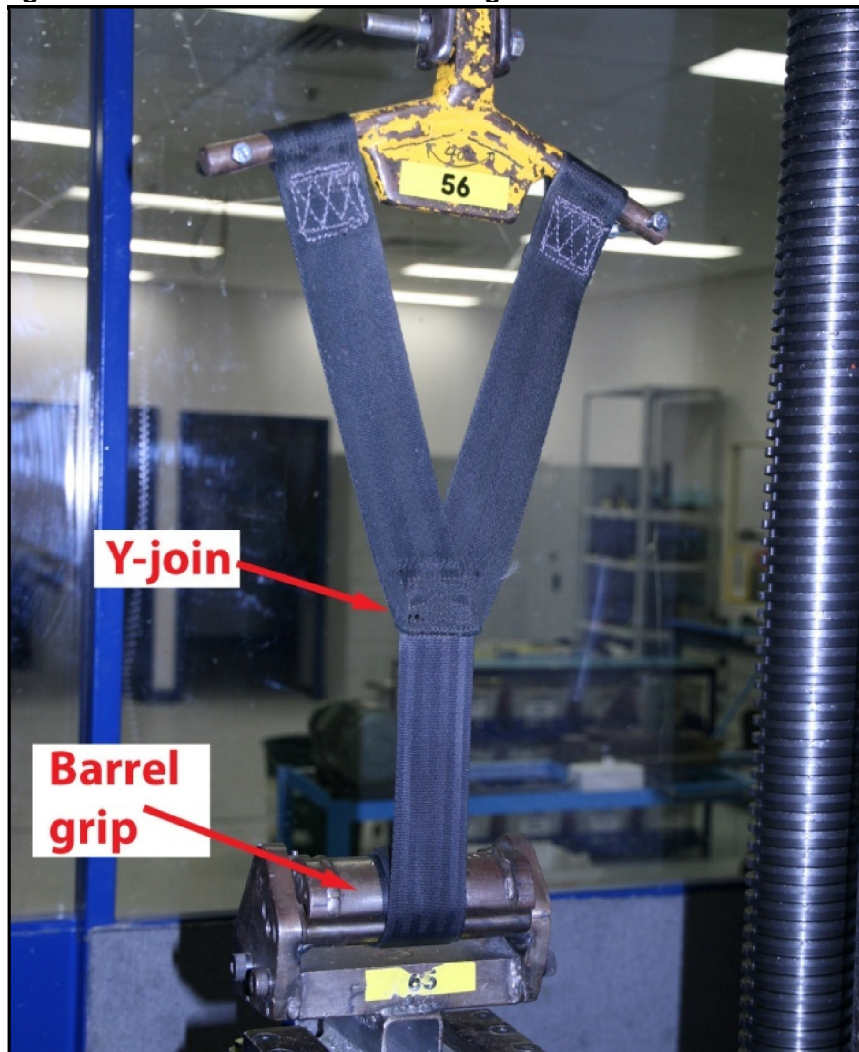
The pilot's shoulder harness was of the same design, age and specification as the failed passenger shoulder harness, was intact and appeared to be in good condition.

The pilot's and passenger's shoulder harnesses had been re-webbed at a CASA-approved repair facility in 2003. The available evidence for that re-web indicated that it was performed in accordance with the approved engineering drawings, using the specified webbing, stitch material and stitch pattern.

A test of the pilot's shoulder harness was carried out at an approved test facility under the supervision of the ATSB to compare the performance of the installed belts to that of a new assembly. That included tensile testing of the webbing material and Y-join from the pilot's shoulder harness (Figure 6), and of two new harness assemblies.

At test, the pilot's shoulder harness Y-join failed at about 70% of the strength of a newly-manufactured Y-join. That degradation in strength was consistent with the effect of a combination of the higher-than-usual stresses placed on the harness during the accident sequence, and the general degradation of the harness due to ageing.

Figure 6: Shoulder harness load testing



Emergency locator transmitter

The helicopter was equipped with an Artex Aircraft Supplies Inc, ME406 series emergency locator transmitter (ELT). Examination of the wreckage showed that the ELT was correctly stowed in the helicopter and in an activated condition. Emergency responders confirmed that the ELT was transmitting after the accident.

Organisational and management information

Visual meteorological conditions

Flight under the VFR required specified minimum conditions of visibility and distance from cloud that are collectively known as visual meteorological conditions (VMC). Those specified conditions varied depending on the:

- class of airspace in which a flight was undertaken
- height of the VFR flight
- type of aircraft (whether it is an aeroplane, helicopter or balloon).

The Aeronautical Information Publication Australia, En Route 2.5 listed the VMC criteria for takeoff, en route operations and landing in helicopters below 700 ft above ground or water in Class G non-controlled airspace (such as in the area of the accident). Those criteria included the requirement for a minimum of 800 m visibility, and that the helicopter must remain clear of cloud. No minimum distance from cloud was stipulated

NPWS requirements for helicopter operations

The NSW State Air Desk maintained a list of operators that satisfied a series of minimum standards and requirements for inclusion on an on-call register. Operators were considered for inclusion on that register after responding to the Air Desk-administered *Expressions of interest for call when needed helicopters and fixed wing aircraft to support emergency and other operations 2009/2010*.

In terms of pilot experience and qualifications, the minimum standards and requirements affecting the on-call register included the need for:

- an Australian CPL (H) or higher
- a night VFR rating (desirable)
- a low-flying approval and experience
- 1,500 flight hours pilot in command, including 500 flight hours turbine experience, 100 flight hours on type and 50 flight hours experience in fire operations.

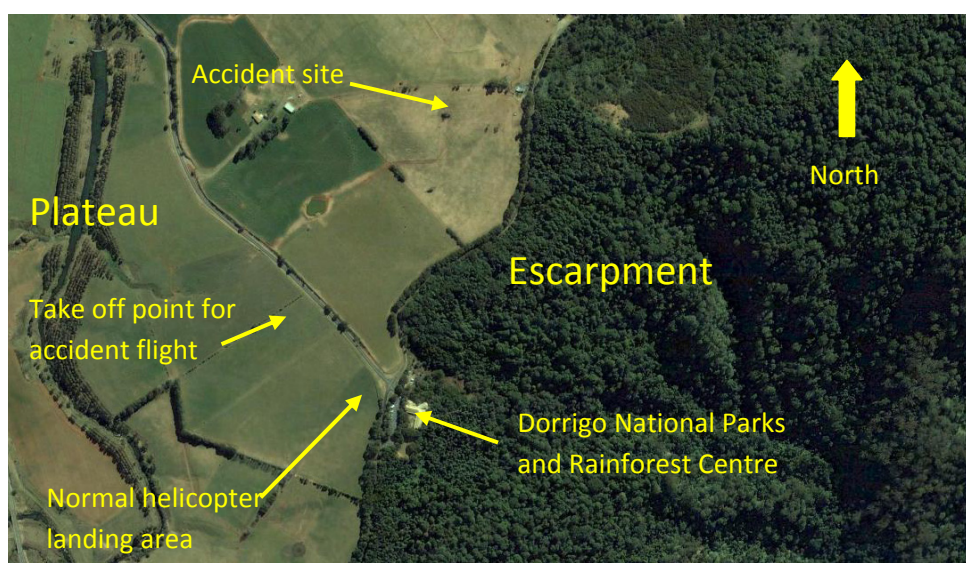
Most of the helicopter support used by the NPWS was sourced via the NSW State Air Desk's on-call register on an as-required basis.

NPWS helicopter operations area at Dorrigo

The NPWS helicopter operations at Dorrigo were conducted in and out of a plateau adjacent to the Centre, which was built on the edge of an escarpment (Figure 7). The helicopter landing area consisted of a privately-owned open grass field that was located to the west and adjacent to the Centre's car park.

Numerous helicopter operations had been carried out in the past 20 years from that area in support of various NPWS requirements, and were restricted to visual operations only. The NPWS aviation standard operating procedures identified that responsibility for assessing the suitability of the weather conditions affecting an operation rested with individual pilots. The procedures included guidance to facilitate the provision of current weather and other operational documentation to assist pilots in their assessment.

Figure 7: Helicopter operating area at Dorrigo



NPWS Centre employees indicated that reduced visibility in the form of low cloud or fog was prevalent for parts of, or all day about 20% of the year in the area around the Centre. One employee advised that, when the Centre was affected by reduced visibility, it could quite often be clear about 2 km to the west of the centre, towards the Dorrigo Township.

The helicopter operator's chief executive officer, who is also a helicopter pilot, stated that he had been caught out by the weather in the same location several years earlier. He described taking off and 'getting hit by a wave of cloud', which forced him to rapidly turn around, land and wait for the weather to improve.

Additional information

Aircraft stability

Aircraft stability refers to the behaviour of an aircraft after it has been disturbed from its trimmed position, and is described in terms of static and dynamic stability. Static stability refers to the initial behaviour of an object when subjected to a disturbance, while dynamic stability refers to the behaviour of that object over time.

For an aircraft to be statically stable, it must return to its original position after a disturbance, with no control input by the pilot. If a statically unstable aircraft experiences a disturbance, such as a nose-up pitch, the aircraft will continue upwards until the pilot corrects the situation via control input.

If an aircraft continues to oscillate at the same rate as the initial disturbance, then it is said to have neutral dynamic stability. If the oscillations continue to reduce and eventually dissipate, then it is said to have positive dynamic stability. If the oscillations increase after the initial disturbance, then the aircraft is said to have negative dynamic stability.

An aircraft cannot be dynamically stable without first being statically stable.

If a helicopter pilot maintains the controls in a fixed position following a disturbance, a hovering helicopter is generally considered to be statically stable and dynamically unstable.

Maintaining the hover

Experienced helicopter pilots state that a pilot generally holds a helicopter in the hover by maintaining constant visual reference to external fixed objects. The pilot must continually manipulate the controls to maintain a fixed position because of a number of factors such as wind, turbulence, the relative stability of the helicopter and the inherent tendency for a helicopter to drift.

If all outside visual references are lost, for example by entering cloud, it is not possible to maintain the helicopter in a fixed position for anything other than a short time period without the use of an autopilot with auto hover capability, and other instrumentation. Additional pilot qualifications are required for flight in other than VMC.

VFR flight into IMC occurrences

In June 2004, the ATSB published an aviation research report titled *General Aviation Fatal Accidents: How do they happen? A review of general aviation accidents, 1991 to 2000*¹¹. That report highlighted 163 fatal aeroplane accidents in the 10-year period, resulting in 331 fatalities. Of those accidents, 22 (or 13.5 %) were identified as a consequence of VFR flight into IMC conditions. Those 22 accidents resulted in 52 fatalities, or 15.7 % of the 331 fatalities recorded.

A June 2005, the ATSB aviation research report titled *General Aviation Pilot Behaviours in the Face of Adverse Weather*¹² concluded that:

The very serious nature of VFR into IMC accidents was apparent in that 75.6% of cases involved a fatality, 8.9% involved serious injury, 4.4% resulted in a minor injury, and in only 11.1% of cases did the pilot, and passengers if any, escape injury entirely.

¹¹ http://www.atsb.gov.au/publications/2004/fatal_accidents_how_happen.aspx

¹² http://www.atsb.gov.au/publications/2005/pilot_behaviours_adverse_weather.aspx

Spatial Disorientation

In December 2007, the ATSB published an aviation research report titled *An overview of spatial disorientation as a factor in aviation accidents and incidents*.¹³ The research paper explained that:

In order to correctly sense the orientation of the body relative to its environment, information is processed from the:

- eyes (Visual system)
- inner ear (Vestibular system)
- skin, muscles, joints and tendons (Proprioceptive system).

The three systems do not have equal importance in terms of providing orientation information. The visual system is by far the most important of the three systems, providing some 80 per cent of the raw orientation information. In conditions where visual cues are poor or absent, such as in poor weather or at night, up to 80 per cent of the normal orientation information is missing. The remaining 20 per cent is split equally between the vestibular system and the proprioceptive system, both of which are prone to illusions and misinterpretation. In poor or absent visual cue situations, humans are forced to rely on the remaining 20 per cent of orientation information, which is less accurate.

Spatial disorientation occurs when the brain receives conflicting or ambiguous information from those sensory systems. The resulting state of confusion is dangerous for a pilot, as it can lead to incorrect control inputs and the resultant loss of aircraft control. Rotary wing aircraft are inherently less stable platforms than fixed wing aircraft, yet helicopters are less likely to be fitted with an autopilot system. There is a strong argument in favour of fitting autopilot systems to rotary wing aircraft as a risk control against spatial disorientation.

Further information on other aviation research papers and relevant occurrence investigations can be found on the ATSB website at www.atsb.gov.au.

¹³ <http://www.atsb.gov.au/publications/2007/b20070063.aspx>

ANALYSIS

Introduction

The pilot's report that there was nothing mechanically wrong with the helicopter, its systems or its operation leading up to the accident confirmed that the serviceability of the helicopter was not a factor in the occurrence.

This analysis will examine the weather conditions and other operational factors that contributed to the development of the occurrence in the context of the unpredictable and rapidly changing weather in the area of the Dorrigo National Parks and Rainforest Centre (the Centre). Those weather conditions are reported unsuitable for helicopter operations on many occasions throughout the year, and increase the risk of inadvertent entry into instrument meteorological conditions (IMC). In addition, a number of survivability aspects that influenced the severity of the outcome will be discussed.

Development of the occurrence

The difference in the pilot and witness accounts of the helicopter's initial movements may be explained to some extent by the different aspects when viewed from the ground and cockpit, and the minimal reference frame due to the cloud. The GPS data did not show the initial ground movements as described by the witness, possibly because the movements were too small (less than 185 m) for the GPS to register. The investigation could not fully reconcile the differences in the pilot and witness accounts.

Although the pilot assessed that the weather conditions when he lifted to the hover complied with the required visual meteorological conditions, the dynamic weather conditions and rapidly fluctuating low cloud contributed to the pilot's decision not to immediately depart the area. The pilot's action to initially remain in the local area to assess the weather while remaining clear of cloud was consistent with the pilot's conduct of a precautionary landing due to adverse weather on the previous day, and with his action to land adjacent to the normal landing area on his initial return to the Centre.

The pilot anticipated a suitable break in the weather once established in the hover that would have allowed a visual departure, and relied on the option to immediately land the helicopter in open ground if visual reference was lost. However, the movement of cloud underneath the helicopter, and subsequent complete loss of all outside visual cues minimised any possibility of remaining in, or landing from the hover.

The in-general dynamic instability of a hovering helicopter meant that any loss of outside visual references, even momentarily as in this case, could result in spatial disorientation, incorrect control inputs, and loss of control. That was confirmed by the rapidity of the helicopter's movement from the take-off position to the impact with the ground in this occurrence, as recorded by the helicopter's GPS equipment.

Although considered appropriate by the pilot due to his lack of proficiency on instruments and experience in IMC, and reflective of the desire to complete the task, the pilot's decision to attempt to remain in the hover and await a clearance of

the weather suggested a lack of understanding of the difficulty associated with that strategy.

Survivability

As evidenced by the failure of the skid landing gear, bending and rotating of the crosstubes and downward bending of the tail boom, the helicopter impacted the ground with a high rate of decent and most likely with skids level. The proximity of the initial ground impact marks to the main wreckage indicated low forward speed at that time. As indicated by the relative structural integrity of the cockpit, it was probable that the energy from the initially primarily vertical impact forces, was largely absorbed by the skid landing gear, crosstubes and lower fuselage.

The pilot's survival, and nature of the injuries sustained by the passenger suggested that the initial impact forces were survivable. However, the overstress failure of the passenger's shoulder harness at the Y-join meant that the passenger was not restrained in the upper torso area by the time the helicopter came to rest.

The damage to the left cockpit area and injuries sustained by the passenger were consistent with the intrusion into that area by a main rotor blade. It could not be determined whether the failure of the passenger's shoulder harness was the result of the passenger's inertia during the impact sequence, or of the forces imparted by the main rotor.

Although the use of helmets generally provides a safety benefit, it is unlikely that a helmet would have prevented the fatal injuries sustained by the passenger in this case. In addition, although there was no operational imperative for the passenger to be in the left front seat, the variability of accident dynamics makes it difficult to reliably conclude that seating the passenger in the rear of the helicopter would have resulted in a different outcome.

The emergency locator transmitter functioned as designed and would have been instrumental in locating the wreckage had a search been required.

Conclusion

The circumstances of this occurrence highlight the significant risk of spatial disorientation and subsequent loss of control associated with attempted visual operations in IMC. In addition, the occurrence shows how rapidly a pilot can lose situational awareness and aircraft control when all visual reference with their surroundings is lost. In consequence, pilots should err on the side of caution when considering visual operations in potentially marginal weather conditions, especially when the weather is highly dynamic.

FINDINGS

Context

From the evidence available, the following findings are made with respect to the visual flight rules into instrument meteorological conditions accident involving Bell 206L-1 helicopter, registered VH-MJO, that occurred at Dorrig, New South Wales on 9 December 2009 and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The cloud in the area of the helicopter landing and take-off point at around the time of the accident was rapidly fluctuating around the minimum required for flight under the visual flight rules.
- Following the pilot establishing the hover, the helicopter entered cloud and the pilot lost all visual reference with the ground and horizon.
- Due to a loss of all visual references outside the cockpit, the pilot became spatially disoriented and the helicopter impacted the ground in an uncontrolled state.
- The helicopter landing area was occasionally subjected to rapidly-moving fog or low cloud that increased the risk of flights under the visual flight rules encountering instrument meteorological conditions. *[Minor safety issue]*

Other key findings

- There was no mechanical or systems anomaly in the helicopter that might have contributed to the occurrence.

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.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

(The then) NSW Government Department of Environment, Climate Change & Water - National Parks and Wildlife Service

Dorrigo helicopter landing area

Minor safety issue

The helicopter landing area was occasionally subjected to rapidly moving fog or low cloud that increased the risk of flights under the visual flight rules encountering instrument meteorological conditions.

Action taken by the NSW National Parks and Wildlife Service

The NSW National Parks and Wildlife (NPWS) ceased operations at the Dorrigo helicopter landing area in December 2009.

ATSB assessment of action

The ATSB is satisfied that the action taken by NPWS adequately addresses the safety issue.

Other action taken by the NPWS

Although no safety issue was identified in respect of the NPWS operational procedures that were in place at the time of the occurrence, the NPWS has advised of proactive action following the occurrence to review those procedures. An action plan was implemented that outlined the action being taken jointly by the NPWS, the NSW Rural Fire Service and other NSW fire-fighting authorities, and progress against that plan. At the time of writing this report, the plan's progress included:

Action

1. That a full review be conducted of the Fire Agencies Bush Fire Aviation Standard Operating Procedures 2004 Version 2 (SOP).

Progress

The Joint Fire Agencies Fire Aviation SOP's have been reviewed. Final operational draft SOPs have been adopted for a 12 month period. Following review at the end of that 12 month period, they will be finalised and adopted.

Action

2. That the Expression of Interest for Call When Needed (Approved List of Operators) be amended to include:-
 - Night Visual Flying Rules (NVFR) qualification for pilots and
 - Attitude and radar altimeters instruments fitted to helicopters
 - All helicopters rated to NVFR
 - Operators must demonstrate that they have provided guidance to pilots for "action to take if inadvertent instrument conditions are encountered."

Progress

Industry forum held 27 July 2010. Industry feedback was very negative and overwhelmingly indicated that this would not only be practically unachievable but would likely significantly decrease safety levels. This recommendation is therefore no longer being actively pursued.

It is considered unachievable because:

- The additional hardware required is very expensive and it may not be physically possible to install it in some aircraft types.
- The pilot workforce in this market is often 'entry level' and transient. Due to high turnover of staff, the training cost would be unacceptably high.

It is considered that safety levels would be decreased because:

- Compulsory capability to fly in Night Visual Meteorological conditions (NVMC) is likely to lead to perverse outcomes eg operators/Incident Management Teams (IMTs) may be tempted to include night flying operations as part of standard operating procedures, thus increasing risk.
- A NVFR rating is not a true instrument rating. Flight under NVMC relies on maintenance of visual reference with the horizon or ground. The ATSB interim report on the Dorrigo incident states that the pilot lost positive visual reference hence an NVFR would not have helped.

- Lessons learned from numerous light aircraft incidence worldwide indicate that pilots who do not hold full Class 1 Instrument Flight Rules (IFR) ratings should never allow themselves to fly into Instrument Meteorological Conditions (ie no visual reference to the horizon or ground).

It is widely acknowledged in aviation that a little knowledge often falsely boosts a pilots confidence in their abilities.

Action

3. That random field audits be undertaken to ensure Expression of Interest for Call When Needed requirements are being met by Operators.

Progress

Audit requirements included in the 2010/11 Expressions of Interest document for Approved Operators List. Audits will proceed as resources allow.

Action

4. That guidelines be developed for Helicopter Landing Areas [HLAs] that are generally and regularly used during bush fire operations.

Progress

A new SOP for airbase management including guidelines for HLAs will be included in the 2010 version SOPs (see 1 above).

Action

- 4(a) That the guideline for Helicopter Landing Areas include a list of hazards that may preclude the use of the area as a Helicopter Landing Area.

Progress

As per 4 above. A draft template based on these principles has been prepared for use by staff to simplify assessment of existing HLAs regularly used by PWG [Parks and Wildlife Group]. Once finalised, this template will be distributed and progressive, compulsory formal assessment of HLAs will be rolled out.

Action

5. That a Bush Fire Helicopter Landing Area directory be developed.

Progress

Data and assessment of HLAs will be collected and developed into a centrally available directory in conjunction with 4(a) above.

Action

6. That a full audit of [the helicopter operator] be conducted prior to any further contract being awarded to them.

Progress

Audit completed July 2010.

Action

7. That the Helicopter Landing Area at the Dorrigo Rainforest Centre utilised on the day of this accident be closed.

Progress

Implemented by DECCW [the then Department of Environment, Climate Change & Water] December 2009.

APPENDIX A: SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

- the pilot of the helicopter
- the helicopter manufacturer
- the New South Wales National Parks and Wildlife Service (NPWS)
- the helicopter operator
- the Bureau of Meteorology (BoM)
- the NSW Police Service
- the NSW Coroner
- a number of witnesses.

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 and operator of the helicopter, the witness to the takeoff, the witnesses, the helicopter manufacturer, the Transport Safety Board of Canada, the BoM and the Civil Aviation Safety Authority (CASA).

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

Visual flight into instrument meteorological conditions – Dorrigo, NSW
9 December 2009 – VH-MJO, Bell Helicopter 206L-1 LongRanger