



Australian Government
Australian Transport Safety Bureau

Loss of control and collision with terrain, Bell 206L-1 helicopter VH-VDZ

13 km SE of Essendon Airport, Victoria | 2 November 2013



Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
AO-2013-199
Final – 1 June 2016

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

Publishing information

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Addendum

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Safety summary

What happened

On 2 November 2013, the pilot of a Bell 206L-1 helicopter, registered VH-VDZ, was conducting passenger-carrying charter operations between Olympic Park oval and Flemington Racecourse, Melbourne, Victoria. At about 1830 Eastern Daylight-saving Time, the pilot prepared to reposition the helicopter from one of the temporary helipads at Olympic Park. There were no passengers on board.

As the pilot lifted the helicopter into a hover it started rolling about the right skid, which was in contact with the ground. The helicopter rapidly rolled further right until the main rotor blades struck the ground. A large amount of main rotor and other high energy debris was released from the helicopter and impacted a nearby marquee, a number of vehicles and a helicopter on an adjacent helipad. The pilot sustained minor injuries.

Helicopter rollover



Source: Witness

What the ATSB found

The ATSB found that the pilot did not identify and react to the helicopter's right-skid low attitude in sufficient time to prevent the helicopter rolling over. In addition, an unsecured ballast bag was positioned on the left front floor of the helicopter, increasing the risk of injury to occupants. Further, the helicopter's dual flight controls were removed to facilitate the flights. The person who removed the controls did not have the training or authorisation to conduct the maintenance procedure. The left cyclic stub cover was not installed, leaving the stub exposed. This resulted in the potential for the ballast bag to inhibit movement of the pilot's cyclic control due to fouling of the left cyclic stub.

The ATSB identified safety issues relating to the availability of first aid and emergency response equipment at the oval and the proximity of the helipads to the perimeter fence and public access areas. Each increased the risk of injury to bystanders in the event of an accident.

What's been done as a result

For subsequent operations at the Olympic Park oval for the remainder of the event, the charterer positioned firefighting equipment at each helipad and first aid equipment was made available nearby. In addition, the helipads were repositioned further from the passenger marquee, and passengers were not loaded or unloaded if helicopters were in the process of landing or taking-off from adjacent helipads. Operations at the Olympic Park oval ceased following the 2013 carnival.

Safety message

This accident highlights the importance of coordinated control inputs by pilots during lift-off to control any roll, and if necessary smoothly lowering the collective in coordination with cyclic input to re-establish the helicopter's weight evenly on the ground before any roll becomes excessive. The importance of properly securing any equipment, particularly if stowed in aircraft cockpits, and of the correct removal and re-fitting of dual flight controls to prevent any obstruction or fouling of the controls is emphasised.

In addition, this accident is a reminder of the risks involved when operating helicopters in public areas. Although the likelihood of a helicopter accident on the ground that results in injuries was found by the ATSB to be low, in the event of an accident, high energy rotor and other debris can travel large distances. Where possible, operators should consider larger distances around helicopter landing areas, in particular when operating close to public areas.

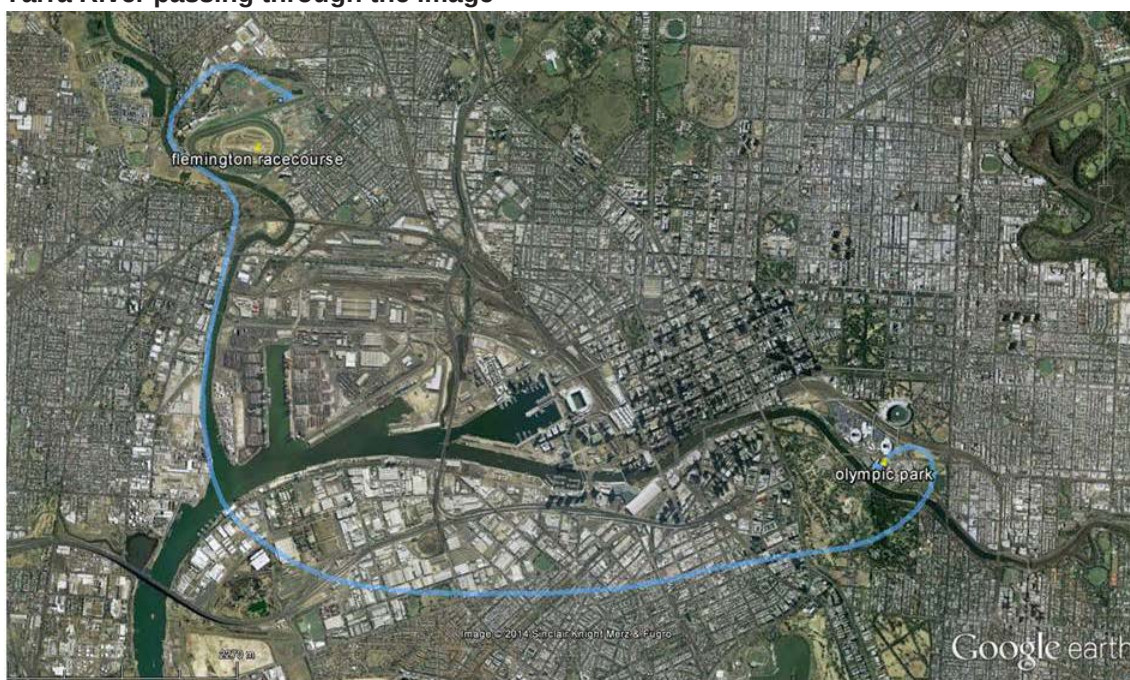
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The occurrence

On 2 November 2013, the pilot of a Bell 206L-1 helicopter, registered VH-VDZ (VDZ), was conducting passenger-carrying charter operations between Olympic Park oval and Flemington Racecourse (Flemington), Melbourne, Victoria. At about 1830 Eastern Daylight-saving Time¹ the pilot prepared to reposition the helicopter from one of the temporary landing pads (helipad) on the western side of the oval, to a position that would facilitate a departure for Flemington (Figure 1). The helicopter was orientated on a westerly heading.

Figure 1: Previous flight path of VH-VDZ from Flemington Racecourse to Olympic Park. Yarra River passing through the image



Source: Google earth, modified by the ATSB

Before the pilot could lift off and taxi the helicopter for departure, another helicopter approached the oval to land at an adjacent helipad. As the landing helicopter approached from a position that was beyond the view of the departing pilot, a marshaller, who was positioned in front of VDZ, signalled to the pilot of VDZ to hold their position on the helipad. Once the approaching helicopter landed on the adjacent helipad, the pilot of VDZ was given a visual signal by the marshaller to indicate that there were no conflicting aircraft or obstructions and that the pilot was clear to commence taxiing.

As the pilot began to lift VDZ into a hover, witnesses observed the helicopter's skids lift slightly and drift to its right before the helicopter commenced rolling about the right skid. The pilot did not observe any right drift of the helicopter but affirmed that the right skid seemed to remain 'stuck' to the ground.

In rapid succession the left skid continued to rise and the helicopter rolled further right. Reported efforts by the pilot to recover from the roll were ineffective and the helicopter's main rotor blades struck the ground. A large amount of high energy main rotor and other debris was released from the helicopter and impacted a nearby marquee, a number of vehicles and the helicopter on the adjacent helipad.

¹ Eastern Daylight-saving Time (EDT) was Coordinated Universal Time (UTC) + 11 hours.

The helicopter was extensively damaged. Although witness photographs showed smoke after the rollover, there was no fire. This would suggest that the smoke was a result of escaping oil or hydraulic fluid coming into contact with hot aircraft parts or components.

The pilot sustained minor injuries and was able to exit the wreckage through the damaged front windscreen. Passengers disembarking from the adjacent helicopter, bystanders, company personnel, and others situated at a nearby marquee were not injured by any of the high energy debris.

Context

The charterer² secured the services of other operators in support of the passenger-carrying charter flights that day. This provided additional capacity to move passengers between Olympic Park oval and Flemington Racecourse during peak periods.

Personnel information

Pilot

The pilot held a Commercial Pilot (Helicopter) Licence and was endorsed on the Bell 206 (B206) helicopter. The pilot also held a valid Class 1 Aviation Medical Certificate.

The pilot indicated that, at the time of the accident, they had a total aeronautical experience of about 1,020 flying hours, which included about 50 hours flying B206 Jetranger helicopters and about 22 hours flying the B206 Longranger. The pilot's most recent check flight was conducted on 21 January 2013 in a Robinson R44 helicopter. The pilot was not approved for pilot-permitted maintenance on the B206 in relation to the removal of flight controls (see *Conduct of the flights* and *Dual flight controls*).

A review of the pilot's training file identified that sections relating to the pilot's ab-initio training, B206 endorsement and recurrent training were incomplete. The pilot's former employer reported that these sections were missing.

The pilot attended operational briefings 1 week prior to the passenger-carrying charter flights from Olympic Park that day. The briefings, conducted by the charterer's chief pilot, included preferred routes, airspace boundaries, radio frequencies and other flight procedures. These included passenger loading and helicopter positioning.

Charterer's chief pilot

The charterer's chief pilot held the appropriate approvals and endorsements to fulfil their role. Although endorsed to fly the B206 helicopter, the chief pilot was not approved for pilot-permitted maintenance on the B206 in relation to the removal of flight controls.

For the purposes of the contract with Olympic Park for the conduct of flights between Olympic Park oval and Flemington, the charterer undertook a project management role, providing, through its chief pilot and other staff, oversight from both locations throughout the day.

Marshalls

The marshalls stated that they acted in a similar capacity during the previous year's events. They were reported to have attended a specific ground crew briefing conducted by the charterer's chief pilot 1 week prior to the event. It was also reported that, on the morning prior to commencing the passenger-carrying charter operations, an additional briefing session was conducted at Olympic Park oval for all operational personnel. The charterer stated that the marshalls had completed first aid training and were instructed on the use of emergency equipment, such as fire extinguishers.

² The ATSB sought clarification from the Civil Aviation Safety Authority in respect of under which aircraft operator's certificate the helicopter was being operated at the time of the accident. The Civil Aviation Safety Authority advised that the helicopter was being operated under the charterer's certificate at that time.

Aircraft information

General information

VH-VDZ (VDZ) was a Bell Helicopter Co. 206L-1/C30P (Bell 206L-1), and was manufactured in the United States in 1981 (serial number 45693). It was first registered in Australia on 20 September 1991 and had accumulated about 6,159 hours total time in service at the time of the accident. The helicopter had been appropriately modified to incorporate a single Rolls-Royce 250-C30P turboshaft engine under a supplemental type certificate.

In the charter role, VDZ had seating for a pilot in the front right seat and six passengers. It was certified for day and night charter operations under the day/night Visual Flight Rules³.

VDZ was installed with a handheld fire extinguisher.

Maintenance History

Examination of the helicopter's current maintenance release indicated that it was maintained to a night Visual Flight Rules standard in the charter category. At the time of the accident, all of the scheduled maintenance recorded on the maintenance release had been completed. No maintenance entries were identified on the maintenance release in relation to the removal or installation of the dual flight controls.

Weight and balance

A minimum weight of 170 lb (77 kg) was required in the cockpit to operate the Bell 206L-1. This meant that, due to the reported pilot weight of about 65 kg, supplemental ballast was required for flights in VDZ where no passenger or crew occupied the front left seat. This took the form of a ballast bag (see the section *Conduct of the flights*), which was placed in the left of the cockpit.

The aircraft's weight and longitudinal centre of gravity (CofG) at the time of the accident was calculated to be within limits. The lateral CofG was slightly to the right of the helicopter's centre-line.

Meteorological information

Photographic evidence and witness observations indicated a light wind at the time of the accident and that it crossed the helicopter from left to right. Weather observations by the Bureau of Meteorology at a nearby airport recorded that, at about the time of the accident, the wind was from the south at 12 kt.

The Bell 206L-1 flight manual stated that satisfactory stability and control was demonstrated in relative winds of 17 kt from the side of the helicopter. The pilot reported that meteorological conditions at the time did not adversely affect the operation of the aircraft and that the crosswind was within the helicopter's normal operating limits.

Operational information

Planned operations

In preparation for the flying activities the charterer assessed the Olympic Park helicopter landing site. This enabled the charterer to draft a suite of event-specific documents that was issued to operational crew during a pre-event briefing. This included to all pilots involved in the charter operations on the day of the accident. The documents included information on the locations of the helipads, the passenger access points and hazards at each site, the preferred flight routes and altitudes and relevant emergency procedures.

³ A set of regulations that allow a pilot to only operate an aircraft in weather conditions generally clear enough to allow the pilot to see where the aircraft is going.

Prior to the event, representatives of the charterer had meetings with the Victorian Racing Club and the Melbourne and Olympic Park Trust. These meetings reviewed the operational procedures and other requirements surrounding the proposed aviation activities. It was reported that this included items of the charterer's risk management plan and safe work method statement.

The charterer's risk management plan identified nine key risks to the operation. The risk areas that were pertinent to the accident included personnel error/fatigue and passenger safety and loading. In order to treat these risks, the charterer required that operational crew had regular breaks, including for meals, passengers were briefed before entering the operational area and all passengers were escorted to and from the helicopters by trained ground crew.

In addition to the risk management plan, the charterer's safe work method statement⁴ established the means to protect the public from hazards associated with operating helicopters from Olympic Park in support of the Spring Racing Carnival 2013. The identified hazards included the potential for members of the public to be struck by a helicopter, be exposed to hazardous and noisy environments, and that a helicopter may be damaged as a result of interference. A number of control measures were imposed by the charterer to reduce the associated risk. These included:

- providing a suitable physical barrier such as high visibility fence bunting around the helicopter landing site
- attaching warning signs to the fencing
- restricting public access by utilising security and ground crew
- trained ground crew present during all helicopter operations
- locating the helipads away from roads and footpaths
- 24-hour security at access points
- access to first aid facilities, equipment and trained personnel
- suitable communications equipment and emergency contact details.

Conduct of the flights

Although the charterer had been conducting spring racing carnival passenger transfer flights for a number of years, it was the pilot's first time operating the flights. As such, the charterer's chief pilot elected to accompany the pilot on their first passenger transfer flight from Olympic Park to Flemington. The purpose of the flight was to familiarise the pilot with the designated route and procedures discussed during the pre-event operational briefings. Dual flight controls were fitted to the left pilot's position as the charterer's chief pilot would occupy that seat for the flight (see the section *Dual flight controls*). The charterer reported that the chief pilot did not intend to use, nor used the dual controls during the flight.

The charterer's chief pilot assessed the pilot's operation of the helicopter and compliance with the prescribed procedures during the familiarisation flight as 'satisfactory'. After the familiarisation flight, the charterer's chief pilot exited the aircraft and the dual flight controls were removed from the left pilot's position. Removal of the dual flight controls allowed for the possible carriage of an additional passenger during the day's operations and eliminated the risk of a front seat passenger inadvertently bumping the flight controls.

The pilot reported that a 20 kg supplemental ballast bag was placed on the front left seat during the return leg of the first flight after the familiarisation flight as there were no passengers. The pilot indicated that for all subsequent flights, the ballast bag was positioned unsecured on the front left cockpit floor, regardless of whether there were passengers or not.

⁴ Revision 0 of 6 October 2013.

The charterer advised that as many passengers were expected to be transferred to and from the spring racing carnival using multiple helicopters, they had developed a specific procedure for passenger loading. This included that:

- prior to boarding, passengers were staged at a marquee, given a safety briefing, weighed, and then included on a passenger manifest
- passengers were then re-briefed and escorted to the helicopter by the marshalls.

During loading or unloading of passengers, it was normal practice for other helicopters to operate from the adjacent helipads.

A number of return passenger flights were conducted from Olympic Park that morning before a scheduled lunch break. This break also allowed pilots to refuel the helicopters and rest prior to recommencing operations later that afternoon. The pilot of VDZ reported refuelling the helicopter to a total fuel load of 400 lb prior to commencing their last return passenger-carrying flight to Olympic Park before the accident.

The pilot reported that the helicopter operated normally that day.

Emergency response

The charterer had an emergency response plan that was included in the briefing documents issued to operational staff. The plan documented a number of procedures should an aircraft accident be observed. These included for the observer to:

- phone for assistance from off-site emergency services, including police, fire and ambulance
- render assistance if able or safe to do so
- utilise available emergency response first aid equipment and fire extinguishers.

There was no ground-based emergency response equipment readily available at the Olympic Park landing site at the time of the accident.

Helicopter landing site information

Civil Aviation Regulation (CAR) 92 stated that an aircraft shall not land at or take off from any place unless it was 'suitable for use as an aerodrome for the purposes of the landing and taking-off ... having regard to all the circumstances of the proposed landing or take-off'.

Civil Aviation Advisory Publication (CAAP) 92-2(1), which was current at the time of the accident, provided detailed guidelines for the establishment and use of helicopter landing sites (HLS). A basic HLS was defined as 'a place that may be used as an aerodrome for infrequent, opportunity and short term basis for all types of operations, other than RPT [Regular Public Transport], by day under helicopter VMC [Visual Meteorological Conditions].' The CAAP also recommended that helicopter pilots and operators should ensure that:

...no person outside the helicopter, other than a person essential to the operation, is within 30 metres of the helicopter.

The charterer's operations manual stated that pilots had to comply with the CAAP. According to the landing site criteria in the CAAP, the landing site at Olympic Park oval was consistent with a basic HLS.

Before conducting helicopter operations, pilots and operators needed to ensure that neither the helicopter nor its rotor downwash constituted a hazard to other aircraft, persons or objects (Civil Aviation Orders 95.7 (paragraph 3.2)). In this regard, it was reported that security personnel and ground staff were employed to restrict public access at the Olympic Park HLS.

As the information contained in CAAP 92-2(1) was not a requirement, other operators were queried by the ATSB regarding the use of HLSs for operations away from their base. Those operators stated that, prior to conducting charter operations requiring the use of HLSs, an in-flight

survey of the intended landing site was conducted. Where possible, a ground survey was also undertaken to confirm the suitability of the site.

Dynamic rollover

General

Static rollover occurs when a helicopter is pivoted about one of its landing skids or wheels and the helicopter's CofG passes outside the in-contact skid or wheel. Once in this position, removal of the original force that raised the helicopter to that angle will not stop the helicopter from rolling further. This angle is termed the 'static rollover angle'.

A rotors-running helicopter resting with one landing skid or wheel on the ground may, without appropriate pilot input, commence rolling. Under certain circumstances, this roll cannot be controlled and the helicopter rolls over. This condition is known as 'dynamic rollover' and is a function of the interaction between the:

- horizontal component of the total rotor thrust (or lift) acting about the point of ground contact
- weight of the aircraft, initially acting between the helicopter's skid-landing gear or wheels. This second, counter-rolling moment decreases the greater the roll.

The angle beyond which it is impossible to stop an already-rolling helicopter from further roll is termed the 'critical angle'.

The principles of dynamic rollover are well-known to helicopter pilots as they are covered during their ab initio and recurrent pilot training. A number of pre-conditions are necessary before a helicopter can sustain dynamic rollover. Depending on the type of helicopter, the roll characteristics may differ but, if not controlled early, the condition is generally catastrophic.

Recovery from dynamic rollover is by smoothly lowering the collective lever while controlling any tendency to roll in the opposite direction with cyclic. Alternatively, some publications suggest that, if normal in-flight rotor rpm is available and a safe take-off is possible, it may be appropriate to lift from the ground. These publications caution that, if a safe take-off is not possible, further application of collective lever only aggravates the situation and worsens the roll.

In general, the application of smooth collective inputs is more effective in avoiding rollover problems than using the cyclic control.

Normal take-off in the Bell 206L-1

The procedure normally used by pilots to lift to the hover (commonly termed 'pick-up') is to scan to the front of the helicopter in preparation to establish the necessary hover attitude. A distant object forward of the helicopter is used as a heading reference as the collective lever⁵ is slowly raised.

Although initially still on the ground, as the collective lever is raised the pilot controls any tendency to roll/drift and/or yaw⁶ with the cyclic control⁷ and tail rotor pedals respectively. As the helicopter becomes lighter on the skids and breaks from the ground, the pilot assesses and then makes appropriate control inputs to maintain ground position and heading and control any roll. The pilot applies additional collective lever to lift the helicopter further from the ground and cyclic to establish the hover attitude, thereby maintaining the helicopter's position over the ground. The tail rotor pedals are used to control heading.

The amount and number of tail rotor pedal and cyclic control inputs during lift-off depends on variables such as the helicopter's CofG, the slope of the landing area, the wind direction and

⁵ A primary helicopter flight control that simultaneously affects the pitch of all blades of a lifting rotor. Collective input is the main control for vertical velocity.

⁶ Term used to describe motion of an aircraft about its vertical or normal axis.

⁷ A primary helicopter flight control that is similar to an aircraft control column. Cyclic input tilts the main rotor disc varying the attitude of the helicopter and hence the lateral direction.

speed relative to the helicopter, the presence of any turbulence, pilot inputs and so on. Given these variables, appropriate pilot input to control the helicopter during lift-off is crucial.

Viewed from above, the Bell 206L-1 has a counterclockwise rotating main rotor system. This generally requires the application of left tail rotor pedal to counter the right yaw and left cyclic control input to counter any right drift and control any roll during lift-off. The action of countering the right drift can normally be expected to result in the helicopter hovering in a left skid-low attitude. The aim is to make a clean break from the ground with no drift or yaw and with any roll under control before adopting the hover attitude at the appropriate height.

Dynamic rollover in helicopters with counterclockwise rotating main rotors

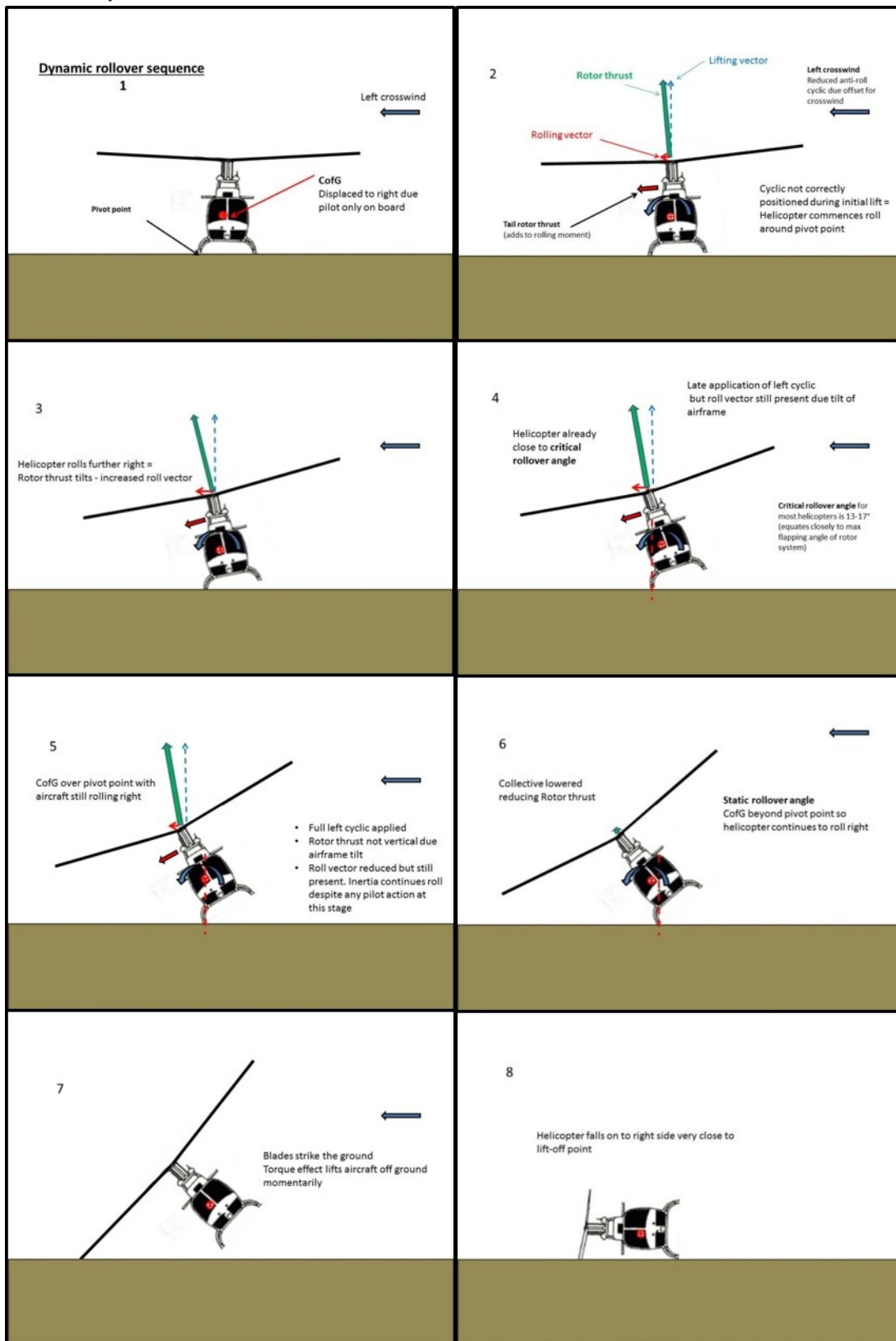
A number of factors influence the critical angle in helicopters with counterclockwise rotating main rotors such as the B206L-1. These include:

- **The rate of any roll.** The faster any roll allowed to develop by the pilot, the smaller the critical angle. Controlled application of collective lever allows the pilot time to make adjustments for drift, roll or yaw.
- **Which skid (or wheel in other helicopter types) is in contact with the ground or other object.** When this contact is via the right skid, the normal tendency to drift right during lift-off exacerbates any roll. This reduces the critical angle.
- **Left crosswind at lift-off.** A left crosswind results in the main rotor blades 'flying up' on the left of the helicopter, adding to the tendency to roll and drift right.
- **A lateral CofG to the right of the helicopter's centre-line.** Should the pilot raise the collective lever to lift-off without appropriately controlling any drift, a lateral CofG to the right of the helicopter's centre-line adds to the tendency to drift right during lift-off. If the right landing skid remains in contact with the ground this tendency to drift right will, without appropriate pilot input, result in right roll.
- **Sloping ground.** A take-off from sloping ground requires careful application of cyclic to control roll around the upslope landing skid. In this instance, too little cyclic can result in the helicopter rolling down the slope. Too much into slope cyclic can contribute to the helicopter rolling up the slope.

Failure to address any uncompensated roll with one landing skid or wheel in contact with the ground or other object can result in the helicopter quickly approaching its critical rollover angle. If the roll does not abate, exceedance of the helicopter's static rollover angle follows. Recovery is not possible and the helicopter rolls over.

Figure 2 illustrates the various forces acting on VDZ during the attempted pick-up to the hover and a representation of the approximate rollover angles relative to the helicopter's lateral CofG. The perception from the preceding discussion, and representation at Figure 2, may be that dynamic rollover in helicopters with counterclockwise rotating main rotors only occurs to the right. This is not the case. For example, consider a lift-off with the right landing skid down slope. If the pilot applies too much into slope cyclic during lift-off, or maintains too much into slope cyclic after the right skid breaks the ground, the helicopter may roll left, up the slope.

Figure 2: Dynamic rollover of VH-VDZ showing the forces acting on the helicopter during the attempted lift-off and a representation of the approximate rollover angles relative to the helicopter's lateral CofG



Source: ATSB

Dual flight controls

The pilot reported that, on completion of the familiarisation flight, the dual flight controls were removed from the left pilot's position by the charterer's chief pilot. This included removing the left cyclic and collective controls and isolating the tail rotor pedals. Later, the charterer's chief pilot reported that, although they removed the collective control and isolated the tail rotor pedals, the pilot removed the cyclic control while remaining secured in their seat. The ATSB could not reconcile the respective pilots' differing recollections of this action.

As the helicopter was still running during the removal of the controls, the pilot remained at the primary (right) flight controls with their seatbelt harness fastened. The cyclic control and collective lever stub covers were not fitted after removal of the respective flight controls. Figure 3 shows the exposed stub of the left cyclic control. Examination of the wreckage identified the dual flight controls and control stub covers in the rear baggage compartment of VDZ.

CAR 1988 Schedule 8 permitted pilots to conduct basic maintenance such as the replacement of seatbelts or harnesses and batteries on Class B aircraft, such as VDZ. However, fitment and removal of dual controls was not permitted under that schedule. This required specific approval by CASA under CAR 1988 sub regulation 42ZC Maintenance on Australian aircraft in Australian territory, and may entail supporting conditions, such as the requirement for training and required the issue of a certificate of approval.

In the case of VDZ, approved pilot maintenance training and the subsequent issue of a certificate of approval would have ensured instruction on the removal of the dual controls, disconnection of the dual tail rotor pedals and fitting of the control stub covers in accordance with the manufacturer's procedures. The pilot reported that, as no training was provided to them for fitting or removing the dual flight controls, another pilot with the appropriate authority fitted the dual flight controls prior to what became the familiarisation flight with the charterer's chief pilot.

In 1993, Bell Helicopter Co. (formerly Bell Helicopter TEXTRON) issued an Operations Safety Notice in response to reports of binding of cyclic controls through possible contact between the copilot's⁸ cyclic control assembly (stub) and objects located on the cockpit floor. The safety notice stated that:

...INSTALLATION OF CYCLIC AND COLLECTIVE STUB SAFETY COVERS IS RECOMMENDED
WHENEVER THE CO-PILOT QUICK-DISCONNECT DUAL CONTROL STICKS ARE REMOVED.

Another Operations Safety Notice, issued by Bell Helicopter in 1984, highlighted that a fatal helicopter accident resulted from a loss of lateral cyclic control due to an improperly-installed copilot's quick-disconnect dual cyclic stick (or control).

Ballast bag

There was no manufacturer-specified ballast bag, or method or procedure for securing ballast in the helicopter in the aircraft flight manual. However, the manufacturer advised that was common industry practice to secure any ballast using a seatbelt assembly. Given the right front seat is the primary control position in the Bell 206L-1 helicopter, this suggests that the ballast would be secured with the left front seatbelt.

It was reported by the pilot that whenever a passenger occupied the left front seat, they had their feet on the ballast bag on the floor during flight. There were no passengers on board for the repositioning flight and the bag was not secured to the airframe. This explained the bag being ejected through the copilot's front window during the rollover, as shown in a sequence of rapid photographs that were taken by a witness to the accident (Figure 3).

⁸ The copilot seat and flight controls were located on the front left of the helicopter.

Figure 3: Ballast bag and exposed cyclic control stub (at inset)



Source: ATSB

Wreckage and helipad information

Wreckage examination

Examination of the wreckage and surrounding area indicated that the helicopter was orientated in a westerly direction and the right landing skid was located along the right edge of the helipad landing mat (Figure 4). The right side of the helicopter sustained significant damage and was resting on the ground.

The engine was generating significant power when the main rotor blades impacted the ground as the main rotor transmission and engine were torn from the fuselage and large amount of debris was strewn about the area (Figure 5). Of note, a 1 m section of main rotor blade travelled about 40 m before lodging into a parked car and another section of rotor blade entered the passenger marquee about 30 m from the helipad (Figure 6 and Figure 7). The marquee was not occupied at the time of the rollover and there were no reports of injuries sustained as a result of the flying debris. The furthest piece of debris was located 44 m from the helipad landing mat.

On-site examination of VDZ confirmed the continuity of the flight control system. No mechanical defects were identified that would have precluded normal flight.

Helipad landing mat

The helipad landing mat was secured to the ground by small metal retaining pegs. These pegs were located at various intervals around the edge of the matting and along the midline where two sections of the matting adjoined. All retaining pegs were in place and, when examined, required a small amount of force to dislodge them from the grass and sandy loam subsurface. The charterer had reportedly used the semi-flexible meshed plastic matting on numerous previous occasions without incident. Witness photographs recorded the helicopter positioned with both skids on the landing mat immediately prior to the accident.

Figure 4: Helipad landing mat and right landing skid (looking east)



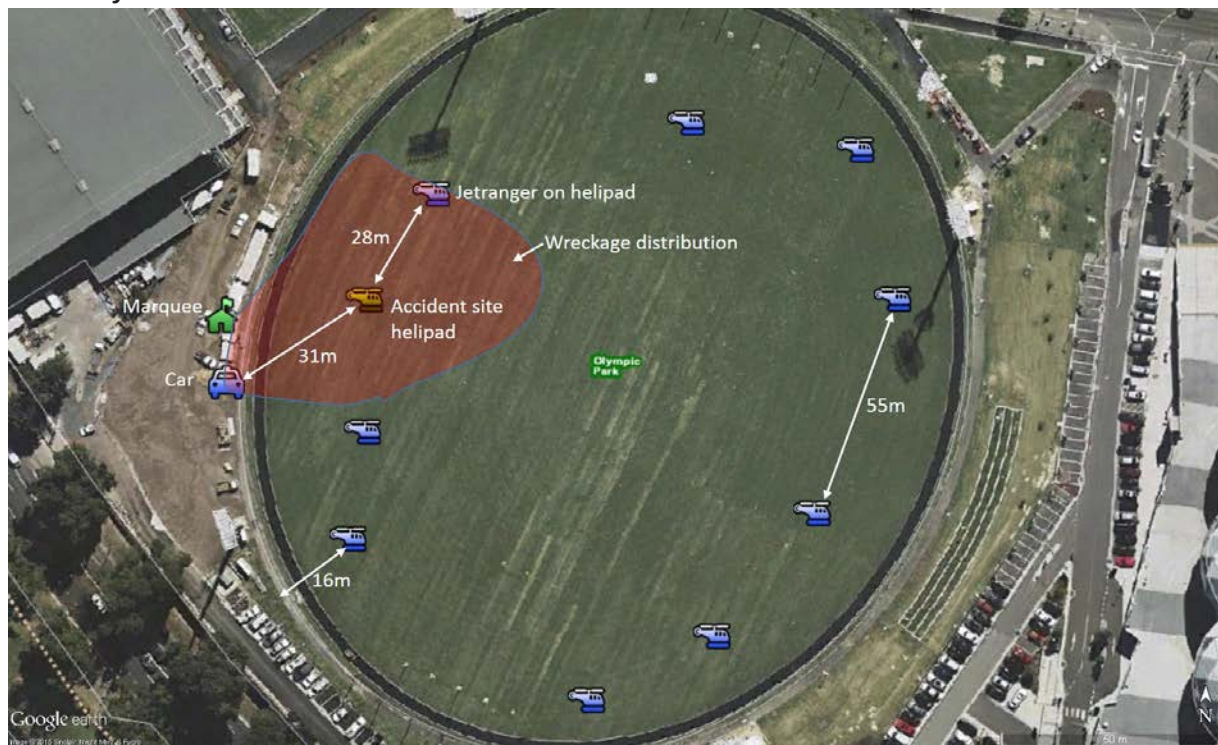
Source: ATSB

The helipad for VDZ was about 28 m from the perimeter of the oval where plastic bunting and a fence provided a barrier between the public access areas and the helicopter landing site. Distances from other helipads to the perimeter fencing varied, and in some instances were observed to have been closer than that of VDZ. The spacing between each of the helipads varied from about 24 m to 55 m (Figure 5).

Although the distance of some helipads to the perimeter fence or persons was less than the recommended 30 m, there were no reports of issues with rotor downwash or the operation of helicopters from the Olympic Park or Flemington venues.

A helicopter that was operating from the helipad adjacent to VDZ sustained some minor damage from the debris that required an engineering inspection before it departed Olympic Park. It was reported that the passengers on board that helicopter had not yet commenced disembarkation when the accident occurred.

Figure 5: Accident site and wreckage distribution showing the car and marquee that were struck by main rotor blade debris



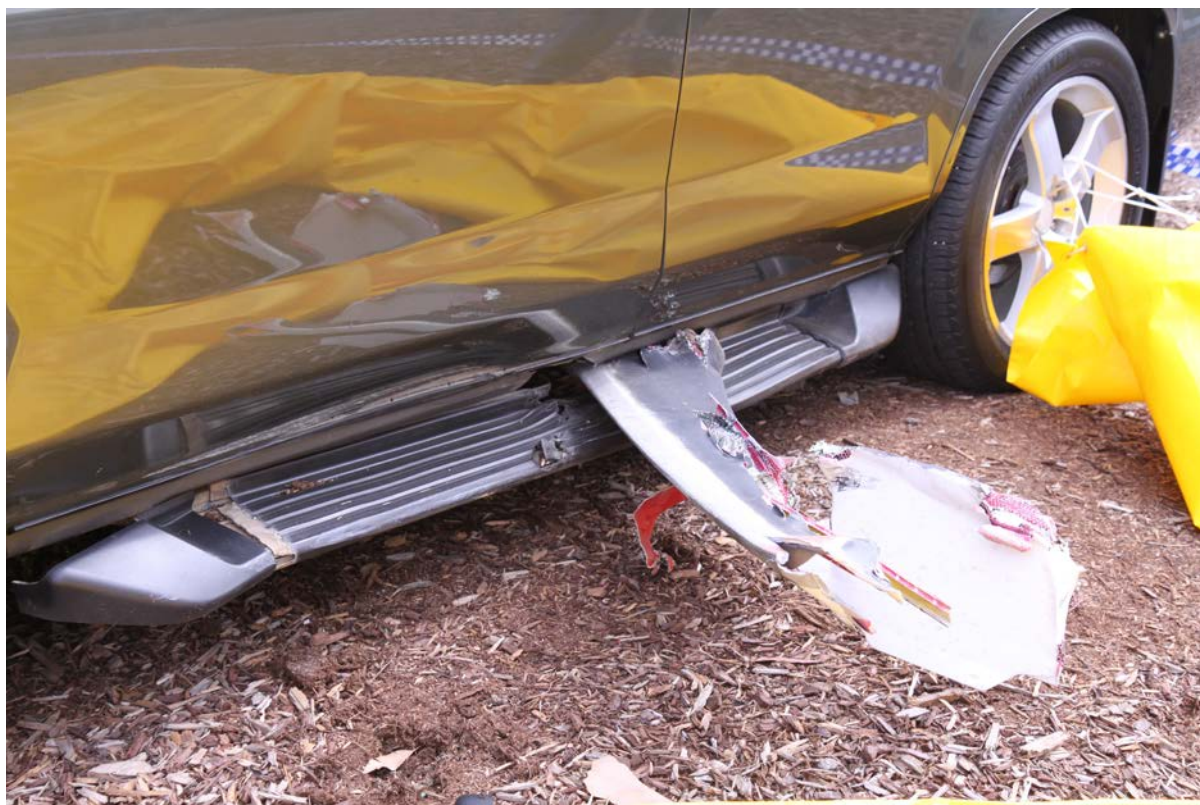
Source: Google earth, modified by the ATSB

Figure 6: Main rotor debris imbedded in the marquee in the passenger staging area



Source: ATSB

Figure 7: Main rotor debris imbedded in the nearby car



Source: ATSB

Related occurrences

A review of the ATSB's aviation occurrence database from 2005 to 2014 identified that although a total of 324 helicopter accidents were recorded, only five involved injuries or fatalities to persons located on the ground. Interestingly, 15 occurrences involved some form of helicopter rollover, of which eight were considered to have resulted from dynamic rollover. No fatalities resulted from the dynamic rollover occurrences.

As a comparison, a presentation by the National Transportation Safety Board as part of the NTSB's 2015 Most Wanted List titled [Remarks at Helicopter Association International Industry-Government Forum, Alexandria, VA](#) included a review of United States general aviation helicopter accident data. The presentation highlighted that, although there were a proportionally larger number of helicopter accidents, a small percentage were non-fatal dynamic rollover occurrences.

The ATSB has investigated several occurrences involving dynamic rollover. Two are reviewed in the following sections and are available from the ATSB website at www.atsb.gov.au.

AO-2014-108: Collision with terrain involving Bell 206, registered VH-KSV, 200 km SW of Kalumburu, Western Australia on 13 June 2014

On 13 June 2014, at about 0810 Western Standard Time⁹, the pilot of a Bell 206 helicopter, registered VH-KSV, departed Mitchell Plateau campground, Western Australia, on a flight to a remote landing site about 30 NM (56 km) away to collect passengers.

⁹ Western Standard Time (WST) was Coordinated Universal Time (UTC) + 8 hours.

As the pilot lowered the helicopter towards the rear of a rocky, sloped sandstone platform, he looked out of the pilot side window to select the best position to touch down. The front portion of the right landing skid touched down first and the right skid was sitting on a rock. The pilot was concerned about the suitability of the landing site and attempted to lift back into the hover. As the pilot raised the collective lever, the helicopter start to roll. The pilot assessed that this may have been an ‘incipient dynamic roll’ and lowered the collective lever. Although the pilot’s action recovered the helicopter from the roll, the helicopter tipped backwards off the edge of the rocky platform and slid about 2 m down the slope before coming to a halt.

AO-2014-161: Loss of control during landing involving a Bell 206B3, registered VH-CLR, 9 km south-east of Cooktown Airport, Queensland, 7 October 2014

On 7 October 2014 at about 0800 Eastern Standard Time¹⁰, the pilot of a Bell 206B3 helicopter, registered VH-CLR, departed Cairns, Queensland with one passenger on board. The purpose of the flight was to conduct a charter flight to Mount Cook, about 9 km south-east of Cooktown Airport, Queensland.

As the pilot had not used the landing area previously, he conducted an aerial reconnaissance of Mount Cook landing area prior to arriving at Cooktown Airport to pick up the remaining passengers. The landing area was a rocky ledge near the top of Mount Cook. To assess the conditions in the area, the pilot made 3–4 practice approaches and a practice landing, touching down with the right skid on the ledge. The pilot assessed that stabilising the helicopter with the right skid on the ledge for embarking and disembarking the passengers was preferable to the previously-decided method of placing both skids on the uneven surface.

During the approach to land, the pilot reported feeling that the helicopter was stable and appeared unaffected by the increased wind. Guidance into the landing area was provided by the charter client’s ground coordinator, who was in radio contact with the pilot.

Just prior to stabilising the helicopter and touching down, the pilot felt it momentarily lift, most likely from a gust of wind, and drift to the right. The right skid scraped along the rock ledge and the helicopter rolled rapidly onto its right side and slid a short distance forward, prior to coming to rest.

The ATSB found that the occurrence was consistent with dynamic rollover.

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

Safety analysis

Introduction

During the conduct of passenger-carrying charter flights between Olympic Park oval and Flemington Racecourse, Melbourne, Victoria on 2 November 2013, Bell 206L-1 helicopter, registered VH-VDZ, collided with terrain as the pilot prepared to depart from the helipad.

There was no evidence of a mechanical or other helicopter system failure that contributed to the occurrence. In addition, there was no evidence that the helipad landing mat impacted on, or interfered with the helicopter during the pick-up procedure.

This analysis discusses a number of operational considerations in the development of the occurrence, including:

- dynamic rollover
- the potential for a flight control obstruction to have been a factor
- the safety considerations when operating in close proximity to public access areas and gatherings.

Helicopter operations

Dynamic rollover

The lift-off was attempted with a left crosswind and a lateral centre of gravity that was to the right of the helicopter's centre-line. Together with the helicopter's normal tendency to drift right during lift-off, had the right landing skid been in contact with the ground and acted as a pivot point, each of these factors increased the tendency of the helicopter to roll right during lift-off.

The pilot recalled that the right landing skid seemed to remain 'stuck' to the ground during the attempted lift-off. In contrast, the marshaller reported observing both of the helicopter's landing skids lift from the ground slightly before the helicopter drifted to the right and the right landing skid again contacted the ground. In either case, an in-contact right skid would have acted as a pivot point as the pilot continued the take-off, increasing the risk of dynamic rollover.

The degree of cyclic input and rate of collective application by the pilot could not be determined. However, the reported rapid rise of the left landing skid from the ground and right roll of the helicopter was consistent with the application of collective lever without appropriately-coordinated cyclic input to control any roll. Coordinated control inputs would have allowed the pilot more time to detect and address the roll. In any event, the speed of the roll rapidly reduced the critical angle, increasing the likelihood of rollover.

The most effective means to recover from dynamic rollover is to smoothly lower the collective in coordination with appropriate cyclic input to control any roll and re-establish the helicopter's weight evenly on the ground. The reported attempt by the pilot to lower the collective lever in response to the rapid roll was ineffective in stopping the roll before the helicopter passed the static rollover angle, after which recovery was not possible.

Helicopter landing sites

While the operation of helicopters near public areas carries a degree of risk, a review of ATSB occurrence data for the period 2005–2014 indicated that the risk of injury or death to people on the ground from helicopter operations was low. Guidance provided in Civil Aviation Advisory Publication (CAAP) 92-2(1) was intended to minimise the potential for injury while operating helicopters from helicopter landing sites and the charterer adopted elements of this guidance in its operations manual. Although the separation between most of the helipads at the Olympic Park

oval was at least 24 m, other helipads were located within 15 m of the perimeter fence and nearby public walking tracks. These distances were less than the recommended 30 m in the CAAP, increasing the risk of injury to bystanders from rotor downwash.

The suggested perimeter distance of 30 m from a hovering or taxiing helicopter was intended to address the hazards associated with those operations. This is consistent with the inherent flexibility of a helicopter and its ability to access small landing, winching and other areas as measured by the widespread use of helicopters for search and rescue and aeromedical operations. However, the associated risk of this operational flexibility and utility is that, in the case of an accident during those operations, high energy main rotor and other debris can travel beyond the 30 m distance.

It is therefore prudent that, where possible and operational and/or safety imperatives dictate, operators consider increasing the recommended distance from their helipads to public access areas. This will further reduce the potential for injury in the event of an accident during helicopter operations.

Emergency response and first aid equipment

As the charterer had included an emergency procedure brief in the document suite issued to operational personnel, there was an expectation that those procedures would be followed in the event of an emergency. This included in case of injury to passengers or personnel or the containment of a fire relating to the operation of the helicopter.

Apart from the mandatory first aid and fire extinguishing equipment on board the helicopters, no ground-based fire extinguishing or first aid equipment was available at the Olympic Park basic helicopter landing site. In the case of an accident, the availability of those resources would have provided for a more effective and timely first aid response and offered an immediate response in the case of a minor fire until emergency services arrived. However, had there been a serious fire as a result of the rollover, it could be expected that the intensity of the fire would have been difficult to suppress, no matter what handheld device was used. It is likely that an immediate response by something approaching the *Aerodrome Rescue & Fire Fighting Service* normally associated with a major airport would be required to extinguish a serious fire.

In this case there was no fire. However, the amount of fuel and hydraulic fluid dispersed around the accident site increased the potential for a fire when combined with an ignition source. Potential ignition sources included the helicopter's exhaust or other hot components or an electrical spark.

The pilot was the only occupant and was able to escape the smoke by exiting the helicopter through the damaged front windscreen, sustaining minor injuries. The severity of the occurrence may have increased if passengers were on board at the time and a fire erupted. With minimal available means to contain a fire, and a potentially more difficult exit from the rear of the helicopter, the risk of post-accident injury was increased.

Carriage of ballast

Despite the helicopter's flight manual requirement for supplemental ballast with a combined front seat weight less than 77 kg, there was no indication of the ballast type to be used or method for securing it in the helicopter. As such, the pilot had no guidance as to whether the ballast bag was fit for purpose, though it was reported by the manufacturer as common practice to secure a heavy flight bag or ballast bag in the copilot's seat using the existing seat harness.

Placing the unrestrained ballast bag on the front left floor was convenient and catered for the high frequency, short duration passenger- and non-passenger-carrying flights. However, it increased the risk that in the event of an emergency or turbulent flight, occupants may be injured by unintended movement of the bag about the cockpit/cabin. In addition, positioning any unrestrained object close to an unprotected control stub, such as the cyclic control, or collective lever increases

the risk of control fouling and damage to the control stubs. Steps to mitigate those risks include the installation of the control stub covers.

Dual flight controls

Helicopters are often required to be reconfigured depending on the type of operation. The removal and installation of dual flight controls required a specific maintenance authorisation, often with appropriate conditions such as the completion of relevant training. This authorisation was not held by either the charterer's chief pilot or the pilot of the helicopter. Removal of the helicopter's dual flight controls in those circumstances increased the risk of fouling of the flight controls during the subsequent passenger-carrying charter operations.

Findings

From the evidence available, the following findings are made with respect to the loss of control and collision with terrain involving Bell 206L-1 helicopter, registered VH-VDZ, which occurred 13 km south-east of Essendon Airport, Victoria on 2 November 2013. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- Given the left crosswind and right lateral centre of gravity, which would have increased the tendency of the helicopter to roll right during lift-off, the pilot did not react to the developing right roll in sufficient time to prevent the dynamic rollover of the helicopter.

Other factors that increased risk

- The helicopter's dual flight controls were removed after the familiarisation flight by a person without the training or authorisation to conduct the maintenance procedure, increasing the risk of fouling of the flight controls during the subsequent passenger-carrying charter operations.
- The pilot positioned an unsecured ballast bag on the left front floor of the helicopter, which increased the risk of a control restriction as a result of the exposed cyclic control stub and injury to the aircraft occupants in the case of an accident.
- There was limited availability of fire extinguishers and first aid equipment at the Olympic Park basic helicopter landing site, which had the potential to inhibit an effective emergency response.
- The proximity of the helipad to the perimeter fence and public access areas of the Olympic Park basic helicopter site increased the risk of injury to bystanders during the passenger-carrying charter operations.

Safety issues and actions

Proactive safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this accident.

Charterer of the helicopter

The charterer of the helicopter advised that for subsequent operations during the 2013 Spring Racing Carnival, portable fire extinguishers were located close to each helipad and first aid equipment was made available nearby. In addition, the helipads were repositioned further from the passenger marquee and passengers were not loaded or unloaded if helicopters were in the process of landing or taking off from adjacent helipads.

Operations at the Olympic Park oval ceased following the 2013 carnival.

General details

Occurrence details

Date and time:	2 November 2013 – 1830 EDT	
Occurrence category:	Accident	
Primary occurrence type:	Loss of control	
Location:	13 km south-east of Essendon Airport, Victoria	
	Latitude: 37° 49.5' S	Longitude: 144° 58.85' E

Aircraft details

Manufacturer and model:	Bell Helicopter Co. 206L-1 Longranger	
Year of manufacture:	1981	
Registration:	VH-VDZ	
Serial number:	45693	
Total Time In Service	6,159 hours	
Type of operation:	Charter	
Persons on board:	Crew – 1	
Injuries:	Crew – 1 minor	Passengers – 0
Damage:	Substantial	Passengers – 0

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- pilot of the helicopter
- charterer of the helicopter
- owner of the helicopter
- Civil Aviation Safety Authority (CASA).

References

Wagtendonk, WJ 1996, *Principles of Helicopter Flight*, Aviation Supplies & Academics, Inc. Washington, USA.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the 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 CASA, the aircraft owner, the charterer of the helicopter and the pilot.

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

Australian Transport Safety Bureau

The ATSB is an independent Commonwealth Government statutory agency. The ATSB 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 operations involving the travelling public.

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 factors related to the transport safety matter being investigated.

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.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report Aviation Occurrence Investigation

Loss of control and collision with terrain, Bell 206L-1 helicopter,
VH-VDZ 13 km SE of Essendon Airport, Victoria, 2 November 2013

AO-2013-199

Final – 1 June 2016