Australian Government
Australian Transport Safety Bureau

Loss of control and collision with water involving Eurocopter EC120B, VH-WII

Hardy Reef, 72 km north-north-east of Hamilton Island Airport, Queensland on 21 March 2018

ATSB Transport Safety Report
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Addendum

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Safety summary

What happened

On 21 March 2018, a Eurocopter EC120B helicopter, registered VH-WII and operated by Whitsunday Air Services, departed Hamilton Island Airport, Queensland on a charter flight to Hardy Reef. On board were the pilot and four passengers.

The pilot conducted the approach to the pontoon landing site at Hardy Reef into wind. During the approach, the pilot slowed the helicopter to allow birds to disperse. The pilot was then planning to yaw the helicopter left into the intended landing position, and there was about 20 kt crosswind from the right of the intended position.

When the helicopter was yawing left into position, just over the pontoon, the pilot noticed a message illuminate on the helicopter's vehicle engine multifunction display (VEMD), and elected to conduct a go-around. During the go-around, after the helicopter climbed to about 30–40 ft, there was a sudden and rapid yaw to the left. In response to the unanticipated rapid yaw, the pilot lowered the collective but was unable to recover the situation.

In the limited time available after the unsuccessful action to recover from the rapid left yaw, the pilot did not deploy the helicopter's floats and conduct a controlled ditching. The helicopter collided with the water in a near-level attitude, with forward momentum and front-right corner first. Almost immediately, the helicopter rolled to the right and started rapidly filling with water. The pilot and two of the three rear seat passengers evacuated from the helicopter with minor injuries. Although the impact forces were survivable, the other two passengers were unconscious following the impact and did not survive the accident.

The helicopter sank and, associated with unfavourable weather conditions in the days following the accident, subsequent searches were unable to locate and recover the helicopter.

What the ATSB found

Although none of the possible VEMD messages required immediate action by the pilot, the pilot considered a go-around to be the best option given the circumstances at the time.

During the go-around, the helicopter continued yawing slowly to the left, and the pilot very likely did not apply sufficient right pedal input to correct the developing yaw and conduct the go-around into wind. The helicopter then continued yawing left, towards a downwind position, until the sudden and rapid yaw to the left occurred. In response to the rapid yaw, it is very likely that the pilot did not immediately apply full and sustained right pedal input.

The operator complied with the regulatory requirements for training and experience of pilots on new helicopter types. However, the ATSB found the operator had limited processes in place to ensure that pilots with minimal time and experience on a new and technically different helicopter type had the opportunity to effectively consolidate their skills on the type required for conducting the operator's normal operations to pontoons. In this case, the pilot of the accident flight had 11.0 hours experience in command on the EC120B helicopter type, and had conducted 16.1 hours in another and technically different helicopter type during the period of acquiring their EC120B experience. Associated with this limited consolidation on the EC120B, it is likely that the pilot was experiencing a high workload during the final approach and a very high workload during the subsequent go-around.

In addition to limited consolidation of skills on type, the ATSB found that the safety margin associated with landing the helicopter on the pontoon at Hardy Reef was reduced due to a combination of factors, each of which individually was within relevant requirements or limits. These factors included the helicopter being close to the maximum all-up weight, the helicopter's engine power output being close to the lowest allowable limit, the need to use high power to make a slow approach in order to disperse birds from the pontoon, and the routine approach and landing position on the pontoon requiring the pilot to turn left into a right crosswind (in a helicopter with a clockwise-rotating main rotor system).

The ATSB also identified that the passengers were not provided with sufficient instructions on how to operate the emergency exits and the passenger seated next to the rear left sliding door (emergency exit) was unable to locate the exit operating handle during the emergency, and as a result the evacuation of passengers was delayed until another passenger was able to open the exit. The nature of the handle's design was such that its purpose was not readily apparent, and the placard providing instructions for opening the sliding door did not specify all the actions required to successfully open the door.

The investigation also identified safety factors associated with the operator's use of passenger-volunteered weights for weight and balance calculations, the operator's system for identifying and briefing passengers with reduced mobility, bird hazard management at the pontoons, and passenger control at the pontoons.

What has been done as a result

In July 2019, the helicopter manufacturer released a safety information notice about unanticipated left yaw in helicopters with a clockwise-rotating main rotor system. The notice provided detailed advice regarding the circumstances where unanticipated yaw can occur and the importance of applying full opposite right pedal if it occurs. The notice also stated that, for helicopters with a clockwise-rotating main rotor system, to prefer (as much as possible) yaw manoeuvres to the right, especially in performance-limited conditions.

Following the accident, the operator implemented several additional processes for pilots transferring to new helicopter types and for operations at pontoons. This included pilots conducting only into-wind operations at pontoons until they had obtained 20 hours on type. The operator also introduced a safety management system (SMS), revised processes for obtaining accurate passenger weights, and introduced training for pilots in how to avoid birds and how to inspect blades following a birdstrike.

In addition, the operator revised their pre-flight safety briefing video and passenger-briefing cards to include all types of seatbelts and instructions on how to operate all emergency exits and address other matters. The Civil Aviation Safety Authority (CASA) revised its passenger safety briefing guidance, which now contains information specific to helicopter operators. The Civil Aviation Safety Regulation (CASR) Part 133 Manual of Standards applicable to helicopter operators also requires that passengers seated in an emergency exit row are briefed about what to do when an exit is required to be used. In addition, all passengers must be verbally briefed on the location of exits and the brace position.

Safety message

This accident and many other previous accidents demonstrate the importance of pilots having experience in the helicopter type when faced with unfamiliar situations in performance-limited conditions. Operators, as part of their safety management processes, should consider skill consolidation during and following the in command under supervision (ICUS) phase and provide as much consolidation as possible to reduce the risk of transitioning to a new aircraft type. This is particularly relevant for types with significant differences to those a pilot has previously flown and for operations with reduced safety margins.

Operators are also encouraged to build safety margins into their operations, to minimise the risk of performance-limited conditions during critical phases of flight, and provide pilots the best opportunity to succeed.

Industry understanding of yaw control problems in helicopters is always developing. Pilots and operators should identify and avoid situations that present potential for loss of yaw control in their helicopter type. This could include planning approaches that can be rejected by turning with the torque of the helicopter (for example, if crosswind turns are required when landing, conduct turns to the right in a helicopter with a clockwise-rotating main rotor system).

In the event of a loss of yaw control at low height and airspeed, pilots need to follow the immediate actions specified by the relevant helicopter manufacturer (which typically include immediately applying full opposite pedal input).

For helicopter flights over water, given the risk of inversion, capsize and disorientation following a ditching, it is imperative that passenger safety briefings include how to operate the passenger's seatbelt and the location and operation of the emergency exits. In addition, for operators and pilots of EC120B aircraft, passengers in the rear of the helicopter should be specifically briefed about the location of the operating handle and the three actions required to open the rear left sliding exit: pull the handle up, push the door out, and slide the door back.

Contents

The occurrence

Overview

On 21 March 2018, a Eurocopter[1] (Airbus Helicopters) EC120B helicopter, registered VH-WII, was operated by Whitsunday Air Services[2] on a scenic charter flight under visual flight rules (VFR) from Hamilton Island, Queensland, to a helicopter landing site (HLS) on a pontoon at Hardy Reef, Queensland (Figure 1). On board were a pilot and four passengers.

On approach to the pontoon, when the helicopter was just above the pontoon surface and yawing left into the intended landing position, the pilot initiated a go-around. After climbing to about 30–40 ft, the helicopter yawed suddenly and rapidly to the left. The pilot's control inputs did not arrest the yaw, and the helicopter impacted the water in a near-level attitude with forward momentum, front-right corner first, before rolling inverted.

The front left passenger and rear middle passenger did not survive and the other three occupants received minor injuries. The helicopter sank and could not be recovered.

Events prior to the flight

On the morning of 21 March 2018, the passengers departed Hamilton Island on a cruise to Hardy Reef. About 1 hour into the tour, the vessel experienced engine problems and returned to Hamilton Island, arriving at about 1300.[3]

The passengers made enquiries about helicopter flights to and from the reef as an alternative, and booked a flight with Whitsunday Air Services to depart Hamilton Island at 1430.

The pilot of the allocated flight was in the process of conducting another flight with other passengers in VH-WII. During that return flight from Hardy Reef, not long after take-off, the pilot was notified by the operator of the additional allocated flight to the reef, scheduled for 1430. The pilot advised the operator that the next flight could not be commenced until later, as the current flight would not be arriving back at Hamilton Island until about 1450.

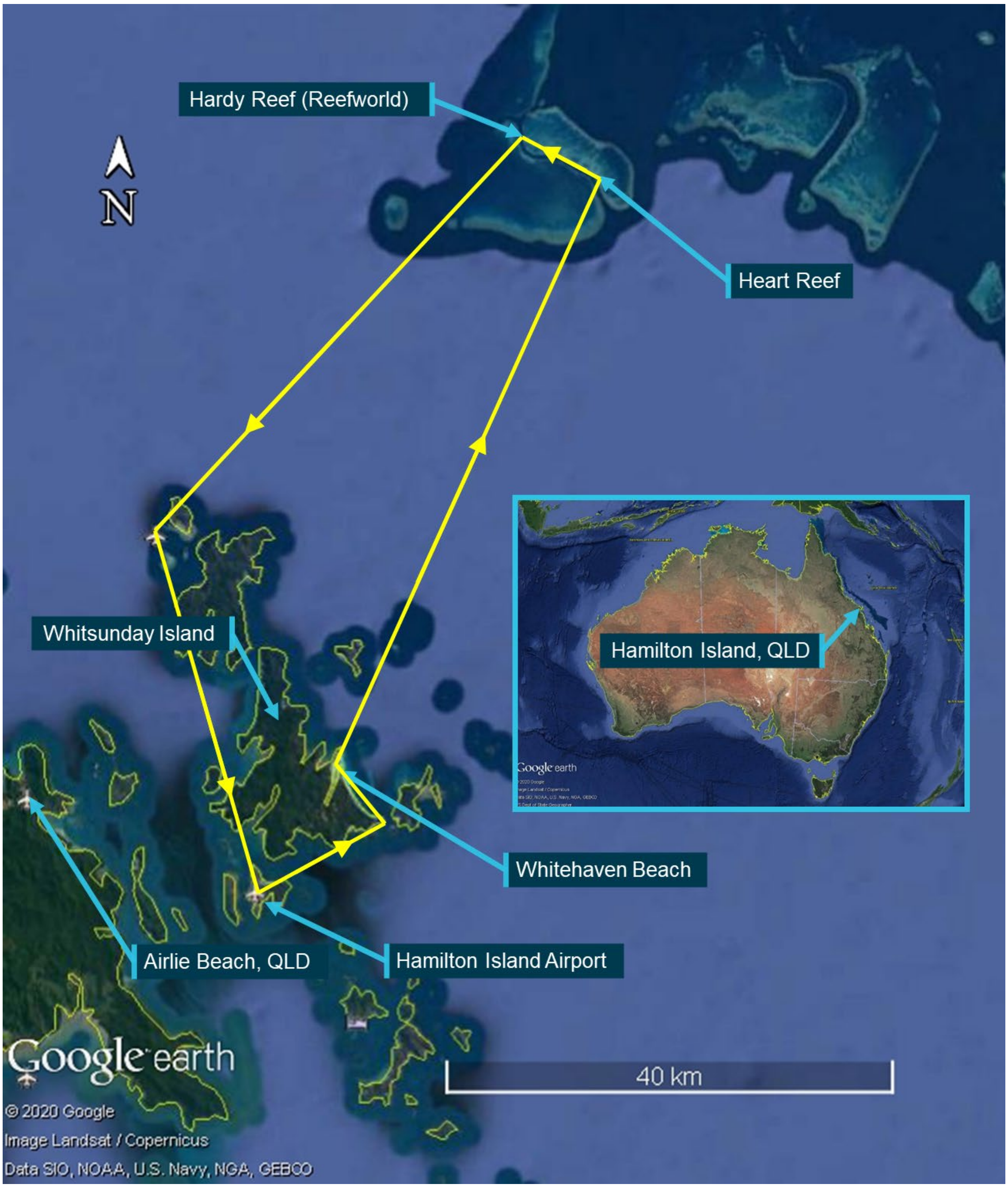
Prior to arriving back at Hamilton Island, the operator provided the pilot with a total passenger weight for the next flight, and the pilot used this for weight and balance calculations and fuel planning for the next flight. The pilot also advised the operator about a high amp draw during the previous start (at Hardy Reef). This prompted the pilot to request that a portable auxiliary power unit (APU) be loaded onto the helicopter at Hamilton Island for the next flight.

[1] The EC120B Colibri was originally manufactured by Eurocopter in 1995. Eurocopter was purchased and became Airbus Helicopters in 2014. Airbus Helicopters ceased production of the EC120B in 2017.

[2] Whitsunday Air Services trading as Hamilton Island Air.

[3] Eastern Standard Time (EST) is Coordinated Universal Time (UTC) + 10 hours.

Figure 1: Planned scenic flight path from Hamilton Island to Hardy Reef (Reefworld) and return



Source: Google Earth, annotated by the ATSB

Passenger briefing and loading

The group of four passengers arrived at the operator's Hamilton Island terminal to complete check-in at about 1415. Following check-in, the passengers watched a passenger safety video in the terminal lounge. At about 1445, a guest liaison officer fitted the group with life jackets.

The helicopter arrived back at Hamilton Island Airport at 1447 and staff members unloaded the previous group of passengers with the rotors turning. The pilot re-positioned the helicopter to refuel, with 69 L of fuel uploaded by an assisting staff member; another staff member loaded an APU into the baggage compartment. While these duties were underway, the pilot was told over the radio to hurry as the passengers for the next flight had been waiting for some time.

At 1455, the pilot positioned the helicopter back at the operator's helipad to accept the new group of passengers. The guest liaison officer and an assisting pilot escorted the passengers out onto the tarmac. The pilot remained at the controls of the helicopter and the passengers were 'hot loaded',[4] consistent with the operator's normal practices.

The pilot and the assisting pilot noticed that the front left passenger had a brace on their right arm, and appeared to have difficulty getting into the helicopter and putting on their headset. The rear middle passenger also required assistance, and one of the other passengers assisted this passenger into the helicopter.

Once the passengers were inside the helicopter, the guest liaison officer and the assisting pilot fastened the passengers' seatbelts and put on their headsets. The guest liaison officer then checked that all doors and the baggage compartment were secure, and signalled to the pilot that the helicopter was ready for departure. The pilot provided the passengers with a short briefing and the helicopter departed Hamilton Island at about 1501.

Approach to Hardy Reef pontoon

The pilot reported that the operator's standard scenic flight path around Hamilton Island and out to Hardy Reef was conducted. This involved cruising at an altitude of 1,000 ft to Whitehaven Beach before climbing to 1,500 ft when flying to Heart Reef and then Hardy Reef (Figure 1). The pilot noted that the weather was fine and clear during the flight.

The operator had two pontoon landing sites at Hardy Reef, each with two helicopter aiming points. As there were already two helicopters parked on the pontoon closest to Reefworld (the main tourist centre), the pilot planned to land on the furthest pontoon, and position the helicopter such that another of the operator's helicopters, following a few minutes behind, could also land on the pontoon. Consistent with the operator's normal practice, the pilot intended to land on the upwind end of the pontoon.

The operator required pilots to fly a north-west track along Hardy Reef and descend into a circuit for landing on a pontoon. The pilot recalled following the operator's normal processes during the descent and approach to the pontoon. This involved the pilot commencing descent from 3 NM (5.6 km) from the pontoon. They then contacted the operator at about 1530 by radio to cancel the SARTIME,[5] before overflying Reefworld to alert staff to the imminent arrival of guests. The pilot then conducted a right circuit for landing at the pontoon (Figure 2).

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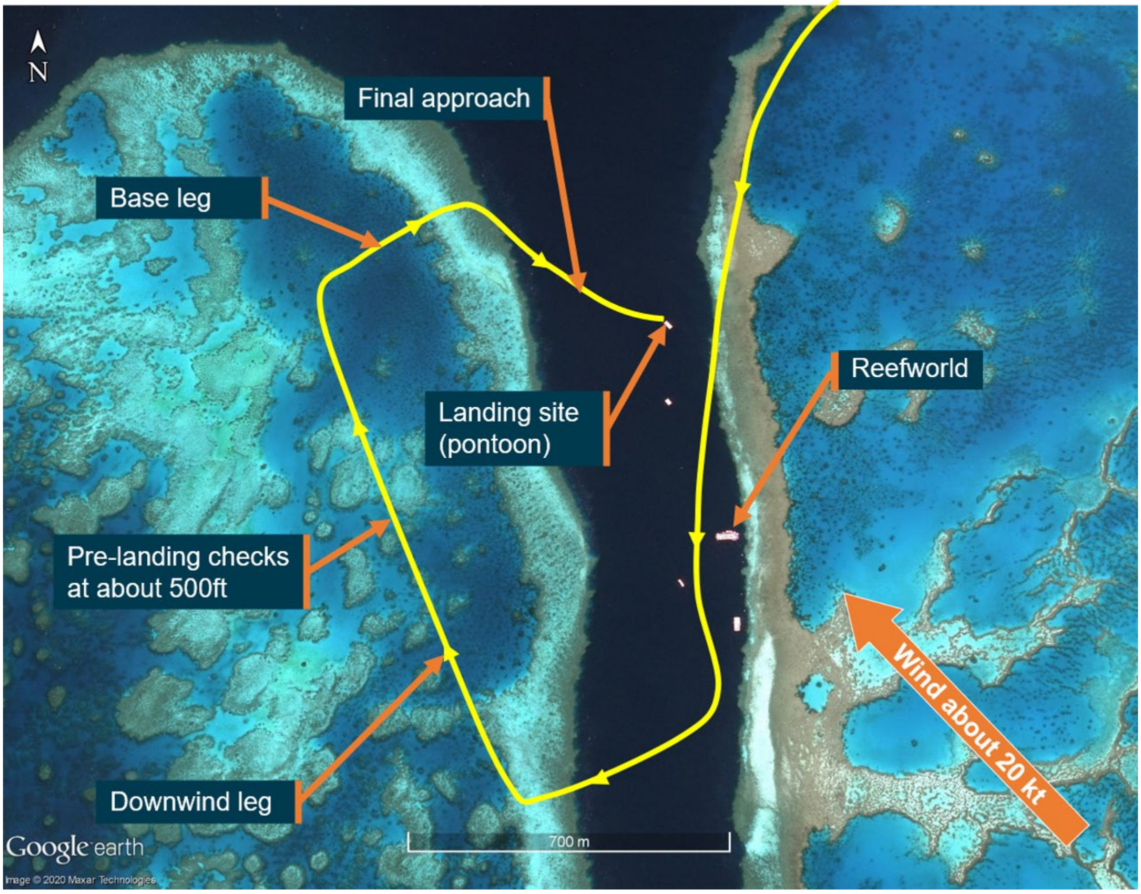
[4] Hot loading: occurs when the helicopter is loaded while the engine(s) is running and the rotors are turning.

[5] Search and Rescue time (SARTIME): the time nominated by a pilot for the initiation of Search and Rescue (SAR) action. If the pilot does not contact the SARTIME holder by the allotted time the search and rescue response will begin.

Figure 2: Pilot recollection of approach to Hardy Reef pontoon



Source: Google Earth, annotated by the ATSB

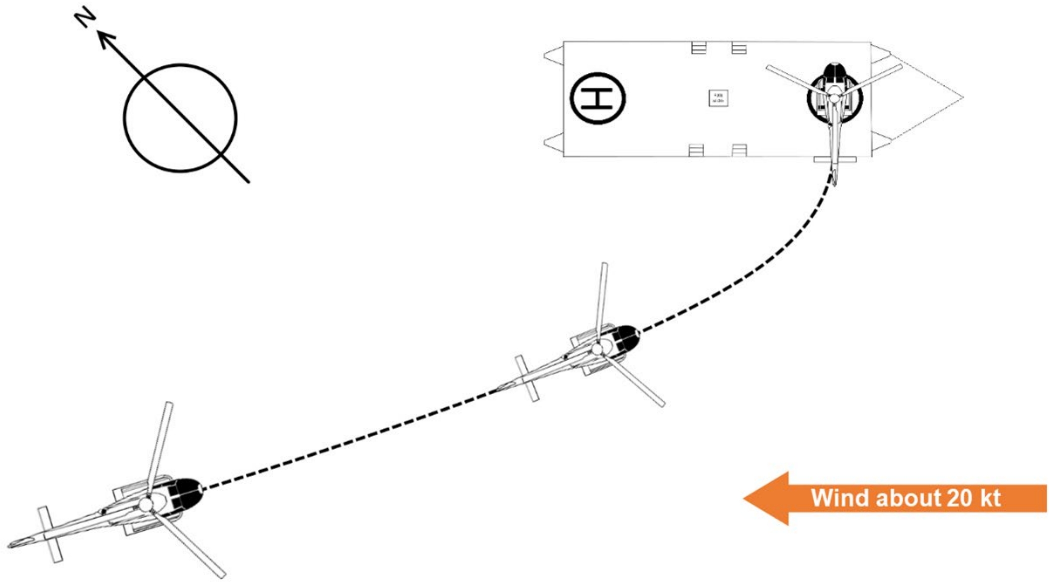
At about 1535, the pilot flew the downwind leg of the circuit at 500 ft. During this leg, they confirmed the wind direction at the pontoon by sighting a small flag on Reefworld, and assessed the wind to be about 15–20 kt from the south-east (see also *Meteorological conditions*). The pilot also completed the required pre-landing checklist tasks, including turning off the air-conditioning to reduce load on the engine during landing.

The pilot stated that, from the turn onto final approach, everything looked normal; there were no indications of any issues as the helicopter descended through 100 ft while slowing from 40 kt.

The pilot recalled setting up the approach with a headwind component. As per the operator's normal practice for landing at the pontoon, the pilot's intention was to make a left turn to land crosswind when at the pontoon. This would enable the helicopter to land perpendicular to the long axis of the pontoon, which was at a heading of about 55–60° (Figure 3).

The transition to a crosswind landing simultaneously involved slowing the helicopter as much as possible to encourage birds on the pontoon to disperse. This required the use of sufficient power to come to a high hover in a 20 kt crosswind while ensuring controllability.

Figure 3: Planned approach with left turn to a crosswind landing



Source: ATSB

Go-around

Pilot recall

The pilot reported that the final approach to the pontoon looked normal. As the helicopter neared the pontoon, the front left passenger asked about the birds on the pontoon. At about the same time, the pilot noticed a message on the vehicle engine multifunction display (VEMD). The pilot recalled that, when these events occurred, the helicopter (pilot eye height) was about 20 ft above the water and at an airspeed of 10–15 kt. The front of the helicopter was over the pontoon and the pilot had commenced, but not completed, the left turn onto the intended landing heading. They subsequently estimated that the left turn had reached about 20–30° from the intended landing heading.

The pilot stated that this was a high workload period and they were feeling ‘pretty busy’, so to enable them to troubleshoot the reason for the VEMD message they decided to go around. As their priority was flying the aircraft, they did not answer the passenger’s question. The pilot recalled telling the passengers ‘she doesn’t like this, we might give it another go’ when initiating the go-around.

The pilot reported applying take-off power by lifting the collective[6] to increase the helicopter’s height, and pushing the cyclic[7] forward to increase the forward speed during the go-around. They recalled that, after commencing the go-around, the engine power was most likely at or close to the

6 Collective: 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.

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

red band (maximum take-off power) (see *VEMD and first limit indicator*). The pilot was trying to climb away from the pontoon and water as efficiently as possible, and it was a slow climb out.

The pilot's initial statement and interviews did not indicate which direction the helicopter was flying during the go-around. The pilot subsequently stated that the intended go-around path was into wind (to the right) and believed that the helicopter had been flown into wind.

Passenger recall

The passengers recalled that the helicopter came close to or possibly touched down on the pontoon and then the pilot made a comment similar to 'this is not going to work' and the helicopter abruptly started climbing.

The rear right passenger recalled that, during the climb, the helicopter commenced a left turn. The passenger described the manoeuvre as a 'U-turn', thinking that the helicopter was going to land on the other (downwind) end of the pontoon from the opposite direction.

The passenger in the rear left seat recalled that as the helicopter rose from the pontoon it jerked anticlockwise (left). The passenger also thought that the pilot was turning left to approach to land on the pontoon from the other direction, but thought the pilot was intending to land on the same end of the pontoon as the first attempted landing.

During the downwind leg and final approach, the rear right passenger (seated directly behind the pilot) was taking photographs out of the right side window, and the last two photographs were taken when the helicopter was close to the pontoon at about 1537 (Figure 4). A detailed analysis of these photographs indicated that:

- The first image (image 0620) was taken when the camera (passenger eye height) was about 15 ft above the water; this equated to the helicopter's skids being about 7 ft above the pontoon deck. The helicopter's nose was over the pontoon and at a heading of about 62–72° (slightly right of the intended landing heading of 55–60°).
- The second image (image 0621) was taken 8 seconds later, and the helicopter (passenger eye height) had climbed to about 30–40 ft above the water. The helicopter had rotated further to the left, and was now oriented at least 10–20° left, but potentially anywhere from 10–60° left, of the orientation of the first image.

Further details and analysis of these photographs are provided in Appendix A.

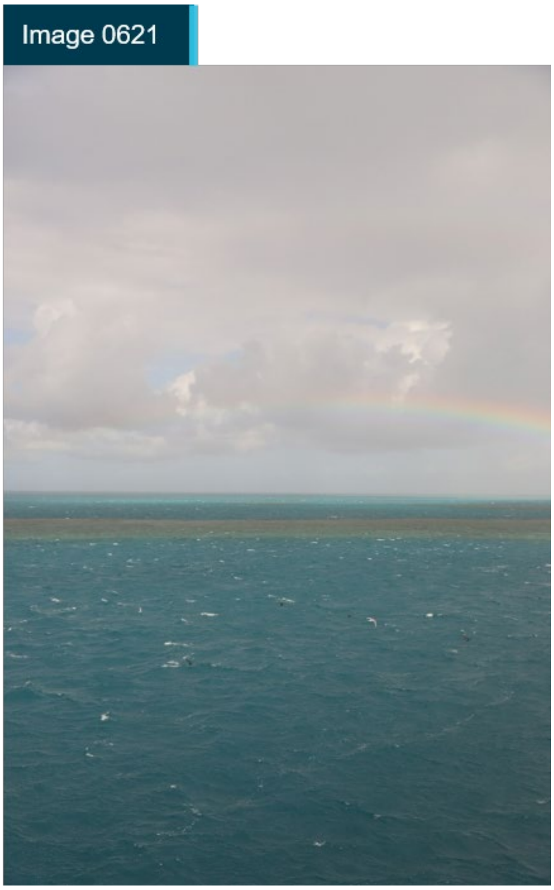
Loss of control and collision with water

The pilot reported that, when the helicopter was at about 40 ft above the water, following a slow climb, and travelling at about 35–40 kt, they heard and felt a 'thud' through the helicopter controls (cyclic and pedals), and the helicopter immediately yawed suddenly and sharply to the left.

The surviving passengers could not recall hearing any noticeable noises or feeling anything unusual during the go-around. They did recall that, a short while after the helicopter lifted and had turned to the left, the helicopter suddenly jerked sharply left and then spun rapidly in that direction.

The pilot reported attempting to fly out of the turn by increasing airspeed and following the helicopter's nose to the left, while simultaneously lowering the collective to arrest the sudden, unanticipated and rapid yaw to the left. The pilot recalled that the rotation slowed but did not stop, and the helicopter descended towards the water. The pilot's initial statement and interviews did not mention the anti-torque pedal positions; the pilot subsequently could not recall the exact details but indicated a significant amount of right pedal input would have been applied.

Figure 4: Unedited Images 0620 and 0621, taken by the rear right passenger during the go-around



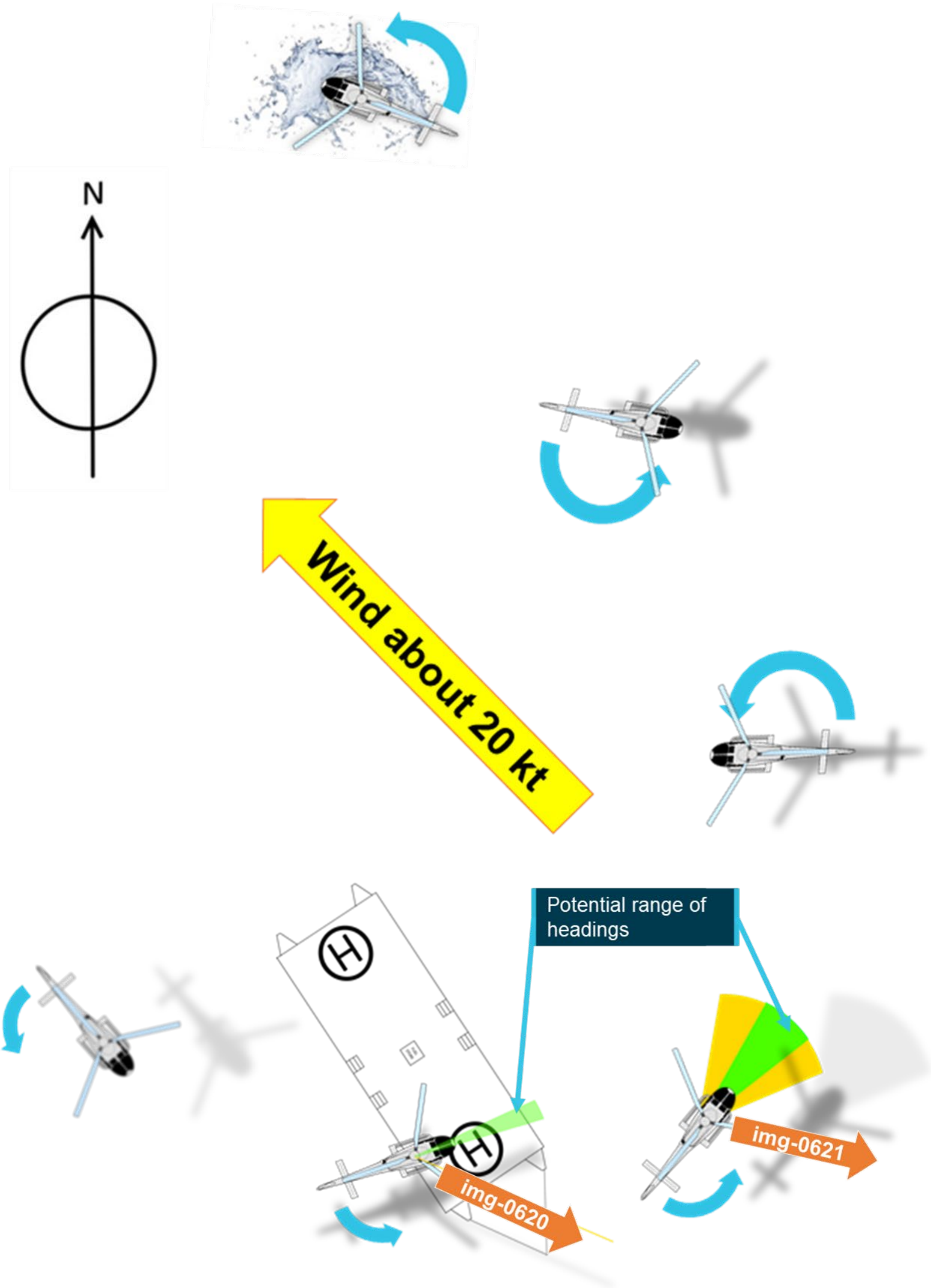
Source: Passenger on board VH-WII

Recognising a collision with water was inevitable, the pilot attempted to flare and level the helicopter before impact. The pilot stated that there was insufficient time to brief the passengers or activate the helicopter's floats prior to impact, and consequently the floats were not inflated.

Figure 5 shows the estimated locations of the helicopter during the go-around and subsequent collision with water, based on the passenger's photographs and interviews with the pilot and passengers.[8]

8 As stated in this section, the passengers reported that the helicopter turned left during the initial part of the go-around whereas the pilot believed the helicopter was flown into wind (to the right). However, the pilot indicated that the helicopter impacted the water in about the location shown in the figure.

Figure 5: Estimated helicopter flight path during the go-around (based on photograph analysis and passenger interviews)



Source: ATSB

Evacuation

The pilot reported that the helicopter was near level when it collided with the water. Almost immediately after impact, the helicopter rolled to the right and began to fill with water and, after a short time, became inverted.

The pilot also recalled that, following the collision, the helicopter filled with water very quickly. In response, they grabbed the pilot seat, as was required in helicopter underwater escape training (HUET),[9] and then grasped the handle of the front right door.

The pilot reported trying to exit the helicopter by using the normal door handle; however, they could not get the door open, and then their hand was (inadvertently) kicked away by a passenger. The pilot undid their four-point harness and, holding onto their seat, unwrapped the headset cord that was around their neck, and then operated the emergency jettison handle on the front right door.

The rear left passenger reported initially having difficulty removing their seatbelt. They also reported being unable to find the handle to operate the rear left sliding door and started punching the left side window to try to escape. This passenger advised that their upper body was above the water level during this period.

The rear right passenger reported becoming disorientated after impact, and braced to kick out a window. At that stage, the right side of the helicopter was submerged, and the passenger recalled managing to take a breath before searching for a way to get out. While searching for something to hold onto across the cabin, this passenger found the handle of the rear left sliding door by touch. They opened the exit, which at that stage was above the water.

The rear left and rear right passengers evacuated the helicopter, and assisted the rear middle passenger from the helicopter. They recalled that the rear middle passenger and the front left passenger appeared to be ‘unconscious’ throughout this period.

During the evacuation, neither of the surviving passengers had removed their life jackets from their wearable pouches. The pilot instructed them to put their life jackets on and inflate them. In addition, the pilot activated the personal locator beacon that was located in the pilot’s life jacket and handed it to the rear right passenger, who had managed to get onto the underside of the now inverted helicopter.

Emergency response

Before the helicopter impacted the water, a staff member situated at Reefworld had heard the helicopter fly past and later sighted it at about 20 m (65 ft) above the water and about 50 m from the pontoon. The staff member also noted that the helicopter was flying into wind. Consistent with normal procedures, seeing the helicopter near the pontoon prompted the staff member to take a passenger transfer vessel (known as a rail boat) to meet the passengers at the pontoon. About 30 seconds after sighting the helicopter, the staff member could no longer see or hear it, and thought at the time it may have conducted a go-around.

As the Reefworld rail boat approached the pontoon, the staff member saw the helicopter inverted in the water with the skids showing and a person wearing a yellow life jacket in the water. The staff member initiated an emergency response.

After the rail boat arrived at the helicopter, the rear left passenger and the pilot assisted the incapacitated rear middle passenger onto the vessel and commenced resuscitation. The pilot returned to the water, retrieved the rear right passenger from on the helicopter, and assisted them onto the rail boat.

The pilot then attempted to extract the front left passenger from inside the helicopter but could not locate that passenger. The pilot then realised they were entering through the rear left sliding door, rather than the front left door. They opened the front left door, undid the passenger’s four-point harness and manoeuvred the passenger out of the helicopter and onto the rail boat, with the assistance of others.

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9 Helicopter underwater escape training (HUET): a specialised training course that utilises a simulator to enable participants to practice escaping from a helicopter that has capsized and inverted.

The passengers and pilot were taken on the rail boat to the Reefworld pontoon, where staff members and an off-duty medical doctor continued resuscitation efforts on both the front left and rear middle passengers for a number of hours. A rescue helicopter with further medical personnel arrived about 2 hours after the accident.

The front left and rear middle passengers did not survive the accident. The pilot and the other two passengers received minor injuries.

The helicopter inverted soon after impact and, without the floats inflated, it sank. Associated with unfavourable weather conditions in the days following the accident, subsequent searches were unable to locate and recover the helicopter.

Context

Pilot information

Qualifications and experience

The pilot held a valid Commercial Pilot Licence (Helicopter), issued in June 2011, with a class rating for single-engine helicopters. At the time of the accident, they had a total flying experience of 1,363.6 hours, with 1,201.4 hours as pilot in command.

Prior to starting with the operator, the majority of the pilot's experience was in agricultural operations, conducting low-level aerial surveys in Robinson 44 (R44) helicopters as well as operations in Bell 206 helicopters. In addition, the pilot also held the following endorsements and ratings:

- Hughes 269 helicopter
- night visual flight rules (NVFR)
- grade 3 instructor
- sling load operations
- aerial application.

The pilot joined Whitsunday Air Services in August 2017. After a period of induction and flying in command under supervision (ICUS), the pilot completed a proficiency check with the chief pilot on the R44 on 28 August 2017 and then commenced passenger charter flights as pilot in command of R44 aircraft from Hamilton Island to the Hardy Reef pontoons, as well as scenic flights from the pontoons. On 15 December 2017, the pilot completed a proficiency check with the chief pilot on the Bell 206L3, and was cleared to undertake passenger charter operations for the operator in the Bell 206L3.

In relation to the EC120B, the pilot:

- obtained a rating for the helicopter type from an external training provider on 7 March 2018, paid for by the operator
- conducted 5.5 hours ICUS with one of the operator's senior pilots during 11–13 March 2018
- completed a proficiency check (0.6 hours) with the chief pilot on 13 March 2018, after which the pilot was cleared to undertake passenger charter operations for the operator in the EC120B.

The check to line with the chief pilot covered various operational aspects, but it did not include, nor was it required to include, any pontoon landings or practice emergencies.[10] The pilot's last helicopter flight proficiency check, which included practice emergencies, was the flight review conducted as part of the EC120B type rating training.

The pilot obtained a certificate of competency in emergency procedures for the EC120B type aircraft on 13 March 2018. The proficiency test included, but was not limited to, procedures related to passenger briefings, ditching and emergency evacuation of the aircraft.

In addition to conducting passenger charter flights, the pilot was acting in the position of senior base helicopter pilot, which involved maintaining various aircraft records and other administrative tasks.

10 Practice emergencies are conducted in a helicopter flight proficiency check. Such practice emergencies typically include engine failure, hydraulic system failure and tail rotor emergences.

Experience on the EC120B

During the period after obtaining the EC120B rating on 7 March (3.6 hours), the pilot alternated between flying Bell 206L3 and EC120B helicopters, accumulating 16.1 hours in the Bell 206L3 and 11.0 hours in the EC120B (including 5.5 hours ICUS). Further details are provided in Table 1.

Table 1: Pilot hours in the weeks prior to the accident (including type-rating training)

Date	Type	Registration	Flight type	Flight Time
6/03/2018	EC120B	VH-JBY	Training (dual controls)	2.7
7/03/2018	EC120B	VH-JBY	Flight review (rating obtained)	0.9
8/03/2018				
9/03/2018	Bell 206L3	VH-VTO	Charter	4.6
10/03/2018	Bell 206L3	VH-VTO	Charter	1.7
11/03/2018	EC120B	VH-HIL	ICUS (charter)	3.9
12/03/2018				
13/03/2018	EC120B	VH-HIL	ICUS (charter) Check to line	1.6 0.6
14/03/2018	Bell 206L3	VH-VTO	Charter	3.1
15/03/2018	Bell 206L3	VH-VTO	Charter	3.4
16/03/2018	Bell 206L3	VH-VTU	Charter	1.6
17/03/2018	EC120B	VH-HIL	Charter	2.9
18/03/2018				
19/03/2018	EC120B	VH-WII	Ferry (Airlie Beach to Hamilton Island)	0.3
20/03/2018	Bell 206L3	VH-VTO	Charter	1.7
21/03/2018	EC120B	VH-WII	Charter	1.7

During 7 months with the operator, the pilot had landed on the pontoons at Hardy Reef over 270 times, mostly in the Bell 206L3. A review of the operator's flight logs indicated that the pilot had conducted nine landings on pontoons in the EC120B, with passengers on board, prior to the accident flight. These included six pontoon landings ICUS, and the last pontoon landing was conducted on the morning of the accident.

The pilot's flights for obtaining an EC120B rating were conducted in a relatively light helicopter (that is, with an instructor but no passengers on board). The pilot's first six pontoon landings in an EC120B were conducted in VH-HIL and ICUS, with a relatively heavy helicopter (another pilot and three passengers). The next two were also conducted in VH-HIL, the first with four passengers and a starting fuel load of 45 per cent, and the second with two passengers and a starting fuel load of 64 per cent. The ninth landing was conducted in VH-WII on the day of the accident with four passengers and a starting fuel load of 67 per cent (see *Operator's loading procedures and practices*). The accident flight was conducted with four passengers and a starting fuel load of about 50 per cent (see *Weight and balance*).

The pilot of the accident flight and other pilots reported that VH-WII had less engine power than the operator's other EC120B helicopter (VH-HIL). Prior to and after obtaining an EC120B rating, the pilot was conducting pontoon landings using Bell 206L3 helicopters, which have more available power than an EC120B.

The EC120B was the pilot's first helicopter type where the main rotor rotated in a clockwise direction. It was also the pilot's first helicopter type with a Fenestron rather than a conventional tail rotor (see *Fenestron tail rotor*).

The pilot reported having conducted a go-around in the EC120B but could not recall if this was during normal operations or during the type rating training. They recalled conducting a go-around once in the Bell 206L3 during approach to a pontoon.

Medical information and recent history

The pilot held a valid class 1 aviation medical certificate, which was valid until 25 May 2018. The certificate required distance vision correction to be worn while flying and have reading correction available. No significant medical concerns were noted in the pilot's recent aviation medical examinations, and the pilot reported no medical issues.

The operator's pilots were usually rostered to work 5 days on and 2 days off. The pilot of the accident flight was rostered off duty on 18–19 March, although they conducted a short ferry flight on 19 March to relocate VH-WII from Shute Harbour to Hamilton Island on its return from maintenance. On 20 March, the pilot conducted 1.7 hours in a Bell 206L3.

The operator's pilots stated that they normally started work at about 0800 and finished when the last aircraft had returned and hangar duties were complete. Due to additional duties as acting senior base helicopter pilot, the pilot of the accident flight normally finished work at about 1900.

The pilot reported being well rested and had been sleeping normally in the days leading up to the accident. On 21 March, they had a normal breakfast before starting work at about 0800. During the day, the pilot had muesli bars and a few litres of water.

The pilot's second flight to Hardy Reef on the day of the accident was at short notice and commenced at 1501, after the 1430 departure time arranged by the operator with the passengers. However, the pilot reported not feeling pressured during the flight and that no short cuts were taken to make up time.

According to Civil Aviation Order (CAO) 48.0 (*Flight time limitations – General*), a tour of duty was defined as:

> the period between the time a flight crew member commences any duties associated with his or her employment prior to making a flight or series of flights until he or she is finally relieved of all such duties after the termination of such flight or series of flights and includes reserve time at the airport.

The operator's operations manual did not include a definition of the tour of duty. Amongst other requirements, the manual stated that a normal tour of duty would be 11 hours (maximum 8 hours flight time) and that there would be at least 9 hours rest period (including the hours 2200 to 0600) prior to a tour of duty. It also stated:

> For planning purposes, a minimum allowance of 45 minutes shall be added before the scheduled departure time and 15 minutes after the anticipated duty time finish to allow for pre-flight and post-flight activities.

The pilot logged duty time (or tour of duty) each day as being from about 45 minutes prior to their first flight until 15 minutes after their last flight. The additional duty performed prior to the 45 minutes before the first flight and more than 15 minutes after their last flight was not included in the pilot's recorded duty times. The ATSB noted that, although the recorded duty times did not include all the pilot's work-related activity (which was not consistent with good fatigue management practice), the full duty times still appeared to be within the limits set by CAO 48.1 (*Flight time limitations – pilots*) and there was minimal potential for fatigue to have existed at the time of the accident.[11]

[11] In September 2016, the Civil Aviation Safety Authority (CASA) conducted a surveillance event that included a review of the operator's flight and duty time records. The surveillance found the flight and duty time records to be satisfactory.

Aircraft information

General information

The EC120B is a five-seat, light utility helicopter, powered by a single turboshaft engine. It has a 3-bladed main rotor head and a Fenestron anti-torque tail rotor. The helicopter was certified under the European Joint Aviation Regulations in 1997.

At the time of the accident, there were 24 EC120B helicopters on the Australian civil aircraft register, including two operated by Whitsunday Air Services: VH-HIL and VH-WII (the helicopter involved in the accident).

VH-WII was manufactured in France in 2009 and was first registered in Australia on 18 February 2010. It had accumulated about 1,415 hours total time in service. Whitsunday Air Services had operated the helicopter since 19 May 2015.

VH-WII had a current certificate of registration and certificate of airworthiness. Although the original copy of the current maintenance release was on board the helicopter and was therefore unable to be viewed by the ATSB, the maintenance provider supplied copies of the maintenance release paperwork. The last periodic inspection (required every 100 flight hours or every 12 months) was completed on 24 January 2018. Since then, the helicopter had accrued about 60 hours flight time.

The pilot who flew the aircraft on 21 February 2018 reported that the starter was drawing a high current on engine start and the vehicle and engine multifunction display (VEMD) was supplying a spurious reading of the main rotor RPM. The helicopter was flown to a maintenance facility on 14 March where the starter generator was replaced on 16 March.

The pilot of the accident flight was the only pilot who flew the helicopter following the 16 March maintenance. This included the 0.3 hour ferry flight from the maintenance facility to Hamilton Island on 19 March and the first flights from Hamilton Island to Hardy Reef and return on 21 March, which arrived back at Hamilton Island at 1447.

The pilot stated that the only problem with the helicopter during these flights on 21 March was when the starter generator drew a larger than expected current from the battery during the engine start at Hardy Reef. Although it was within limits, the pilot needed to ensure the helicopter would not be stranded at the pontoon on the next flight, and therefore requested a portable auxiliary power unit (APU) be loaded on to the helicopter. The APU would provide back-up battery power to start the helicopter, if required, at the pontoon.

Flight controls

The helicopter had standard primary flight controls; that is, cyclic, collective, and tail rotor anti-torque pedals. It was equipped with a single hydraulic system, which assisted main rotor movement through three hydraulic servos. The tail rotor was not hydraulically assisted.

Pilot controls for the front left seat were removed and this seat was used as a passenger seat only.

Fenestron tail rotor

The EC120B was equipped with a Fenestron tail rotor or fan-in-fin system (Figure 6). The vertical fin was designed to take the load off the tail rotor in cruise flight, and was larger than those found on helicopters with a conventional tail rotor. The fin was paired with a 0.75 m diameter, eight-bladed tail rotor.[12] The tail rotor was mounted on stators integrated into the vertical fin.

[12] A conventional tail rotor on a helicopter of a similar size would be two bladed and about 1.5 m in diameter.

These features combined to change the aerodynamics of the tail rotor, and the relative effectiveness of the anti-torque pedals for a given range of movement, when compared with helicopters with a conventional tail rotor (see *Aircraft handling characteristics*).

Because the tail rotor blades were located within a circular duct, they were less likely to strike people or objects. The helicopter manufacturer advised that the fairing around the Fenestron protected it from a direct impact with a bird, and that it had no record of a birdstrike to a Fenestron tail rotor. In addition to the EC120B, Fenestrons were also present on the manufacturer's other aircraft, such as the EC130, EC135, EC145T2 and AS365.

Figure 6: Fenestron tail rotor compared to a conventional tail rotor

Source: ATSB and supplied

VEMD and first limit indicator

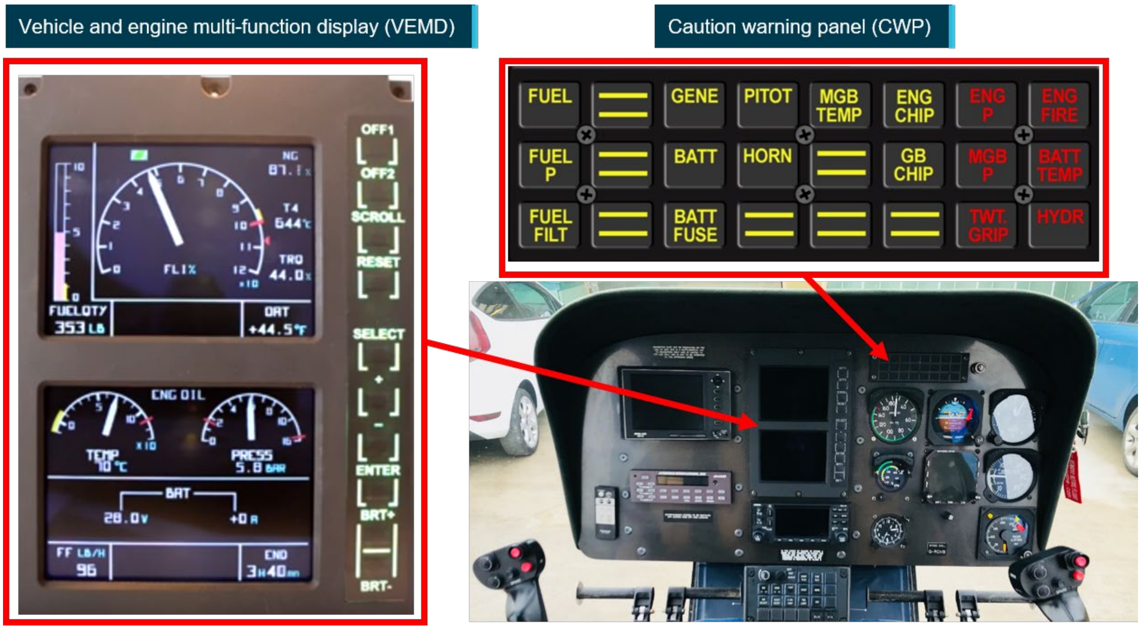
The vehicle and engine multi-function display (VEMD) presented information on various vehicle and engine parameters. Figure 7 shows the location of the VEMD and caution warning panel (CWP) on the console of the EC120B. If a pilot was looking out the front of the helicopter, the VEMD would be in their bottom left peripheral vision.

The VEMD had three main phases of operation:

- ground mode (prior to engine start),
- flight mode (engaged after the pilot started the helicopter and the gas producer climbed to 60 per cent)
- shutdown.

During ground mode, the three dials of the engine page (gas producer speed, engine temperature and torque output) were shown in the upper window. During flight mode, the first limit indicator (FLI) was displayed. The VEMD computed and displayed the FLI by processing data from the three separate sensors. Instead of the pilot monitoring the three dials separately, the FLI presented this as a single gauge (on the flight page). The pilot could still monitor the individual engine parameters using a scroll button on the collective to select the engine page.

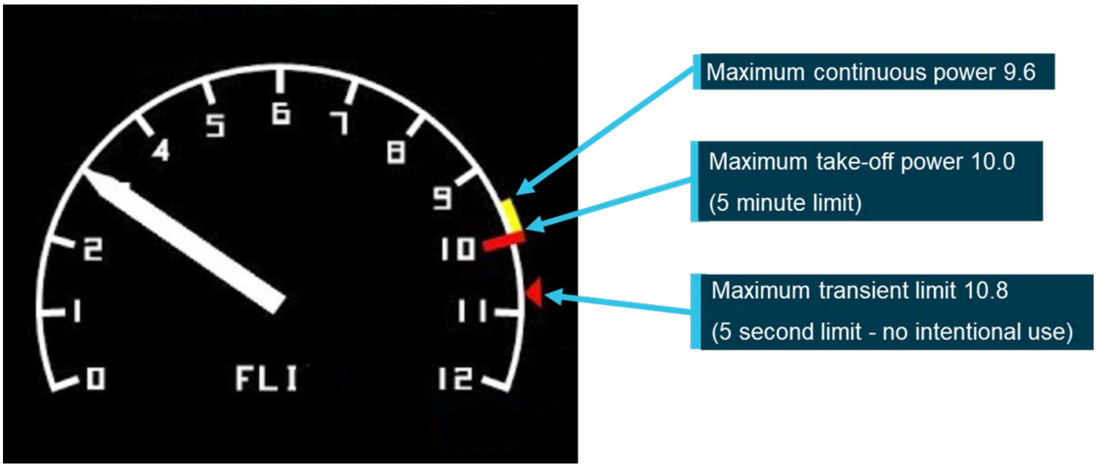
Figure 7: VEMD and CWP



Source: ATSB

The FLI included markings related to relevant power limitations, as shown in Figure 8. The gauge up to the start of the yellow bar at 9.6 indicated the range of power that the pilot could use during normal operations. Beyond the maximum continuous power of 9.6 was the yellow range, which denoted take-off power. This range ran up to 10.0 (maximum take-off power) and the pilot was permitted to use power in that range for no more than 5 minutes. The pilot was not permitted to intentionally use power above 10.0, which was denoted by the red line on the gauge. Inadvertent use in this range did not carry a maintenance requirement if the incursion lasted less than 5 seconds and did not exceed 10.8, which was marked by the red triangle.

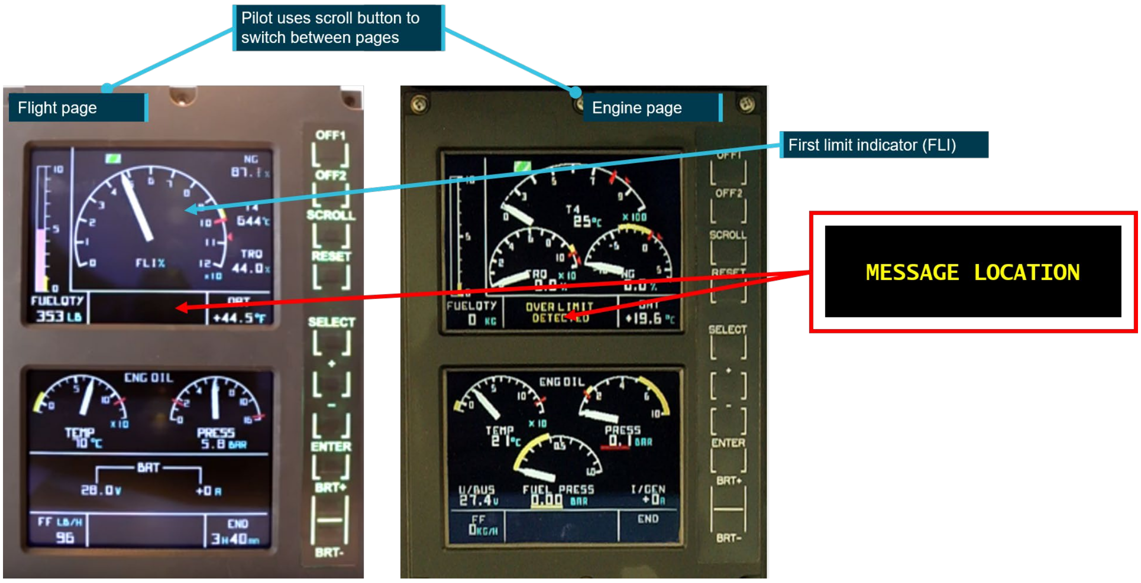
Figure 8: Flight limit indicator (FLI) showing power limitiations



Source: Airbus Helicopters

To ensure the accuracy of displayed information, the VEMD computed data in two lanes. Each lane took an input and made calculations based on the helicopter's current state and operating limits. The two lanes compared their results and, if the lanes agreed, the VEMD displayed the information. If the lanes disagreed, the VEMD displayed a message to the pilot. Depending on which parameter the lanes disagreed on, the FLI could fail and the VEMD revert to displaying the individual engine gauges from the engine page (Figure 9).

Figure 9: VEMD showing flight page, engine page and location of message display



Source: ATSB

The VEMD could display messages concerning the function of the VEMD itself, or engine and vehicle parameters (Figure 9). For example, it would display a message if a parameter was approaching a limit and that parameter was not currently displayed on the VEMD. Table 2 identifies the possible VEMD messages that could occur in the flight phase.

The VEMD also recorded the messages displayed. The unit's memory allowed it to store 256 of the most recent failures, the last 32 overlimits and the last 8 power checks. If the unit was able to be recovered, then it is likely that the displayed message would have been identified.

Table 2: VEMD messages

Message	Meaning and pilot required action
FLI FAILED - - - > CHECK PARAM	The computer cannot read an engine parameter and can no longer calculate data for the FLI. The VEMD will change to the engine page. Pilot action: monitor the engine instruments individually from the engine page.
GENE PARAM OVER LIMIT	Generator parameter over limit (voltage or current). Pilot action: check parameters.
BAT PARAM OVERLIMIT	Battery parameter over limit (temperature, voltage or current). Pilot action: check parameters.
VEH PARAM OVERLIMIT	A parameter on the vehicle page and not currently displayed has reached a yellow or red limit: engine oil temp and pressure, current and voltage. If red, an aural alarm will sound and a warning illuminate on the CWP. Pilot action: use the scroll button to change screen and check parameters.
ENG PARAM OVERLIMIT	A parameter on the engine page and not currently displayed has reached a yellow or red limit: gas producer speed (Ng), engine temperature (T4), engine torque (TQ). If red, an aural alarm will sound and a warning illuminate on the CWP. Pilot action: reduce power to within limits, use the scroll button to change the screen and check parameters.
BRT CNTRL FAILED	Brightness control has failed. Pilot action: consider implications for night flight or even flight over water if there was glare.
LANE (1 OR 2) FAILED - - - > PRESS OFF (1 or 2)	One of the two VEMD modules has failed, and the affected screen goes blank. Pilot action: turn off lane 1 or lane 2.
CROSS TALK FAILED - - - > PRESS OFF 2	Two systems comparing data for self checking can no longer compare. Pilot action: switch off lane 2.
GPS NOT AVAILABLE	VEMD configured for GPS but cannot read data from it.
FLI VALID - - - > PRESS RESET	Computer has recovered and FLI can be used again. Pilot action: press reset to display.
OVER LIMIT DETECTED	Limit exceeded on the previous flight.

There were no VEMD messages that indicated an emergency or required immediate action by the pilot, unless the message was accompanied by a warning on the helicopter's CWP.

As the VEMD relied on a wide array of sensors, both digital and analogue, it could be associated with faults from time to time. Maintenance documentation showed that the VEMD unit installed in VH-WII had recently (January 2018) presented problems by indicating erroneous high main rotor RPM. Troubleshooting was carried out by maintenance personnel with no faults identified.

The pilot of the accident flight recalled the following in relation to the VEMD just prior to initiating the go-around:

- a message was displayed
- the screen changed from the FLI page to the engine page (but did not go blank)
- no alarms were heard or displayed on the CWP
- maximum take-off power was used and no limits were exceeded.

The passengers also reported that they heard no alarms and saw no obvious warning lights during the go-around.

It could not be determined for certain which VEMD message was displayed just prior to the initiation of the go-around. However, based on the available information it is most likely that the message was one of the following:

- FLI FAILED - - - > CHECK PARAM
- GENE PARAM OVERLIMIT
- VEH PARAM OVERLIMIT

- ENG PARAM OVERLIMIT.

As already noted, some VEMD messages could be accompanied by an alarm and a warning message on the CWP. It is also possible that one of the engine parameters could have gone into the yellow range, resulting in a VEMD message but not triggering a warning on the CWP. An EC120B subject matter expert advised that the gas producer (Ng) would likely be the first limit met.

In summary, in the absence of other warnings, no immediate action was required by the pilot in response to the VEMD message, regardless of which message was displayed.

Engine performance

The EC120B is powered by a single Turbomeca Arrius 2F gas turbine engine. The engine in VH-WII was the original engine installed at manufacture and had accrued about 1,415 hours total time in service. The engine manufacturer's time between overhaul period for the engine fitted to VH-WII was 3,000 hours.

A Filter Development Corporation (FDC) Aerofilter series 1120 inlet barrier filter (IBF) was installed on the helicopter at 102.4 hours, under a supplemental type certificate approved by the US Federal Aviation Administration (FAA). An IBF is utilised to protect engine components from erosion and damage, especially in salty and dusty environments. Although an IBF performs a useful role, it also restricts airflow to an engine, reducing the engine's performance.

To monitor the overall condition of the engine, engine health checks were routinely conducted. During such checks, the recorded figures could be plotted manually or calculated automatically by the VEMD.[13] The results would give a power (torque) margin (displayed as TRQ MARGIN and expressed as a percentage) and a temperature margin (displayed as T4 MARGIN and expressed in °C). These provided a measurable tolerance of the actual engine power available, compared to the power of a minimum specification engine, for a given set of parameters. The engine health check was satisfactory if the torque margin was positive and the temperature margin was negative.

The results of an engine health check could also be plotted consecutively on a graph to enable trend monitoring of the engine performance to be achieved. Such a graph provided a visual picture of any degrading power figures over time.

Regular engine health checks on VH-WII were performed in flight during normal operations by the operator's pilots and during routine maintenance. The power checks recorded by the pilots did not include environmental data to enable accurate plotting. The power checks carried out during maintenance were recorded and did include sufficient data to enable plotting. The operator did not collate and plot the results of power checks for engine trend monitoring purposes.

Figure 10 shows the engine performance data for torque margin retrieved from the operator's maintenance documentation and plotted by the ATSB. As indicated in the figure, there was a gradual decline in engine performance over the life of the engine. The torque margin, with IBF fitted, dropped below 0 per cent on two occasions (March 2017 and January 2018).

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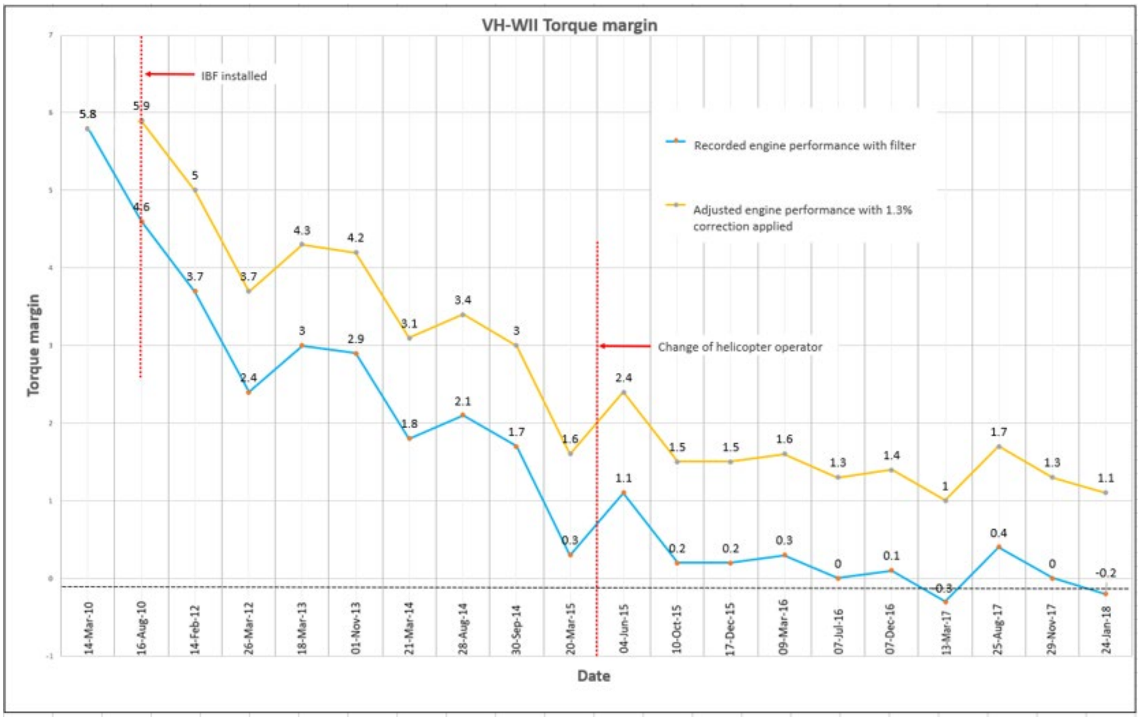
[13] The VEMD had a facility to conduct engine power checks. In flight, the pilot could select power check mode and follow the prompts on the VEMD. The VEMD would monitor airframe and engine parameters and calculate engine temperature and torque margins. Once calculated, the results describing the engine performance were displayed on the VEMD screen.

Figure 10: Plotted engine power checks for VH-WII showing degrading engine power



Source: ATSB

The ATSB asked the IBF manufacturer what maintenance action was required to be taken if a power check result was below the minimum required by the rotorcraft flight manual (RFM). The IBF manufacturer advised that, in accordance with the rotorcraft flight manual supplement (RFMS) section on engine performance:

> the first time a power check result is 'BAD' [torque margin below 0 per cent], maintenance action is supposed to be performed. However, the action may only be in the form of inspections and troubleshooting steps. Operators are then permitted to add a correction of 1.3 per cent and reduce aircraft performance per the RFMS.

The RFMS stated that if the IBF was determined to be the cause of the power to fall below the specified limits, then it was permissible to continue operating using the performance limitations and adding the 1.3 per cent correction.

The IBF manufacturer confirmed that adding 1.3 per cent to the performance results provided a more accurate picture of engine health. However, reductions in hover in ground effect[14] (HIGE) gross weight, hover out of ground effect (HOGE) gross weight, and rate of climb were required when this torque margin correction was used.[15]

Prior to Whitsunday Air Services acquiring VH-WII, the previous maintenance organisation had performed a series of troubleshooting procedures in March 2015 when the torque margin dropped to just above 0 per cent (Figure 10), and it determined that the filter was the cause of the low torque margin.

After the change of ownership, the new maintenance organisation continued to add the 1.3 per cent correction to the torque margin to obtain the corrected figures on each power check, including those with a torque margin below 0 per cent.

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[14] Ground effect: when flying close to solid ground, the helicopter's downwash stops at the surface, reducing the vertical velocity of the air passing through the helicopter's main rotor. Slowing the vertical velocity improves efficiency of the rotor system, and reduces the power required to produce rotor thrust. Operating out of ground effect negates that benefit, and requires more power to produce an equivalent level of rotor thrust.

[15] None of these restrictions had any applicability to the accident flight.

The maintenance provider's most recent power check was performed at the periodic inspection on 24 January 2018. The results indicated a torque margin of -0.2 per cent. The maintenance organisation added the 1.3 per cent correction, resulting in an adjusted torque margin of 1.1 per cent. No additional troubleshooting or maintenance actions were conducted and, according to the IBF manufacturer, no such actions were required.

The helicopter manufacturer advised that it did not support the use of data from the VEMD's power check function to assess the effective torque margin with an aftermarket IBF fitted. It also stated that the IBF manufacturer had not activated a technical agreement with the helicopter manufacturer for the development and certification of the IBF.

Fuel

The helicopter had two crashworthy fuel bladder tanks with a total capacity of 410.5 L and a useable capacity of 406 L.

The pilot reported wanting to keep the helicopter fuel load relatively low, given their inexperience on the helicopter type. They therefore had the helicopter refuelled to about 50 per cent capacity prior to the accident flight, or about 204 L of useable fuel.[16] This included 69 L of fuel added at Hamilton Island just prior to the flight.

The operator's flight records showed that VH-WII consumed Jet A1 turbine fuel (avtur) at a rate of about 128 L/hour during the flights between Hamilton Island and Hardy Reef, whereas the operator's other EC120B helicopter consistently consumed about 120 L/hour. The pilot reported using 120 L/hour for fuel planning for the accident flight.

The flight time for the journey from Hamilton Island to Hardy Reef was planned to be 36 minutes, and therefore the pilot was expecting a total fuel burn of 72 L. This meant that on landing at Hardy Reef there would be about 132 L of useable fuel remaining. This was sufficient fuel to allow for the required fuel reserve (20 minutes plus 10 per cent flight time) and other fuel planning requirements.

Prior to the accident flight, the helicopter was refuelled from a fixed facility at Hamilton Island Airport. Five of the operator's other aircraft refuelled from the same facility on 21 March 2018, with no problems identified. The helicopter was also previously refuelled (the night before the accident flight) from the same facility.

The chief pilot advised that the operator had pre-positioned jerry cans containing avtur and avgas at the pontoon if a 'top-up' was required or if there was a requirement for emergency fuel. The fuel contained in the jerry cans was not intended to be used as planned fuel.

The daily flight records for the operator's two EC120B helicopters showed that the helicopters were refuelled from the jerry cans on a routine though not daily basis. This was often conducted if the helicopter was used for short scenic flights at the pontoons prior to returning to Hamilton Island. VH-WII was last refuelled from these jerry cans with 60 L of fuel on 14 March 2018.

The average fuel load on departure for the trip from Hamilton Island to Hardy Reef in the operator's EC120B aircraft with four passengers over the previous month was 66.3 per cent (269 L). The pilot reported expecting to add fuel from the jerry cans at the pontoon for the return flight, given the lower than normal fuel load taken for the flight over.

Weight and balance

The basic empty weight of the helicopter (including unusable fuel) was 1,155.30 kg and the maximum all-up weight was 1,715 kg.

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16 The last calibration of the helicopter's fuel quantity indicator, conducted in March 2017, found that a 50 per cent indication equated to 204 L of useable fuel, slightly more than half the total useable fuel capacity (203 L). Based on all the available documentation, the estimated fuel on board after refuelling was consistent with a 50 per cent fuel load.

The pilot conducted pre-flight weight and balance calculations on a mobile device with an application designed for that purpose. The mobile device was unable to be recovered, and the data was not stored remotely. The pilot recalled that the helicopter was well within the relevant weight and balance limitations.

The pilot was able to recall some of the figures used in the weight and balance calculations, and some of these figures were obtained from other sources. An estimate of the helicopter's weight based on the pilot's recalled figures is as shown in Table 3. With regard to these figures:

- The pilot was supplied a total weight for the four passengers of 301 kg prior to arriving at Hamilton Island, and was provided with their individual weights on a passenger manifest after arriving at Hamilton Island. These were the passengers' volunteered or self-declared weights.
- The pilot believed that the passengers had two or three small bags, which were placed in the baggage compartment, and believed that the portable APU was about 5 kg. However, the weight the pilot used for baggage could not be determined.
- The pilot recalled that there was about 50 per cent fuel on board (or 161.2 kg) after refuelling. After allowing for a small amount of fuel burn for taxiing and then operating on the ground to load passengers, the amount of fuel on board would have been slightly lower at take-off (about 48 per cent or 156.2 kg).

The ATSB recalculated the helicopter's weight using the weights of the two deceased passengers determined during post-mortem examinations, the weights of the other occupants based on their statements, the weight of the passengers' baggage based on descriptions provided by the surviving passengers, the weight of life jackets and headsets, and the weight of the portable APU based on information about the model supplied by the operator. These calculations showed that the helicopter was about 25 kg above the maximum all-up weight at take-off at Hamilton Island, and about 27 kg below the maximum all-up weight at the time of the go-around at Hardy Reef.

One of the differences between the pilot's estimates and the ATSB estimates was with the passenger weights, with one of the passenger's weighing 10 kg more at post-mortem than their volunteered weight. The other major differences related to the weight of the portable APU being 13.6 kg (8.6 kg more than the pilot's estimate) and the passenger's baggage and other items not being effectively considered (18.7 kg total), including 9.5 kg in the cabin (which included about 4 kg for life jackets and headsets).

Further information regarding the operator's processes for determining a helicopter's weight, including the weights of passengers, is provided in *Helicopter loading information*.

Table 3: Pilot estimated and ATSB estimated weights (kg)

Item	Pilot estimate	ATSB estimate	Difference
Basic empty weight	1,155.3	1,155.3	
Pilot seat	85.0	85.0	
Font left seat	59.0	60.0	1.0
Rear left seat	79.0	79.0	
Rear middle seat	95.0	105.0	10.0
Rear right seat	68.0	68.0	
Items in the cabin	0	9.5	9.5
Items in baggage compartment (including portable APU)	(at least) 5.0	22.8	17.8
Zero fuel weight	1,546.3	1,584.6	38.3
48% fuel (196 L)	155.2	155.2	
Weight at take-off	**1,701.5**	**1,739.8**	**38.3**
Max all-up weight	1,715.0	1,715.0	
Margin at take-off	13.5	-24.8	
Fuel burn (0.6 hours flight)	56.9	60.7	
Fuel remaining on arrival	104.3	100.5	
Weight at landing	**1,650.6**	**1,685.1**	**34.5**
Margin at landing	64.4	26.8	

As the take-off weight was greater than 1,715 kg, standard flight manual charts could not be used to determine performance. Instead, the charts from the flight manual supplement *External Load Transport "Cargo Sling"* were used to determine centre of gravity limits and out of ground effect hover performance, as these charts extended to a maximum all-up weight of 1,800 kg.[17] Using these charts, VH-WII was within centre of gravity limits for external load operations at 1,745.8 kg (take-off). On arrival at Hardy Reef, the helicopter was also within centre of gravity limits.

Helicopter performance planning

The pilot reported that, while manoeuvring close to the ground on the apron at Hamilton Island for the 1501 take-off, the FLI showed the helicopter power used was at the first red marker (denoting maximum take-off power, Figure 8), and they were able to slowly turn the helicopter into wind. This description implies that maximum power was required to hover at the 15 ft elevation of Hamilton Island Airport in similar meteorological conditions to those that existed at the pontoon.

The manufacturer provided performance charts to assess the ability to hover in ground effect (HIGE) and hover out of ground effect (HOGE). Water and mesh surfaces do not provide the same level of ground effect as solid surfaces. Therefore, to hover at a mesh pontoon over water would require using the HOGE performance charts, as they were more conservative and the only available alternative.

Performance charts in the flight manual (for external load) stated that at 1,745.8 kg an EC120B helicopter should have been able to hover at a pressure altitude of up to 1,800 ft. When arriving at the pontoon at 1,685.1 kg, an EC120B helicopter should have been able to hover at a pressure

[17] The external load charts were used only for investigative purposes as no other options were available for the weight of the helicopter; such charts are not able to be used for operations without an external load.

altitude of about 3,000 ft.[18] Based on these figures, the helicopter should have had sufficient performance to conduct operations at the pontoons.

Although flight manual charts are used to determine performance, they cannot replicate the actual conditions at the time of the accident. Such charts are based on nil wind conditions, whereas the pontoon had a crosswind of 20 kt, which provides translational lift.[19] The manufacturer also advised that a crosswind implies a certain amount of extra power is necessary to ensure controllability (see also *Effect of direction of approach and landing*).

Aircraft handling characteristics

Role of anti-torque pedals

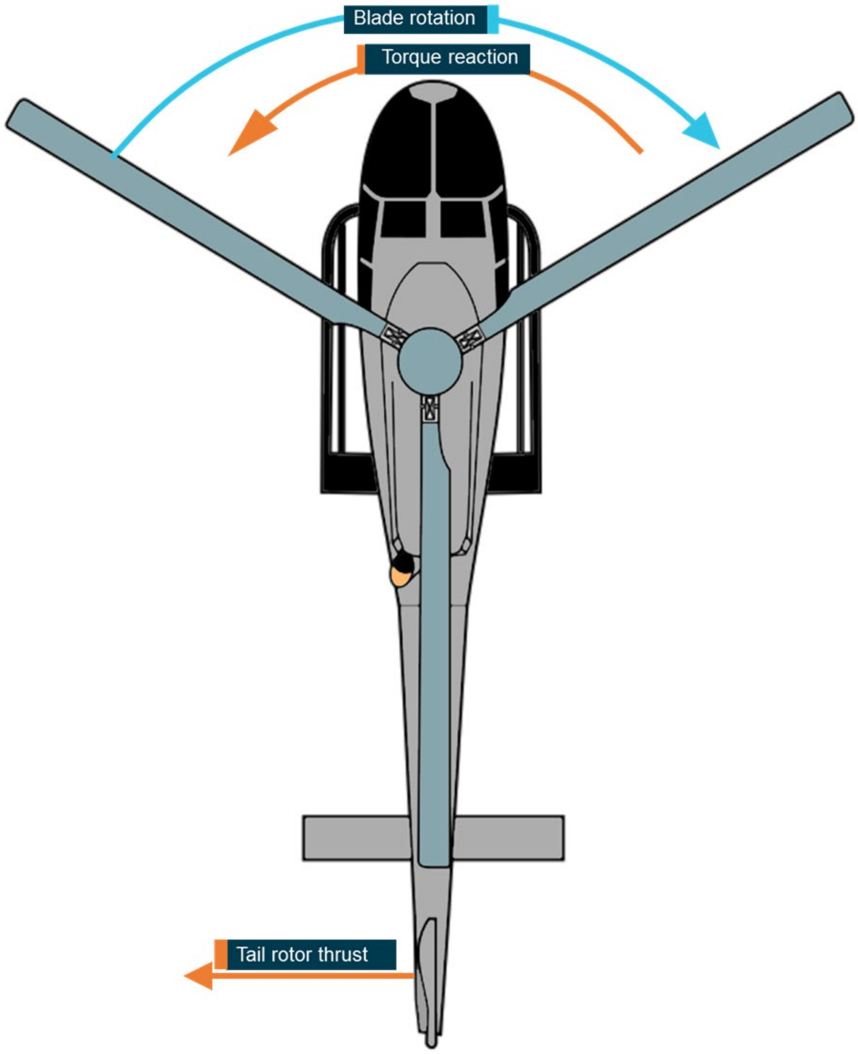
The main rotor on the EC120B rotated clockwise, consistent with many helicopters manufactured in Europe. In contrast, the main rotor of the R44, Bell 206 and most helicopters manufactured in North America rotated in an anti-clockwise direction.

As the main rotor is driven from a central point, a torque reaction causes the fuselage of the helicopter to yaw in the opposite direction to the main rotor's rotation (Figure 12). In the case of the EC120B, this torque reaction means the helicopter will yaw to the left with power applied. The force to resist the yaw is produced by the tail rotor. Tail rotor thrust can be increased by pushing the right anti-torque pedal to force the nose to the right.

[18] For an air pressure of 1,009 hPa (present about the time of the accident), actual heights of these figures above mean sea level would have been 120 ft lower.

[19] Translational lift: occurs when clear, undisturbed air, flows through the rotor system from wind or forward speed. It helps a helicopter produce thrust for less power. The effect increases with airspeed from about 12 kt to 15 kt before being overcome by parasite drag at about 50 kt.

Figure 11: Direction of blade rotation for the EC120B



Source: ATSB

When a pilot demands power from the engine to generate lift, the torque reaction and yaw to the left will increase. The heavier the helicopter, the higher the power required to generate sufficient lift. Therefore, the pilot will need more right pedal to prevent unwanted yaw.

With experience in a helicopter, pilots learn to automatically apply the exact amount of pedal required, and will anticipate and adjust the amount of pedal, for any given power setting. Pilots require a period of repetition and practice to develop this automatic process.

In helicopters with counterclockwise-rotating main rotor systems (such as the R44 or Bell 206L3), as power is increased the nose will yaw to the pilot's right. Therefore, the pilot must divert power to the tail rotor with the left pedal to keep the aircraft straight.

When pilots transition from one type of helicopter to another, an automatic pedal input may produce undesirable results. A common solution to this problem is for pilots to initially look outside the helicopter for visual cues of yaw and apply the appropriate pedal input to maintain the desired heading. This reduces the chance of an incorrect input yet increases the time taken to make an appropriate pedal input.

In cruise flight, the pilot can expect the vertical fin to provide some of the thrust required to counteract the torque reaction from the main rotors. The faster the helicopter travels, the greater the thrust generated by the fin. At lower speeds the fin's effectiveness is reduced, and use of the anti-torque pedals becomes more important.

Fenestron tail rotor

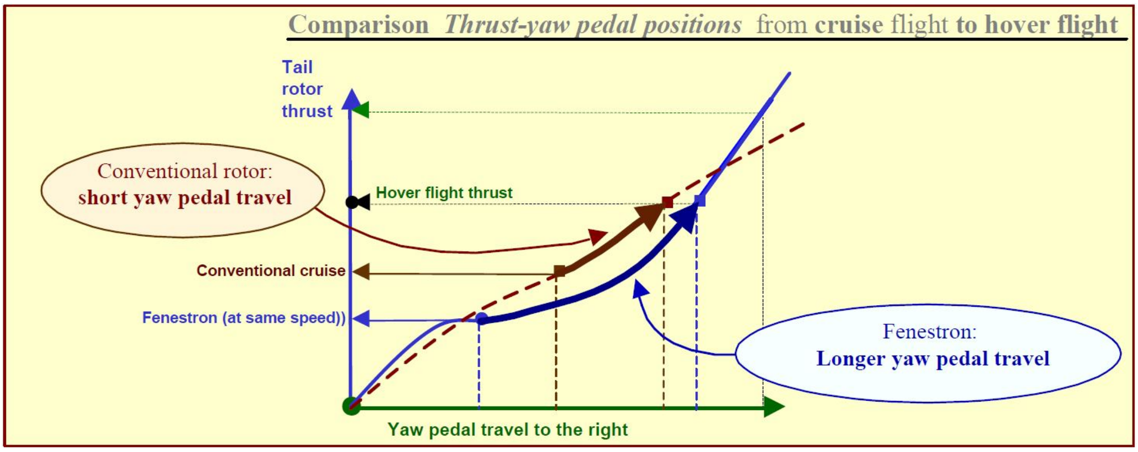
Fenestron tail rotors are used mainly on French-designed helicopters, which have clockwise-rotating main rotors. They are less commonly found on helicopters with counterclockwise-rotating main rotor systems.

In 2005, Eurocopter released Service Letter 1673-67-04 (*Reminder concerning the YAW axis control for all helicopters in some situations*).[20] The service letter reminded pilots that Fenestron tail rotors required significantly more pedal travel then conventional tail rotors when transitioning from forward flight to a hover. It stated:

> With a Fenestron, when changing from cruise flight to hover flight, be prepared for a significant movement of the foot to the right. Insufficient application of pedal would result in a leftward rotation of the helicopter during the transition to hover.

Figure 12, from Service Letter 1673-67-04, shows the pedal input required for both a conventional and Fenestron tail rotor.

Figure 12: Relative pedal travel for conventional and Fenestron tail rotors



Source: Eurocopter

The European Aviation Safety Agency (EASA), in its Operational Evaluation Board (OEB) report of the EC120B in 2012 (see *European requirements for an EC120B type rating*), stated:

> - …conventional tail rotors work more in cruising flight, as the fins surfaces are smaller. For the Fenestron, in cruise flight, the fins are designed to release anti-torque…
> - Fenestron requires greater pedal travel entering hover, but is not less efficient once in hovering.
> - Avoid high rate of turn during ground manoeuvres (e.g. 360°), particularly to the left, since you would need a great pedal travel, and therefore a big amount of power to stop the motion, leading to a risk of over-torque [of the engine].

Manufacturer's guidance on unanticipated yaw (2005)

The helicopter manufacturer's 2005 Service Letter 1673-67-04, issued for helicopters with clockwise-rotating main rotors, stated (with emphasis as per the original document):

> **The analysis of the causes of severe helicopter incidents or accidents leads EUROCOPTER to issue a few reminders as regards YAW axis control in some flight situations.**
>
> **1 - BACKGROUND**
> Various events which occurred during flight near the ground and at very low speed in light wind

[20] Service letter 1673-67004 was superseded in 2020 by IN 3539-I-00 GENERAL - *Fenestron versus Conventional Tail Rotor (CTR) for helicopters equipped with a main rotor rotating clockwise when seen from above.*

> conditions on aircraft fitted either with conventional tail rotors or with Fenestrons, took place as follows:
>
> From hover flight at take-off at very low speed, the Pilot initiates a left turn a few meters above the ground by applying yaw pedals towards the neutral position: the aircraft starts its rotation which increases until the Pilot attempts to stop it by applying the RH yaw pedal.
>
> In the various cases which resulted in the loss of yaw axis control, the action applied to the RH yaw pedal was not enough (amplitude/duration) to stop rotation as quickly as the Pilot wished.
>
> As the aircraft continues its rotation, the Pilot generally suspects a (total or partial) tail rotor failure and decides either to climb to gain speed or to get closer to the ground…
>
> **The investigations carried out following such events have never revealed any defect as regards flight controls and tail rotor assembly.**
>
> **Furthermore, given their altitude and weight conditions the tail rotors were far from their maximum performance limits.**

Guidance in the service letter included:

> In a quick leftward rotation, if the Pilot attempts to counteract this rotation by applying the RH yaw pedal up to a position corresponding to that of hover flight, the aircraft will not decelerate significantly!
>
> In this situation, immediate action of significant amplitude applied to the RH yaw pedal must be initiated and <u>maintained</u> to stop leftward rotation. <u>Never hesitate to go up to the RH stop</u>.
>
> Any delay when applying this correction will result in an increase in rotation speed…
>
> …any intentional manoeuvre to initiate leftward rotation in hover flight conditions or at very low speed, must be performed through a <u>moderate action</u> on the LH yaw pedal!

Manufacturer's guidance on unanticipated yaw (2019)

Airbus Helicopters issued Safety Information Notice 3297-S-00 (*Unanticipated left yaw (main rotor rotating clockwise), commonly referred to as LTE*) in July 2019. Although not available at the time of the accident involving VH-WII, this notice outlined a detailed explanation of the phenomenon of unanticipated yaw due to insufficient pedal application. The full notice is provided in Appendix B, and details of some related accidents are provided in Appendix C.

The notice defined unanticipated yaw as an 'uncommanded rapid yaw rate which does not subside of its own accord'. The notice also stated:

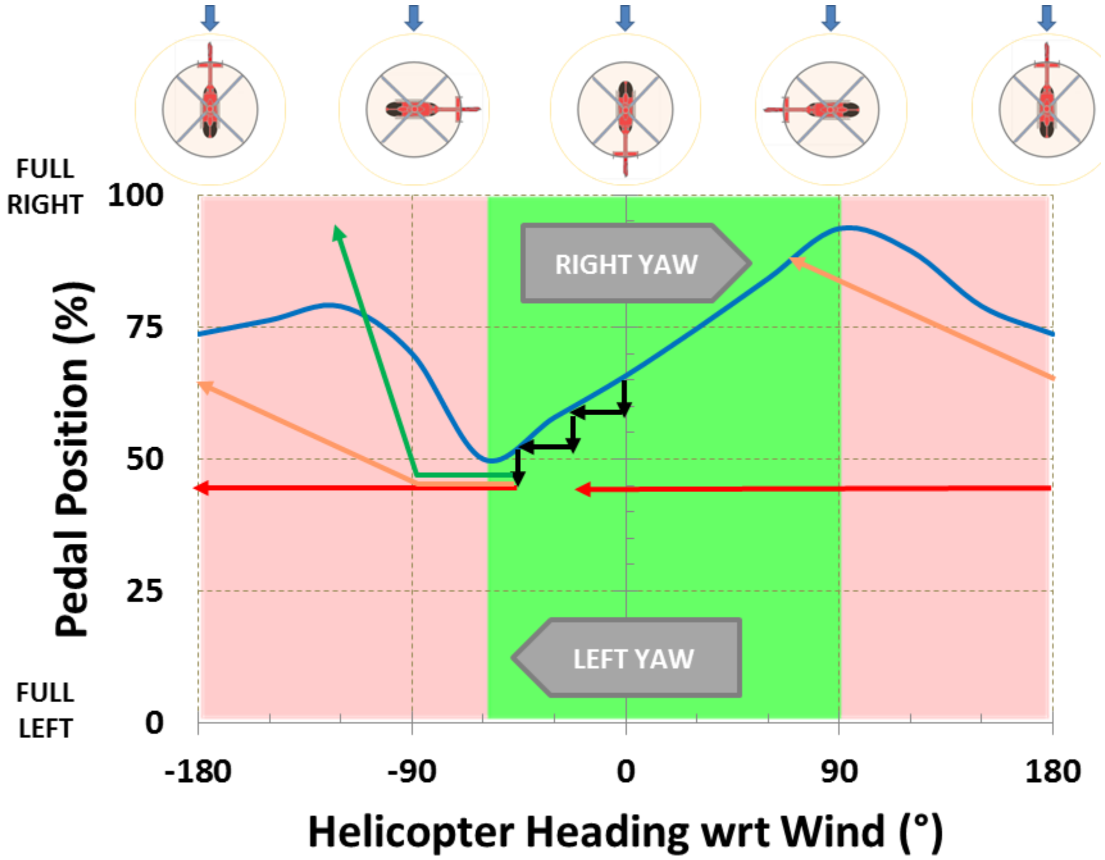
> Unanticipated yaw is a flight characteristic to which all types of single rotor helicopter (regardless of anti-torque design) can be susceptible at low speed, dependent usually on the direction and strength of the wind relative to the helicopter…
>
> Where this type of unanticipated yaw situation is encountered, it may be rapid and most often will be in the opposite direction of the rotation of the main rotor blades (i.e. left yaw where the blades rotate clockwise). Swift corrective action is needed in response otherwise loss of control and possible accident may result.
>
> However, use of the rudder pedal in the first instance may not cause the yaw to immediately subside, thus causing the pilot to make inadequate use of the pedal to correct the situation because he suspects that it is ineffective when, in fact, thrust capability of the tail rotor available to him remains undiminished. "Loss of tail rotor effectiveness" is not, therefore, a most efficient description as it wrongly implies that tail rotor efficiency is reduced in certain conditions.

Figure 13 (from the safety information notice) described areas of yaw stability and instability and the effect of different responses to an unanticipated yaw. The green region represents an area of stability, in which the helicopter, if disturbed, will return to its original heading. The red shaded areas show instability, in which the helicopter, if disturbed, will continue to rotate away from its original heading. The boundary of instability begins with wind from 60° (front right).

The graphed lines in Figure 13 represent pedal positions (vertical axis) against relative wind direction (horizontal axis). More specifically:

- The blue line corresponds to the pedal position required to maintain the same heading when in a hover; a pedal position above the blue line will rotate the helicopter to the right, and a pedal position below the blue line will rotate it to the left.
- The black arrows show that when the right pedal moves back, when in the area of stability, the nose turns left, and the pedal requirement reduces to meet the new pedal position. Once passing into the unstable region, the pedal requirement remains higher than the anti-torque pedal input.
- The red line shows that if the pedal position then remains static, the helicopter will continuously rotate to the left.
- The orange line depicts a slow but large advance of the right pedal. Under that condition, the pedal input requirement outpaces the actual pedal position and yaw control is not restored until the helicopter reaches the zone of stability. With the requirement outpacing the pedal input, the pilot may believe the tail rotor is not producing thrust, and conduct a response to a tail rotor emergency rather than apply full right pedal input.
- The green line depicts what the manufacturer wants the pilot to do if unanticipated left yaw is encountered; use full right pedal without delay. This will return yaw control to the pilot in the shortest time possible.

Figure 13: Recovery from unanticipated yaw



Source: Airbus Helicopters

The safety information notice highlighted that full right pedal was necessary for diagnosing a potentially more serious problem of loss of tail rotor thrust:

> Only full right pedal input will make the required difference and enable the pilot to identify whether he is experiencing unanticipated yaw or full loss of tail rotor thrust (due to malfunction) and, as a result, enable him to take the most appropriate action.

The notice also discussed the nature of unanticipated yaw when the helicopter was performance limited. It stated:

> In pure hover, about 10% of the total power is spent on the tail rotor. Applying full right pedal can more than triple the tail rotor power consumption. When the helicopter is power-limited (engine or [main rotor gearbox] torque limit), it is possible that full pedal cannot be reached while staying inside the helicopter's performance limitations.

This means that, at a certain point if maximum take-off power is reached, a pilot will not be able to use the right pedal without exceeding engine limitations. The manufacturer went on to say:

> If the power is available, applying full right pedal means an over-torque resulting in only maintenance actions rather than loss of control and possible accident…

The manufacturer’s guidance also provided a summary of how to avoid unanticipated yaw and what to do if it occurred:

- Take particular care when wind comes from the right side or forward-right quadrant. Do not fly unnecessarily in those conditions.
- Prefer, as much as possible, yaw maneuvers to the right, especially in performance-limited conditions. It is easier to monitor the torque demand at the start of the maneuver than when responding to an abrupt unanticipated yaw.
- To make a yaw maneuver, apply a low angular rate of turn and closely monitor it. Yaw acceleration will be more obvious than during an aggressive maneuver.
- If unanticipated yaw occurs, react immediately and with large amplitude opposite pedal input. Be ready to use full pedal, if necessary. Do not limit yourself to what you feel sufficient, your feeling can be wrong. Never bring the pedal back to neutral before the yaw is stopped.

Operator guidance on unanticipated yaw

The operator’s operations manual included a section on unanticipated yaw, which stated:

> **UNANTICIPATED YAW**
>
> Will usually occur in slow or hovering flight and again usually in tail wind or rear quarter tail wind conditions.
>
> If sudden unanticipated yaw occurs the recommended recovery technique is:
>
> - Apply full opposite pedal.
> - Apply forward cyclic to gain airspeed and if possible reduce collective to unload the effort required at the tail rotor and to ensure that it is operating in a cleaner airflow.
> - If altitude permits, reduce power.
>
> If operations require flight at or near the hover the pilot should plan an escape route, preferably into wind to account for unexpected yaw.

Other guidance on unanticipated yaw

Guidance material on loss of tail rotor effectiveness (LTE) or unanticipated yaw has also been published by several regulatory authorities and other organisations. For example, the US Federal Aviation Administration issued Advisory Circular AC 90-95 (*Unanticipated right yaw in helicopters*) in December 1995. The document, written about helicopters with counterclockwise-rotating main rotor systems, stated:

> Unanticipated right yaw, or loss of tail rotor effectiveness (LTE), has been determined to be a contributing factor in a number of accidents in various models of U.S. military helicopters…[and] several civil helicopter accidents wherein the pilot lost control. In most cases, inappropriate or late corrective action may have resulted in the development of uncontrollable yaw. These mishaps have occurred in the low-altitude, low-airspeed flight regime while maneuvering, on final approach to a landing, or during nap-of-the-earth tactical terrain flying…

> LTE is a critical, low-speed aerodynamic flight characteristic which can result in an uncommanded rapid yaw rate which does not subside of its own accord and, if not corrected, can result in the loss of aircraft control…
>
> …Flight operations at low altitude and low airspeed in which the pilot is distracted from the dynamic conditions affecting control of the helicopter are particularly susceptible to this phenomena…
>
> **There is greater susceptibility** for LTE in right turns [left turns for helicopters like the EC120B with clockwise rotating main rotors]. This is especially true during flight at low airspeed since the pilot may not be able to stop rotation. The helicopter will attempt to yaw to the right [left for the EC120B]. Correct and timely pilot response to an uncommanded right yaw is critical [left yaw for the EC120B]. The yaw is usually correctable if additional left pedal is applied immediately [right pedal for the EC120B]. If the response is incorrect or slow, the yaw rate may rapidly increase to a point where recovery is not possible.

The AC noted that the problem could be exacerbated by factors such as high weight and low airspeed, as well as rapid power applications.

The US National Transportation Safety Board issued a safety alert in 2017 regarding unanticipated yaw or LTE events.[21] It included the following statements:

> In helicopters, loss of tail rotor effectiveness (LTE), or unanticipated yaw, is an uncommanded rapid yaw that does not subside of its own accord. LTE can occur in all single-engine, tail rotor-equipped helicopters at airspeeds lower than 30 knots and, if uncorrected, can cause the pilot to lose helicopter control, potentially resulting in serious injuries or death…
>
> Due to safety concerns, training for LTE is rarely done in an actual helicopter. Simulators allow pilots to practice recovery; however, the element of surprise—and the rapid yaw that pilots may experience when the helicopter encounters LTE in flight—is difficult to realistically achieve in some simulators…
>
> During the 10-year period from 2004 to 2014, the … [NTSB] investigated 55 accidents involving LTE…

Unanticipated yaw accidents

Appendix C provides details of 16 unanticipated yaw accidents from a number of countries with published investigation reports involving helicopters with a Fenestron and main rotor blades that rotated clockwise in the period from 2008–2019. Accidents were only included if they occurred at low airspeed (during landing, take-off or manouvering) and no technical problems with the helicopter were known to be associated with the loss of control.

A common feature of several of these accidents was that the pilot had a low level of experience on the helicopter type (with six having 15 hours or less and another two having about 24 hours on type). Of these eight pilots, one had more than 1,000 hours total helicopter experience, two had more than 500 hours total experience and two had more than 300 hours total experience. Other features common to multiple accidents included the helicopter being in an intentional left turn prior to the rapid yaw, and the helicopter climbing prior to the rapid yaw (or the pilot lifting the collective during the rapid yaw).

Effect of direction of approach and landing

The operator's normal practice was for the first helicopter to arrive at a pontoon to conduct an approach to the upwind end of the pontoon, into wind, then turn left to land with a right crosswind (as per Figure 3). This practice was the same regardless of whether the helicopter's main rotor rotated clockwise (EC120B and EC130) or counterclockwise (R44 and Bell 206). The second helicopter to arrive at the pontoon would land into wind (with no left turn required).

The operator stated that winds of 20 kt were 'very routine' at the pontoons, and that with a 20 kt wind, a helicopter would have translational lift and therefore more main rotor thrust for less power. In addition, the operator stated that a right crosswind for an EC120B/EC130 would take advantage

[21] NTSB Safety Alert, *Loss of tail rotor effectiveness in helicopters*, SA-062, released March 2017.

of weathervane effect[22] to reduce tail rotor thrust and reduce the risk of LTE. The helicopter manufacturer noted that a crosswind also implied that use of a certain amount of extra power was necessary to ensure controllability. The net effect of these complex interactions is not able to be readily determined.

As noted above (*Manufacturer's guidance on unanticipated yaw (2019)*), the manufacturer recommended in 2019 for helicopters such as the EC120B to make yaw manoeuvres to the right (as much as possible), especially in performance-limited conditions, due to the risk of unanticipated yaw when making yaw manoeuvres to the left.

The Civil Aviation Safety Authority (CASA) advised that the importance of conducting turns at low airspeed on the 'power pedal' (in this case the right pedal, turning opposite to the torque reaction) is taught early in helicopter pilot training. It noted that the CASA *Helicopter Flight Instructor Manual* (issue 3, March 2012) stated the following in a section on air/ground taxi and hovering turns:

> Describe the techniques for making hovering turns, and stress the following points:
>
> The effects of weathercocking must be taken into account.
>
> There can be problems with yaw control and a need for increased power when the helicopter is downwind, or crosswind, in strong wind conditions…
>
> In strong or gusty wind conditions, a turn away from into the wind should be in the opposite direction to the torque reaction (i.e. to the left in a helicopter with a counter-clock turning rotor). In this way it is possible to ensure that there is sufficient tail rotor control available. If control limits are reached at this stage, a safe return to into-wind is easily accomplished.
>
> No turns or any movements from the hover should be initiated until the helicopter is settled in an accurate hover at the required RPM and power setting…

Accordingly, CASA advised that, on this occasion with a helicopter such as an EC120B (with a main rotor that rotated clockwise), the pilot should have conducted an approach that resulted in a final right turn into crosswind.

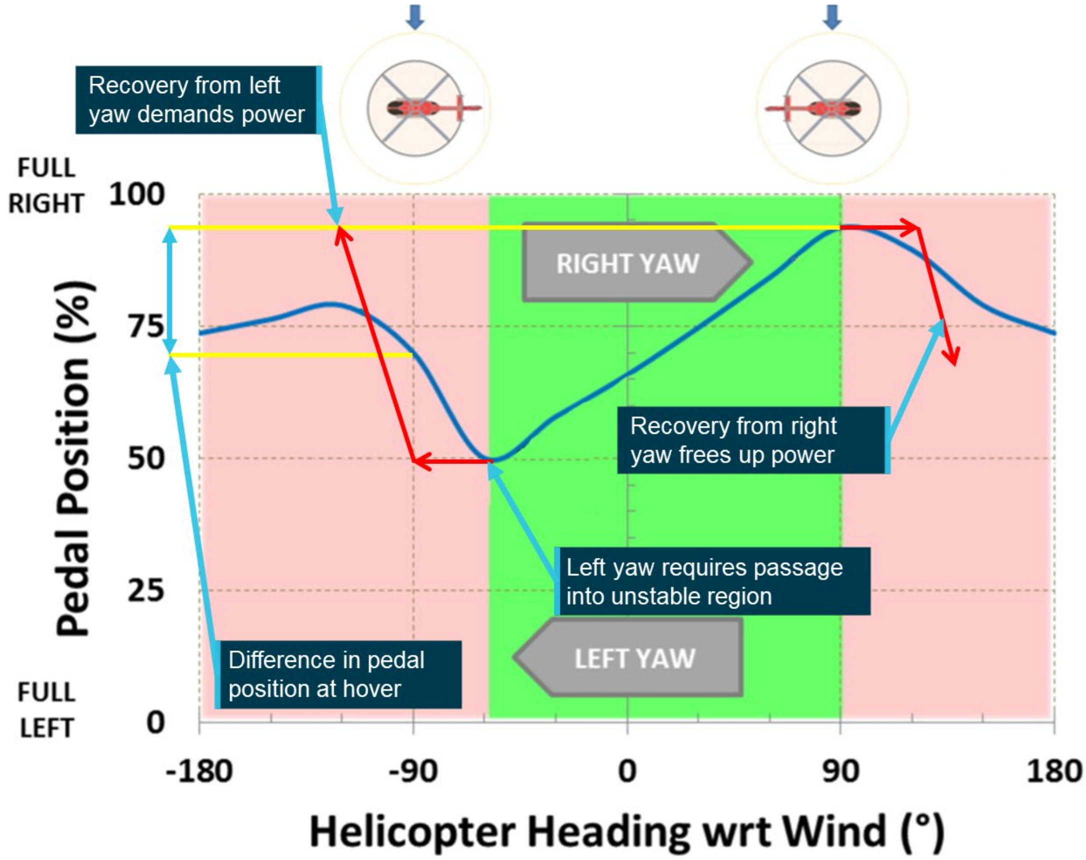
Figure 14 demonstrates that for an EC120B turning left into a right crosswind results in a smaller input on the right pedal, which means the helicopter can be landed with less total power. The trade-off is that, if a pilot is working near the limits of the helicopter's available power, and unanticipated left yaw develops during the turn, the pilot may not have enough right pedal available to counteract it. There is no simple escape route, and a recovery may require the pilot to exceed an engine limitation.

In contrast, for an EC120B turning right into a left crosswind using the right pedal, the power demand is higher. However, it is easier to monitor that power demand. If a pilot is reaching the limits of the pedal or power available, the helicopter will simply tend to yaw left into wind, and into an area of stability. Or, if the pilot needs to respond to an unanticipated yaw, the pilot can use left pedal input, which reduces the power required, to turn the helicopter towards an into-wind escape route without exceeding any limitations.

---

[22] Weathervane (or weathercock) effect: occurs when wind pushes on the empennage of the helicopter, creating a yawing moment which will tend to turn the helicopter into wind.

Figure 14: Difference between left and right crosswind recovery actions



Source: Airbus Helicopters, annotated by the ATSB

Indicative pedal positions during approach and go-around

Using data provided by Airbus Helicopters,[23] and the probable position of the helicopter determined during photographic analysis (Appendix A), the ATSB estimated the right pedal position required to manage the heading of the helicopter during various points of an approach and go-around at Hardy Reef (Figure 15).

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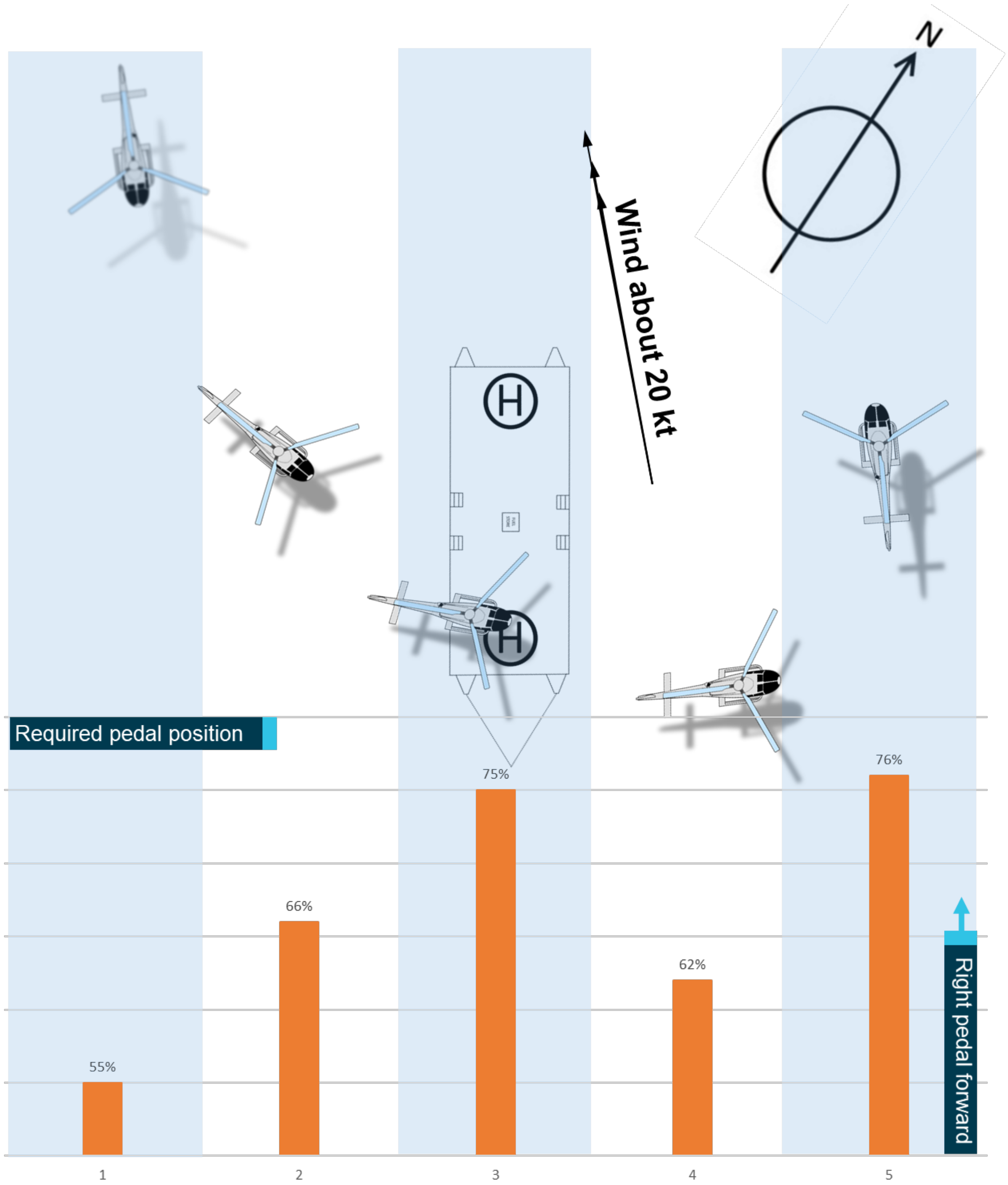
23 The provided data included pedal positions for a variety of wind speeds and directions for the helicopter's weight and the density altitude on arrival at the pontoon.

Figure 15: Indicative pedal position required during the approach and go-around (probable flight path)



Source: Airbus Helicopters, ATSB

When interpreting this figure, note that the pedal position was derived from data for a static helicopter in varying wind conditions. For example, the model for a helicopter hovering in a 40 kt headwind was used as a proxy for the helicopter approaching into wind at 40 kt airspeed. The dynamic event presented would require additional power for the management of rotational energy in the helicopter, and changing acceleration of the airframe which is not accounted for here.

The pedals are connected to each other and pivot in concert; as one pedal goes forward the other comes back. A setting of 50 per cent means the pedals are level with each other, and a setting of more than 50 per cent indicates that right pedal is further forward than left. Moving the right pedal forward increases thrust at the tail rotor, demanding more power from the engine.

In terms of the five positions shown in the figure:

(1) If approaching the pontoon into wind, as the helicopter slows through 40 kt airspeed, the pedal position required to keep the nose straight (current heading) would be 55 per cent, or

slightly right forward. As the helicopter needs to slow approaching the pontoon, the power must to be increased to control the rate of descent. Without additional input on the right pedal, the helicopter would begin to yaw left.

(2) At 45° into wind and slowing to less than 20 kt, the pedal position required to keep the nose straight would increase to 66 per cent. By using less than 66 per cent, a pilot could allow the nose to turn to the left to start lining the helicopter up with the intended landing position on the pontoon.

(3) Slowing to a hover over the pad at a heading of about 062° and still yawing left, the pedal position required to arrest the left yaw would increase to more than 75 per cent, with 75 per cent then required to maintain a heading of about 062°. This position corresponds to the boundary of instability with respect to yaw (see Figure 13). If the pedal input was less than 75 per cent, the helicopter would continue to yaw to the left, into the instability zone. From that point, the requirement for right pedal could outpace a pilot's input, increasing the right pedal requirement further as the helicopter continued to yaw. (Note that, from about this position, the pilot of VH-WII initiated the go-around, during which the helicopter was at maximum take-off power.)

(4) With a crosswind from the right, and the helicopter still yawing left, the required right pedal input to keep the nose straight would be more than 62 per cent, with 62 per cent then required to maintain the heading. A larger input would be required to overcome the left turn and bring the nose to the right into wind. If at this point the helicopter was at maximum take-off power, further application of right pedal would not be available (without exceeding engine limitations or ceasing the climb).

(5) The loss of airspeed experienced by a helicopter turning into a downwind position at low speed increases the power requirement, and the required right pedal input to keep the nose straight (arrest the left turn) would be about 76 per cent. If the use of right pedal was limited by the available power during the initial phase of the go-around, there would not be enough power for a recovery of the left yaw at this point without exceeding engine limitations.

Tail rotor control failure

In relation to tail rotor control failures, the EC120B flight manual stated:

> The helicopter will yaw to the left with a rotational speed depending on the amount of power and the forward speed set at the time of the failure.

The appropriate response differed for three different phases of flight:

- hover in ground effect
- hover out of ground effect
- cruise flight.

Hover in ground effect meant within a height of one rotor diameter from the ground. For the EC120B this was 10 m (33 ft). Within this height, the pilot should close the throttle, negating the torque yet causing the helicopter to sink due to loss of power. The pilot should then use remaining rotor energy to cushion the helicopter onto the ground by raising the collective.

In hover out of ground effect (above 10 m or 33 ft) or at cruise airspeeds, the manual required the pilot to reduce collective (as height allowed) and use forward cyclic to achieve the best rate of climb speed, Vy, which was about 65 kt. Following that, the pilot should conduct an autorotative landing. This required selecting a landing site and landing without power as soon as possible.

At the point the yaw accelerated, the helicopter had low airspeed and height of about 40 ft. Neither of these options were ideally suited to the height and configuration VH-WII was in.

Pilot information related to aircraft handling

Prior to obtaining an EC120B rating, the pilot of the accident flight had only operated helicopter types with a counterclockwise-rotating main rotor system. The pilot indicated in interview that they had received limited information in relation to the specific actions to be taken in the event of unanticipated left yaw in the EC120B. The pilot stated not being aware of, or made aware of, the manufacturer's 2005 Service Letter 1673-67-04, including the content regarding use of the Fenestron anti-torque system.

An instructor from the training organisation that provided the pilot with the EC120B rating advised that, while the Eurocopter Service Letter 1673-67-04 was not provided to students, the content about power and anti-torque pedal management was included in the training syllabus and discussed with students as part of the type training. The instructor also advised that instead of focusing on the different pedal input required for European helicopters, the students were encouraged to look outside of the helicopter into the middle distance so that they can get a 'feel' for the aircraft. The instructor recalled that in terms of this pilot's performance during training, and the control of aircraft yaw, no concerns were identified, and the pilot was observed to be looking outside of the helicopter.

The operator's chief pilot said that the EC120B was not a powerful helicopter and, when operating at high power settings due to high weight, excessive use of the right pedal could 'spike the engine'. That is, a sudden spike in demand when the helicopter was operating at full power could exceed engine limitations and damage the aircraft.

Following the pilot's check to line with the chief pilot on 13 March 2018, the chief pilot noted on the check form that the pilot needed to be gentle on the pedals. The chief pilot advised that all new EC120B pilots were coached the same way and the same comment could be found on many of the check ride records for those pilots.

The pilot of the accident flight also stated that the EC120B was not a powerful helicopter. The pilot noted that the EC120B's differences to the R44 and Bell 206L3, in reference to their handling characteristics for approaches into Hamilton Island and at the pontoons, had been discussed informally among the operator's pilots but there had been no formal guidance provided. In addition, the pilot thought that the information in the Safety Information Notice 3297-S-00, issued by Airbus Helicopters in 2019 (after the accident), would have been valuable as it warned of the effects of prematurely releasing the pedal as opposed to holding the pedal at full right travel.

During the investigation, a number of experienced helicopter pilots advised the ATSB that the EC120B appeared to have less available power relative to its size compared to similar types.

Wreckage information

Following the accident, ATSB investigators interviewed witnesses who were on board the helicopter and witnesses who had observed the helicopter drifting away from where it had collided with the water before it sank. There were no reports from the helicopter's occupants or the first responders of debris around the helicopter (either from the helicopter or from potential foreign objects such as birds) before it sank.

An underwater search for the helicopter was conducted by the Queensland Police Service (QPS) on 26 and 27 March 2018 using side scan sonar radar based on the available information from witnesses and with consideration given to the tide, current and weather at the time of the accident. That search identified a target at a depth of about 60 m, adjacent to Hardy Reef. The target appeared to be consistent with a human-made object.

Shortly after the search, a cyclone passed through the region and weather and sea conditions were not conducive to continuing search operations. Several weeks later, the QPS conducted another search at the same location and again identified a target that appeared consistent with a human-made object.

The ATSB contracted a professional salvage company that had remotely-operated underwater vehicle (ROV) capabilities, suitable to conduct visual identification and capable of attaching a suitable line to facilitate recovery. On 6 May 2018, the ROV was deployed to the target area. The search did not identify the helicopter or a human-made object. The search was further expanded around the target area, but the helicopter was not located. Given the likely degradation to the helicopter over time and the lack of recording devices on board, the ATSB decided that the search would be discontinued.

On about 20 June 2018, personal items belonging to one of the passengers were recovered from a beach at Cape Flattery, Queensland, about 660 km north-west of Hardy Reef. This finding further demonstrated the large potential area where the wreckage may have been distributed.

Helicopter landing site information

General information

A helicopter landing site (HLS) is essentially any area intended for use for the arrival or departure of helicopters. The operator had multiple HLSs on helidecks, commonly referred to as pontoons.

Outside of HLSs at licensed aerodromes, there were no specific regulatory requirements in relation to a HLS. Civil Aviation Regulation (CAR) 92 (*Use of aerodromes*) required that, in effect, an aircraft not land or take-off from any place unless:

> having regard to all the circumstances of the proposed landing or take-off (including the prevailing weather conditions), the aircraft can land at, or take-off from, the place in safety.

The method of determining the applicable circumstances was not specified.

To assist operators in determining appropriate criteria for the development of both onshore and offshore HLSs, CASA provided the following Civil Aviation Advisory Publications (CAAPs):

- CAAP 92-2(2) (*Guidelines for the establishment and operation of onshore helicopter landing sites*) published in February 2014
- CAAP 92-4(0) (*Guidelines for the development and operation of off-shore helicopter landing sites, including vessels*) published in January 2013.

The operator’s operations manual stated:

> the minimum standard for a landing area shall meet the recommended minimum physical characteristics... for a standard HLS, as specified in CAAP 92-2(1),[24] except where a Company pilot has received approval from the Chief Pilot to use a particular Basic HLS. The pilot in command shall be solely responsible for the safe operation at a Basic HLS…

CAAP 92-2(1) recommended criteria for three types of HLS:

- basic HLS, for use on a short-term basis by day
- standard HLS, for use for all types of operations, both day and night
- offshore HLS, a landing area on an offshore resource platform or resource ship.

Appendix 7 of the operations manual specified minimum dimensions of a standard HLS for each helicopter type in the operator’s fleet. For an EC120B, this included a landing and take-off area of at least 4.1 m x 4.8 m, a ground effect area of 10 m diameter, a final approach and take-off area of 23.1 m diameter, and an approach and departure path width of 40 m.

Location of the Hardy Reef pontoons

The channel between Hook Reef and Hardy Reef, known locally as The River, harboured five platforms; Reefworld, a permanent floating platform that was used as a facility for snorkelling and dive tours, and four other platforms on pontoons. The two pontoons at the northern end of the group were owned by the operator and used as HLSs. The operator was responsible for maintaining both pontoons.

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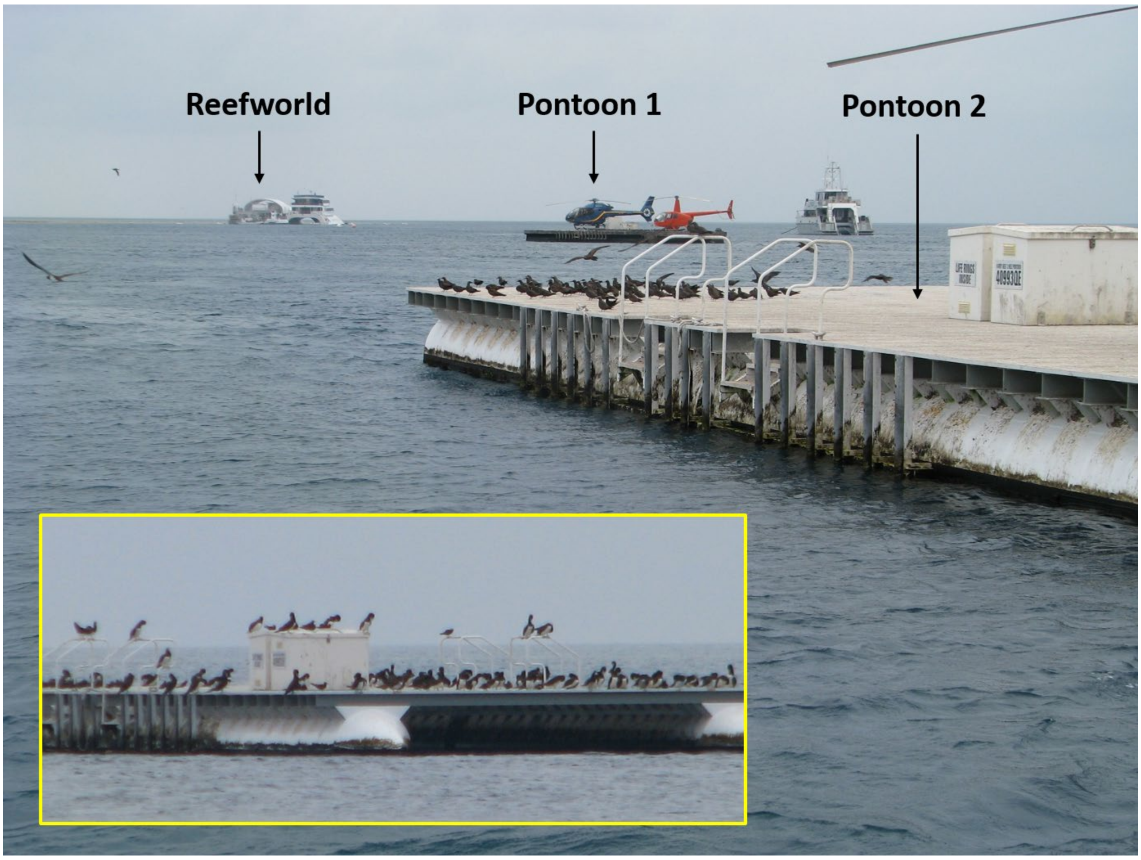
[24] CAAP 92-2(1) was published in January 1996, and the later version 92-2(2) was published in February 2014, The CAAP was re-written to remove reference to the recommended criteria for an offshore HLS, referenced in CAAP 92-4, and to assist operators in the transition to future operational parts in the *Civil Aviation Safety Regulations* (CASR).

The northern pontoon (pontoon 2) was the intended landing site of VH-WII. Its position could vary depending on the tidal current, and it was located about 600 m north-north-west of the Reefworld pontoon at the time of the accident (Figure 16).

Figure 16: Pontoon positions, insert showing bird hazard



Source: ATSB

An examination of satellite photos from Google Earth and other sites showed that the pontoon's position moved a significant amount due to tide and wind. To determine its exact position and orientation at the time of the accident, the ATSB analysed photographs taken by the rear right passenger during the downwind legs of the circuit and at about the time of the go-around. This analysis found that the pontoon was oriented with its long axis heading about 145–150° and therefore the intended landing position (perpendicular to the long axis) being on a heading of about 55–60° (see also Appendix A).

Composition and layout

The pontoon the pilot was intending to land on was 8.54 m wide and 21.96 m long. It had a wooden and carbon fibre surface and was supported by two buoyancy tanks. The pontoon sat 1.10 m above the water when unloaded, decreasing to 0.45 m above the water when loaded. The buoyancy tanks were fastened at one end to a single point swing mooring, allowing the pontoon to align itself with wind and the tidal current.

The pontoon had two touchdown-marking circles, one at each end. The circles had a diameter of 4 m and were painted with lines 0.25 m wide, with a letter 'H' painted inside the circle. There was a fuel storage structure positioned in the centre of the platform, which contained jerry cans of avgas and avtur (Figure 17).

Figure 17: Picture taken from operator's HLS register showing the pontoon layout and hazards

Source: Operator

Overall, the pontoon met the general requirements of CAR 92 and was consistent with the guidance for a basic HLS. It was not consistent with all the guidance for an offshore HLS or standard HLS, nor was that guidance directly applicable to the pontoons used by the operator.

The pontoon was positioned in open water, provided suitable, obstacle free approach and departure paths, and the landing/lift-off area exceeded the minimum dimensions of 4.1 m x 4.8 m for a standard HLS for an EC120B. However, the pontoon did not provide a ground effect area (with 10 m diameter required). Being a mesh surface over open water, ground effect would be reduced to a point that a pilot could not rely on it for performance.

The operator's other pontoon at Hardy Reef was an older pontoon and had a solid wooden surface. This provided more ground effect compared to the mesh surface pontoon. It also made it more susceptible to slipping hazards associated with bird excreta.

Helicopter landing site hazards

CAO 82.1 (*Conditions on Air Operator's Certificates authorising charter operations and aerial work operations*) stated that a charter operator utilising helicopters was required to provide:

> a catalogue of heliports and helicopter landing sites in the area of operations showing, in diagrammatic form, location by co-ordinates or in reference to prominent geographic features or nearest navigation aid, direction of approach and departure paths, dimensions of the approach and take-off areas, ground effect area(s), nature and slope (if any) of the surfaces, elevation above sea level, hazards in the area, any restrictions or specific conditions relating to the use of the particular site and the name, and method, of contacting the owner or controlling authority.

The operator maintained a HLS register[25] which outlined the required information for the pontoons at Hardy Reef. Hazards identified and documented in the register included:

- birds
- a railing located on the edge of the pontoon
- two 1 m x 1.5 m boxes in the centre of the pontoon (that is, the fuel storage structure) (Figure 17).

A landing restriction was also in place when passengers were walking around on the pontoon.

The operator's operations manual outlined the operational factors to be considered when operating to a HLS. As part of the requirements and guidance, it stated:

> Adequate precautions shall be taken by the pilot to ensure that objects, animals and persons not essential to the immediate operation are clear of the total area of the … HLS during approach and take-off operations. In any event, the pilot of a Company aircraft shall not approach, take-off or manoeuvre within 30 metres of animals or persons not essential to the immediate operation.

The pilot and surviving passengers reported that there were a significant number of birds on the pontoon during the helicopter's final approach. Further details about the bird hazard at Hardy Reef is provided in *Bird population at Hardy Reef*.

Approaches to the pontoons

The operator's HLS register for the Hardy Reef pontoons at the time of the accident advised that the pontoons were on a swing mooring and the approach path should be into wind or at 45°, parking on the pontoon at 90°.

The operator's operations manual did not provide any information regarding the stable approach criteria or decision points for its helicopter operations. The operator's pilots stated that their normal decision point (in terms of determining whether the approach was stable or a missed approach was required) would be at about 200 ft above mean sea-level on final approach. Pilots also stated that go-arounds were rarely required.

Leaving the controls of the helicopter at the pontoon

Pilots reported that it was common practice at the pontoons, once the helicopter had landed and with engine running and rotors turning, for them to leave the controls to provide a passenger safety briefing and escort passengers from and to the helicopter. The pilots would ensure that the friction locks[26] were engaged and would brief passengers about safety around the helicopter prior to embarking or disembarking the helicopter.

CAR 225 (*Pilots at controls*) required one pilot to be at the controls of an aircraft from the time at which the engine or engines is or are started prior to a flight until the engine or engines is or are stopped at the termination of a flight. CAO 95.7 (*Exemption from provisions of the Civil Aviation Regulations 1988 – helicopters*) provided relief from the requirements of CAR 225, when certain conditions were met. These included:

> (b) the helicopter is fitted with a serviceable means of locking the cyclic and collective controls; and
>
> (d) the pilot considers that his or her absence from the cockpit is essential to the safety of the helicopter or of the persons on, or in the vicinity of, the helicopter…

The operator's operations manual stated that pilots had to remain at the controls of a helicopter whenever an engine was running, except in the following situations:

---

[25] The operator's HLS register at the time of the accident was developed in 2016 and contained some outdated information relating to the composition and capacity of the pontoons at Hardy Reef. The HLS register was updated in April 2018, following the accident, to be consistent with the nature of operations at the time of the accident.

[26] Friction locks are installed on the cyclic and collective controls in most helicopter types. Tightening a lock increases the force required to move a control. A friction lock will not totally prevent a control from moving.

> (i) passengers are embarking or disembarking at a location where no person other than the pilot is available to brief and or assist the passengers;
>
> (ii) an inspection of the helicopter is required while the engine is running;
>
> (iii) securing seat belts, doors, baggage doors or other equipment.

If a pilot elected to exit a helicopter while the engine was running, the following conditions applied:

> (i) exiting the helicopter with the engine running is not prohibited by the Aircraft Flight Manual or by safety literature issued by the helicopter manufacturer;
>
> (ii) the helicopter is on firm, level and dry surface without any surface protrusions and the area meets the requirements of a standard HLS;
>
> (iii) the helicopter is at ground idle;
>
> (iv) all control locks are serviceable and before the pilot leaves the helicopter, the collective pitch control is down and locked and the cyclic control is centred and locked;
>
> (v) the helicopter is parked into wind and the wind strength does not exceed 15 knots;
>
> (vi) the pilot shall proceed no further than 5 metres of the helicopter to complete his/her duties;
>
> (vii) the helicopter is loaded within its normal C of G limits.

The pilot's operating handbook for the Robinson R44, a type commonly used by the operator, stated at Safety Notice 17:

> NEVER EXIT THE HELICOPTER WITH THE ENGINE RUNNING

The flight manual for the Bell 206L3 in reference to engine shutdown procedures stated:

> 14. Pilot – Remain at flight controls until rotor has come to a complete stop.

Airbus Helicopters in Safety Information Notice 2727-S-00, issued in 2014, stated:

> This document updates the information provided in Service Letter 1788-62-06. This Service Letter was originally issued in 2006 after several accidents occurred when pilots left their aircraft operating on the ground, unattended, with the rotors turning. Unfortunately, there have been several further accidents since then, and one such accident involved a fatality.
>
> Helicopter certification regulations do not address the situation where an operating helicopter is left unattended on the ground i.e., without a qualified pilot at the controls. This situation is governed rather by rules which can vary greatly depending upon policies and procedures deemed acceptable by the appropriate airworthiness authority. Because it is not the responsibility of Airbus Helicopters to define such policies or procedures, Airbus Helicopters will remove the following wording from all applicable aircraft Flight Manuals: "Unless otherwise specified in applicable operational rules, one pilot should be at the controls as soon as the rotors turn until flight ends and the rotors are fully stopped."
>
> Although this wording will be removed from the applicable aircraft Flight Manuals, Airbus Helicopters continues to believe that leaving a helicopter operating on the ground without a qualified pilot at the controls can be dangerous. This situation can result in damage to the helicopter and/or to other property, serious bodily injury, or death. Consequently, Airbus Helicopters maintains that safety is greatly enhanced if there is always a qualified pilot at the controls of a helicopter whenever it is operating and the rotors are turning…
>
> Because airworthiness authorities can authorize the operation of helicopters on the ground without a qualified pilot at the controls, we urge all operators to seek guidance from the appropriate authorities before conducting such operations. Airbus Helicopters, however, continues to believe that a qualified pilot should always be at the controls of the helicopter when the rotors start to turn until the flight ends and the rotors are fully stopped.

CASA advised the ATSB that a friction lock was not a suitable locking mechanism for the purpose of the CAO 95.7 exemption to CAR 225, and that leaving the controls to brief and embark passengers or disembark passengers was not a sufficient safety-related reason to leave the controls while the rotors were turning.

Meteorological conditions

The aerodrome forecast (TAF) for Hamilton Island (72 km south-south-west of Hardy Reef) issued at 1001 on 21 March 2018 and valid from 1000, forecast wind 130° at 22 kt, visibility more than 10 km, scattered cloud at 2,500 ft, light showers with rain, and temperature 27 °C. It also indicated there could be periods of variable wind gusting to 28 kt, showers with rain and broken cloud at 1,500 ft. A subsequent forecast issued at 1402 and valid from 1600 was the same, except that the wind was forecast to be 24 kt.

The area forecast for the area including Hardy Reef was similar to the TAF. The coastal waters forecast for the Mackay Coast was also similar, and indicated south-easterly winds at 15–20 kt, increasing to 20–25 kt in the afternoon, with seas 1.0–1.5 m increasing to 1.5–2.0 m offshore about midday.

There was no recorded weather data at Hardy Reef. Recorded data from nearby locations for the time 1530 included:

- Hamilton Island Airport: wind 130° at 24 kt, visibility more than 10 km, broken cloud at 2,600 ft, temperature 26 °C and dewpoint 23 °C
- Creal Reef (135 km south-east of Hardy Reef): wind 140° at 23 kt, temperature 27 °C
- Mackay Airport (153 km south of Hardy Reef): wind 140° at 18 kt, visibility more than 10 km, scattered cloud at 2,300 ft, temperature 28 °C and dewpoint 23 °C.

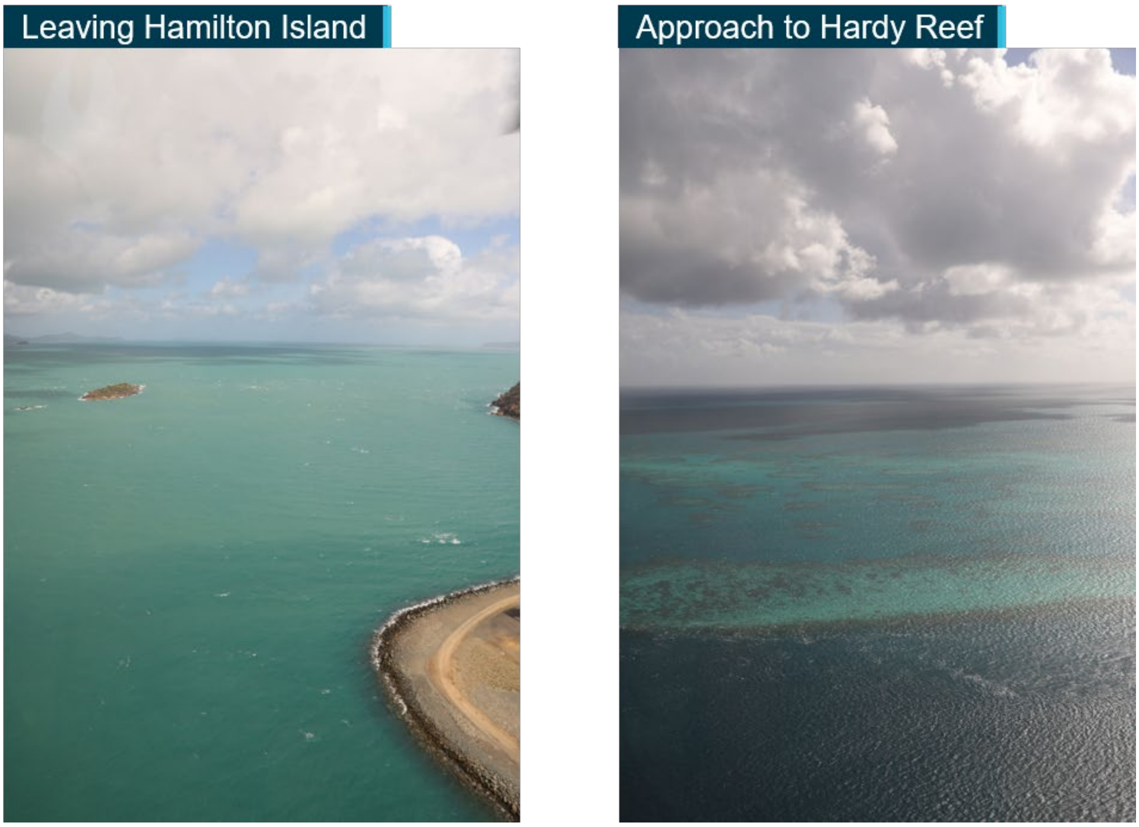
The forecasts and recorded observations were consistent and indicated that, at the time of the accident, the wind in the area of Hardy Reef was from the south-east with a speed of about 24 kt (45 km/h), the outside air temperature was 27 °C, and visibility was more than 10 km. There was some scattered cloud and light rain showers in the area.

The pilot and passengers reported passing through a rain shower between Whitehaven Beach and Hardy Reef, however the flight was smooth and there was no problem with visibility (Figure 18, see also images in Appendix A). A review of images taken by the passenger when close to the pontoon indicated that the sea state was consistent with wind conditions of 17–27 kt.

The pilot recalled estimating that the wind at Hardy Reef (using a flag on Reefworld) was south-easterly at 15–20 kt, with scattered cloud at 2,000 ft.

Based on all the available information, the ATSB estimated the wind at Hardy Reef to be about 20 kt from the south-east at the time of the accident.

Figure 18: Unedited photographs taken by a passenger on board the accident flight, showing weather conditions



Source: Passenger on board VH-WII

Organisation and management information

Overview

Whitsunday Air Services, trading as Hamilton Island Air, conducted tourist charter flights to various locations on the Great Barrier Reef. In April 2015, the Civil Aviation Safety Authority (CASA) reissued its Air Operator's Certificate (AOC) for 3 years. The AOC authorised charter operations in a variety of aeroplane (fixed-wing) and helicopter types.

The operator utilised two fixed bases, Hamilton Island and Hayman Island. It operated a fleet of 15 helicopters and five fixed-wing aircraft, carrying an average of about 50,000 passengers per year.

The operator's helicopter fleet comprised four types:

- Robinson R44
- Bell 206L3 (LongRanger)
- EC120B
- EC130B4.

The operator employed 20 pilots in total, with separate senior base pilots responsible to the chief pilot for the helicopter and fixed-wing operations.

Safety management

The *Civil Aviation Act 1988* outlined general requirements for AOC holders. These included:

> [Section 28BE (1)] The holder of an AOC must at all times take all reasonable steps to ensure that every activity covered by the AOC, and everything done in connection with such an activity, is done with a reasonable degree of care and diligence...

CAOs outlined additional general requirements for charter operators, including CAO 82.0 (*Air Operators' Certificates – applications for certificates and general requirements)* and CAO 82.1 (*Conditions on Air Operator's Certificates authorising charter operations and aerial work operations*).

CASA provided guidance material to operators about safety management from 1998. In 2002, it published a notice of proposed rule making (NPRM) for Civil Aviation Safety Regulation (CASR) Part 119, which proposed detailed requirements and guidance for a safety management system (SMS). CASA subsequently encountered delays with the implementation of Part 119 and SMS requirements. SMS requirements were subsequently introduced in 2009 for regular public transport operators in CAO 82.3 applicable to low-capacity RPT operators and CAO 82.5 applicable to high-capacity RPT operators. SMS requirements for charter operators were not finalised until December 2018, with the introduction of CASR Part 119 (*Australian air transport operators – Certification and management*), to commence in December 2021.

Because Whitsunday Air Services was not conducting regular public transport operations, there was no requirement for it to have a safety management system (SMS) and the operator did not have an SMS. The operator had appointed a safety manager; however, at the time of the accident this person was yet to receive training or direction to be able to undertake the role.

The operator did not have a formal incident or hazard reporting system, or a means of monitoring trends involving incidents, hazards or events over time. Interviews with various staff members indicated that pilots were to manage safety on an individual basis, although they were encouraged to report safety concerns to the relevant senior base pilot or the chief pilot. There were no safety meetings involving pilots or other mechanisms to capture safety risks aside from verbally reporting to more senior members of the organisation.

The chief pilot reported that there were no significant risks involved with conducting operations and landing at the pontoons, and the operator had not undertaken a formal risk assessment in relation to any aspect of these operations. The chief pilot also advised that the operator had landed at the pontoons over 5,000 times since it started operations and that the chief pilot had significant experience operating to pontoons. The procedures utilised by the operator were developed by the chief pilot, discussed with other pilots, and demonstrated to trainee pilots during ICUS flights.

Training, experience and consolidation on helicopter type

Training requirements for a new helicopter type

Different helicopters exhibit wide variations in complexity and handling characteristics. Therefore, under the Civil Aviation Safety Regulation (CASR) Part 61 (*Flight crew licensing*) category of helicopters, aircraft type ratings were required. Without stipulating a specific number of hours, a type rating for a new type required that sufficient training had been undertaken to provide a pilot with knowledge and practical experience of the characteristics of the new type. To be issued an aircraft type rating a pilot had to demonstrate competency during a flight review in that aircraft.

The training and flight review were expected to cover the core competencies listed by CASA in the Part 61 Manual of Standards. These were:

- operating the aircraft's navigation and operation systems
- conducting all normal, abnormal and emergency flight procedures for the aircraft
- applying the operational limitations
- flight planning procedures
- weight and balance requirements
- applying aircraft performance data.

European requirements for an EC120B type rating

EASA released an operational evaluation board (OEB) report in 2012 that analysed the type rating syllabus for the EC120B provided by Eurocopter Training Services. The syllabus had previously been approved by the French aviation regulator (Direction générale de l'aviation civile or DGAC).

The OEB made recommendations for a minimum training syllabus for the EC120B, as outlined in Table 4.

Table 4: EASA recommended syllabus for the EC120B rating

Component	Initial type rating	Additional type rating
Theoretical course program	15.5 hours	13.5 hours
VEMD course	3.0 hours	3.0 hours
Theoretical exam	1.5 hours	1.5 hours
In-flight training	5.0 hours	3.0 hours
Skill test	1.0 hour minimum	1.0 hour minimum

Requirements for pilot experience and consolidation on a helicopter type

CAO 82.0 outlined minimum pilot experience requirements for different types of aircraft for charter operations. For a single-engine helicopter being operated under VFR during the day, the required period in command or acting in command under supervision (ICUS) was 5 hours. If the pilot already had the required period of 5 hours on another type of single-engine helicopter, this could be reduced to 3 hours.

CAO 82.1 outlined some obligations in relation to operating different aircraft types. It stated:

> The operator must ensure that:
>
> (a) the operations manual contains current and appropriate operating information, procedures and instructions (the specific instructions) for each aircraft type and model operated; and
>
> (b) before a pilot operates an aircraft, the chief pilot is satisfied that the pilot:
>
> (i) is competent to operate the aircraft in accordance with the specific instructions for the aircraft type and model; and
>
> (ii) understands the differences in each model of the aircraft type operated by the operator…

There were no specified requirements for a pilot to consolidate their experience on a helicopter type beyond the minimum ICUS experience. That is, there were no requirements for a pilot to not fly other helicopter types while obtaining their ICUS experience on the new type. There were also no requirements after a pilot had obtained their ICUS experience to obtain a specified amount of experience on the type within a defined period, or to not fly other helicopter types until they had achieved a specified level of experience.

The required experienced levels for passenger charter operations in single-engine helicopters was broadly similar in other countries such as the United States, Canada and New Zealand. In addition, there were no requirements for consolidating experience on a helicopter type in any of these countries.

Consolidation requirements on other aircraft types

The only types of operations with specific consolidation requirements were operations in large transport aircraft.

For example, in the United States, for air transport operations conducted in large aeroplanes under Part 21 of the Federal Aviation Regulation (FARs), FAR 121.432 defined consolidation as '…the process by which a person through practice and practical experience increases proficiency in newly acquired knowledge and skills'. FAR 121.434 outlined consolidation requirements. These included, for the pilot in command or second in command of a new aircraft type acquiring '…at least 100 hours of line operating flying time for consolidation of knowledge and skills … within

120 days' after completing a proficiency check. If the pilot conducted flying on another of the operator's aircraft types during this period, they had to conduct refresher training on the new aircraft type.

New Zealand had similar requirements to the United States for air transport operations involving large aeroplanes. The New Zealand Civil Aviation Rules Part 121 required that a pilot complete 100 hours experience (or 75 operating cycles) on a new aircraft type within 120 days for consolidation and must 'operate exclusively during the consolidation period on the one aeroplane type...'.

The United States and New Zealand had no similar requirements under Part 135 of their regulations for on demand or charter operations. Following an accident involving a Bombardier Learjet 60 aeroplane in 2008 being used for Part 135 operations,[27] the National Transportation Safety Board (NTSB) noted the absence of such requirements. Its report into the accident stated:

> A PIC who is not yet confident in commanding a new type of airplane may not respond quickly enough or appropriately in an abnormal situation…
>
> The NTSB is concerned that when a pilot switches between two types of airplanes before the pilot has accrued much experience on either airplane, the pilot may lose proficiency in the newly acquired knowledge and skills…
>
> Minimum levels of operating experience help ensure that, when a pilot transitions to a new type of airplane, the pilot obtains the experience needed in that airplane to gain knowledge of the airplane's particular systems and handling characteristics and to develop skills in flying it. The consolidation of knowledge and skills through operating experience helps the pilot build confidence in flying the new airplane, which is particularly important for the PIC [pilot in command]. The NTSB notes that the cockpit environments and the duties of the dual-pilot flight crews of Part 135 on-demand operations are similar to those of Part 121 operations and often use comparably sophisticated aircraft. The NTSB concludes that, because Part 135 does not require that pilots in on-demand turbojet operations have a minimum level of experience in airplane type, the pilots may lack adequate knowledge and skills in that airplane.

Consequently, the NTSB issued the following recommendation to the Federal Aviation Administration (FAA):

> Require that pilots who fly in 14 Code of Federal Regulations (CFR) Part 135 operations in an aircraft that requires a type rating gain a minimum level of flight time in that aircraft type, similar to that described in 14 CFR 121.434, taking into consideration the unique characteristics of Part 135 operations, to obtain consolidation of knowledge and skills. (A-10-58)

Due to a lack of progress with a response from the FAA, the recommendation was classified as Closed – Unacceptable action in 2017.

The European Union also had requirements related to pilots flying more than one aircraft type stated in the flight crew (FC) sub-part of the organisation requirements for air operations (ORO). Part ORO.FC.240 (*Operation on more than one type or variant*) stated that:

> (a) The procedures or operational restrictions for operation on more than one type or variant established in the operations manual and approved by the competent authority shall cover:
>
> (1) the flight crew members' minimum experience level;
>
> (2) the minimum experience level on one type or variant before beginning training for and operation of another type or variant;
>
> (3) the process whereby flight crew qualified on one type or variant will be trained and qualified on another type or variant; and
>
> (4) all applicable recent experience requirements for each type or variant.

[27] NTSB 2010, *Runway overrun during rejected takeoff, Global Exec Aviation, Bombardier Learjet 60, N999LJ, Columbia, South Carolina, September 19, 2008*.

In terms of (a)(3), the acceptable means of compliance (AMC) stated that for multi-pilot aeroplane types:

> before commencing training for and operation of another type or variant, flight crew members should have completed 3 months and 150 hours flying on the base aeroplane, which should include at least one proficiency check…[28]
>
> after completion of the initial line check on the new type, 50 hours flying or 20 sectors should be achieved solely on aeroplanes of the new type rating …

The AMC also stated that, for helicopters with a maximum take-off weight of more than 5,700 kg, or with a maximum operational passenger seating configuration of more than 19:

> a minimum of 3 months and 150 hours experience on the type or variant should be achieved before the flight crew member should commence the conversion course onto the new type or variant …
>
> 28 days and/or 50 hours flying should then be achieved exclusively on the new type or variant …

Operator requirements for training, experience and consolidation on new helicopter types

The chief pilot of Whitsunday Air Services reported that the operator recruited pilots that met the following minimum requirements:

- 500 hours in helicopters
- 100 hours in command of the R44
- pass of a pre-employment check flight with a senior member of the operator's executive team (who carried examiner privileges)
- helicopter underwater escape training (HUET).

Once inducted, a new pilot would learn the tour routes, including landing on pontoons, with existing pilots before being checked to line by the chief pilot.

The chief pilot also stated that, at the chief pilot's discretion, every pilot would spend at least 1 year operating the R44 before moving on to any other type, regardless of pre-existing type endorsements. They would then undergo a graduated process of qualifying them for the operator's operations on other types that were more complex; typically the Bell 206L3, then the EC120B followed by the EC130. Type training was conducted by external providers, either locally at Shute Harbour or with a training provider based at Moorabbin Airport, Victoria.

The operator's operations manual stipulated that the minimum requirements for a pilot in command of a single pilot helicopter, in addition to the type of class rating, were 5 hours in command or in command under supervision (ICUS). Following ICUS, the chief pilot would conduct a check to line and, if successful, the pilot would be cleared to conduct charter operations as pilot in command on the new type.

The operator did not have any additional requirements for consolidation on any of its helicopter types, including the EC120B. As noted in previous sections, there was no specific regulatory requirements for additional consolidation activities.

Other information about consolidation on aircraft type

The pilot of the accident flight reported that one of the instructors who provided the pilot's EC120B type rating advised that a 30-day period of operating the helicopter with heavy loads (as opposed to the normal light loads during flight training) was advisable after obtaining the type rating. The pilot also noted that on the day of the accident they felt they were unfamiliar with the helicopter

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[28] For this point and the others stated below, the AMC stated 'unless credits related to the training, checking and recent experience requirements are defined in operational suitability data established in accordance with Commission Regulation (EU) No 748/2012 for the relevant types or variants'.

and that this unfamiliarity, combined with distractions, made them feel 'very busy' during the final approach and go-around sequence.

The ATSB identified two other operators that conducted passenger charter flights to reef pontoons but only one of these operators utilised EC120B helicopters. That operator stated that it was common practice for it to include a period of consolidation for pilots. That operator also advised that it had set the following, albeit informal, limitations:

- at least 20 consecutive hours on the helicopter type, on top of type rating and ICUS flying
- an unofficial procedure that involved applying a weight restriction of 50–100 kg below the maximum take-off weight for a period of up to 2 weeks.

An independent EC120B subject matter expert was also consulted about consolidation activities. This expert's background was in marine pilot transfers. They noted that, because of the nature of that activity and the associated training requirements for that activity, pilots would have the opportunity to fly the EC120B exclusively following a type rating. They also noted that most pilots in that environment transitioning to the EC120B also had previous experience on other helicopters with a clockwise-rotating main rotor system (such as the AS350).

Whitsunday Air Services advised that it was not aware of any operators using consolidation requirements after a check to line on a new helicopter type, such as a minimum number of consecutive hours on type or reduced weights, and industry training specialists it had consulted were also not aware of such practices.

The Transportation Safety Board of Canada recently conducted a safety study of passenger charter operations in Canada.[29] The report (released in 2019) noted that some operators only provided training to the level required in the regulations, however others provided training beyond the requirements to address needs and/or to derive benefits that mitigated risk in their operation. It also noted that while there were specialised training requirements for certain operations, such as night flying, there was no requirement for other specialised flying such as mountain flying or coastal flying. The same situation applied in Australia.

Helicopter loading information

Loading requirements and guidance

Civil Aviation Regulation (CAR) 235 (*Take-off and landing of aircraft etc*) stated that a pilot in command must not allow an aircraft to take off if its gross weight exceeded its maximum take-off weight (MTOW), and that the load of the aircraft should be distributed so that the centre of gravity of the aircraft was within the limitations specified in the aircraft's flight manual. The MTOW is also known as referred to as maximum all-up weight (MAUW) in helicopter operations.

CAR 235 did not specifically require that passengers and baggage be weighed. However, Civil Aviation Advisory Publication (CAAP) 235-1(1) (*Standard Passenger and Baggage Weights)* provided advisory information about methods to use for determining passenger and baggage weights. It recommended:

> Because the probability of overloading a small aircraft is high if standard weights[30] are used, the use of standard weights in aircraft with less than seven seats is inadvisable. Load calculations for these aircraft should be made using actual weights arrived at by weighing all occupants and baggage.

Other regulatory agencies provided guidance that was similar but they also provided guidance for other methods of determining passenger weights in situations where passengers were not

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29 Transportation Safety Board of Canada, Air Transportation Safety Issue Investigation Report A15H001, *Raising the bar on safety: Reducing the risks associated with air-taxi operations in Canada*, released 7 November 2019.

30 For larger aircraft, it is common for operators to use the same, pre-defined 'standard' weight for each type of passenger (for example, male adult, female adult, child). CAAP 235 recommended different standard weights depending on the aircraft's size.

physically weighed to obtain their actual weight. This included adding a specified allowance when using a passenger's volunteered weight.

For example, the New Zealand Civil Aviation Rule 135.303 (*Goods, passenger and baggage weights*) required air transport operators of small aircraft (including helicopters) to establish a passenger's weight by one of three methods: actual weights (by measuring), standard weights pre-determined by the operator, or by 'a weight that is declared by the passenger plus an additional 4 kg for every passenger'.

Transport Canada provided the following guidance in Advisory Circular (AC) 703-004 (*Use of segmented passenger weights by commercial air operators under subpart 703 of the* Canadian Aviation Regulations), which applied to aeroplanes with a seating capacity of nine passengers or less:

> (a) **Actual Weight:** When reference to passenger weight, means the weight derived by actually weighing of each passenger just prior to boarding the flight... This weight the allowances [sic] for personal clothing and carry-on baggage are required to be added and the resultant value shall be used as the passenger's weight. Where weighing scales are not available or serviceable, or a passenger refuses to be weighed the following may be used in lieu of actual weight:
>
> (i) **Volunteered Weight:** means weight obtained by asking the passenger for their weight, adding 4.5 kg (10 lb) to the disclosed weight then adding the allowances for personal clothing and carry-on baggage and using the resultant value as the passenger's weight; or
>
> (ii) **Estimated Weight:** means where actual weight is not available and volunteered weight is either not provided or is deemed to be understated; the operator may make a reasonable estimate of the passenger's weight, then add the allowances of personal clothing and carry-on baggage and use the resultant value as the passenger's weight.

The US FAA Advisory Circular (AC) 120.27E (*Aircraft weight and balance control*) stated that operators could determine an 'actual weight' of a passenger using two different methods:

> a. Weighing each passenger on a scale before boarding the aircraft… or
>
> b. Asking each passenger his or her weight. An operator should add to this asked (volunteered) weight at least 10 pounds [4.5 kg] to account for clothing. An operator may increase this allowance for clothing on certain routes or during certain seasons, if appropriate.
>
> NOTE: If an operator believes that the weight volunteered by a passenger is understated, the operator should make a reasonable estimate of the passenger's actual weight and add 10 pounds.

Operator's loading procedures and practices

The operator's operations manual stated:

> Load calculations for all Company operated aircraft will be made using actual weights for all passengers, baggage and cargo carried.
>
> It is the responsibility of the pilot in command not to exceed the maximum weights specified for the aircraft in use

The occurrence flight was one of several standard scenic flights offered by the operator. The operator reported that a maximum total passenger weight had been determined for each helicopter type (which was detailed on the manifest) and that this weight was used by the guest liaison officers to allocate passengers to the different helicopter types. If the total passenger weight was greater than that permitted, this would trigger the guest liaison officer to allocate the passengers to a different helicopter. For the EC120B, the maximum total weight of the passengers was limited to 350 kg.

Although the operations manual referred to 'actual weights', the operator's practice differed from how this concept was described in Australian and some overseas regulatory advisory publications described above. The operator advised that passengers volunteered their weights at the time they booked the flights, and these weights were recorded on the flight manifest by a guest liaison officer. The chief pilot advised that there was no documented procedure; however if the guest liaison officer, other staff member or the pilot noticed an obvious discrepancy between a passenger's volunteered weight and their perceived actual weight then the passenger was to be weighed. The guest liaison officer would generally make an assessment first and, if there was no issue, the pilot had the opportunity to make an assessment either in the terminal or as the passengers approached the helicopter (in the case of hot loading).

The operator had calibrated scales available at the terminal at Hamilton Island and on board the Cruise Whitsundays vessel for weighing passengers whose volunteered weight appeared to be inaccurate.

Although there was a section on the manifest to provide baggage weights, this had not been completed for VH-WII on the day of the accident. The guest liaison officer recalled that they were able to carry all of the bags themselves to load them into the baggage compartment so believed that there was not too much.

Although not documented, the chief pilot advised that they would generally allow 20 kg for baggage in the baggage compartment, and when providing a weight and balance estimate following the accident had used this figure.

As noted in *Weight and balance*, the accident flight departed with about 48 per cent fuel (156 kg), pilot (85 kg), four passengers (312 kg) and passenger baggage and the portable APU (28 kg), and was about 25 kg over the maximum all-up weight. For the first flight of the day in VH-WII from Hamilton Island to Hardy Reef, the volunteered weights for the four passengers totalled 276 kg and the fuel load was about 67 per cent. Allowing 20 kg for baggage and other items in the baggage compartment and the cabin, the maximum all-up weight was about 1,751 kg (36 kg above the maximum all-up weight). It is possible that the weight of the baggage and other items was less than 20 kg (but unlikely to be significantly less), and it is also possible that some of the passengers' weights were different to their volunteered weights (more likely higher than the volunteered weights than lower).

The ATSB did not obtain passenger weights or estimate the maximum all-up weight for other flights. However, it noted the following information:

- A review of the daily flight records over the previous month for the operator's two EC120B aircraft found that flights from Hamilton Island to Hardy Reef commonly departed with four passengers. For such flights, the fuel load ranged from 45–80 per cent, with an average of 66 per cent (268 L), which equated to 212 kg (51 kg more than the accident flight).
- Recent figures from the Australia Bureau of Statistics noted that, in 2011–2012, the average weight of an Australian male was 86 kg and an Australian female was 71 kg. Therefore, a passenger load of two adult male passengers and two adult female passengers from Australia would be expected to be 314 kg. Passengers from other countries may have different average weights, and children would generally weigh less.
- The minimum fuel load that could be used to allow the EC120B helicopter to conduct a flight from Hamilton Island to Hardy Reef and return was 190 L (47 per cent, or about 150 kg). The ATSB estimated that the maximum passenger load that could be taken from Hamilton Island with sufficient fuel to allow a return flight without refuelling at the pontoon was about 304 kg.[31]

Bird hazard management

Helicopter birdstrikes in Australia

The operator's pilots reported that birds were a common hazard at Hardy Reef. Following the accident, the pilot of VH-WII stated that they believed that a birdstrike was the reason for the

[31] These calculations assumed a pilot weight of 86 kg, 20 kg of baggage and other items, a fuel burn of 120 L/hour for block flight fuel for 36 minute flight each way, 10 per cent variable reserve (for one flight), and 115 L/hour fuel burn for holding (for the fixed reserve).

helicopter's rapid yaw to the left during the go-around. Consequently, the ATSB considered relevant information related to birdstrikes and bird hazard management.

The *Transport Safety Investigation Regulations 2003* provide a list of matters required to be reported to the ATSB. One routine reportable matter is a collision with an animal, including a bird, for:

- all air transport operations (including regular public transport or charter operations)
- aircraft operations other than air transport operations when the strike occurs on a licensed aerodrome.

The regulations stated that the reporting requirements applied to matters occurring during the period between when an aircraft is being prepared for take-off and ending when all passengers and crew have disembarked.

Between 2008 and 2017, 16,626 birdstrike occurrences were reported to the ATSB. Of those, 1.8 per cent (301 occurrences) involved helicopters.[32] Details of these birdstrikes included the following:

- Of the 301 occurrences, 107 (36 per cent) involved helicopters in the normal category (maximum all-up weight less than 3,150 kg), 137 (46 per cent) involved helicopters in the transport category (more than 3,150 kg), 46 (15 per cent) involved helicopters manufactured for the military, and the category was unknown for the remaining 11 helicopters (4 per cent).
- For the 284 occurrences where the phase of flight was known, 44 (15 per cent) occurred while the helicopter was standing with rotors turning, 24 (8 per cent) while the helicopter was taxiing or hovering, 24 (8 per cent) during take-off, 28 (10 per cent) during initial climb, 67 (24 per cent) in climb, cruise or descent, 31 (11 per cent) during manoeuvring/airwork, 52 (18 per cent) during approach, and 14 (5 per cent) during landing.
- For the 252 occurrences (involving 253 birds) where the part of the helicopter hit by the bird(s) was known, there were 5 strikes (2 per cent) to the tail rotor, 4 (2 per cent) to the tail area (tail fin, vertical stabiliser or horizontal stabiliser), 148 (58 per cent) to the main rotor, 50 (20 per cent) to the windscreen, and 46 (18 per cent) to other parts of the helicopter's fuselage or airframe.
- Of the 301 occurrences, 44 (15 per cent) resulted in some damage, including 3 which occurred to the tail rotor (7 per cent), 4 to the tail area (9 per cent), 12 to the main rotor (27 per cent), 14 to the windscreen (32 per cent) and 10 to other parts of the helicopter's fuselage or airframe (23 per cent).[33]
- Four birdstrikes resulted in an accident. More specifically, 3 of the 5 birdstrikes to a tail rotor resulted in an accident (see also below) and 1 of the 148 strikes to a main rotor resulted in an accident. All four of these accidents involved normal category helicopters (R22 or R44).

The part of the helicopter struck by the bird varied depending on the phase of flight or flight activity. More specifically:

- For the 44 strikes when the helicopter was standing with rotors turning, 42 strikes occurred to the main rotor (95 per cent), 1 to the tail rotor (2 per cent) and 1 to the tail area (2 per cent).
- For the 62 strikes during landing, take-off, taxi and hover, the part hit was known in 51 cases, including 42 to the main rotor (82 per cent), 1 to the tail rotor (2 per cent), 0 to the tail area, 3 to the windscreen (6 per cent) and 5 to other parts of the fuselage or airframe.

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[32] The aircraft type was not known or specified in 1,410 cases (8.5 per cent). In most of these cases, evidence of a birdstrike was found during a runway inspection, and almost all of these would have involved aeroplanes rather than helicopters.

[33] The proportion of strikes resulting in damage was higher for normal category helicopters (27 per cent) than transport helicopters (9 per cent) and military helicopters (4 per cent). This likely reflects differences in manufacturing standards and reporting rates.

- For the 67 strikes during climb, cruise or descent, the part hit was known in 59 cases, including 10 to the main rotor (17 per cent), 1 to the tail rotor (2 per cent), 2 to the tail area (3 per cent), 32 to the windscreen 54 per cent), and 14 to other parts of the fuselage or airframe.

Of the 5 birdstrikes to a tail rotor, none involved helicopters with a Fenestron.[34] Details of these birdstrikes included:

- An R22 tail rotor was reported to be struck at 40 ft (during approach) by a large bird (type not reported),[35] resulting in a loud bang, nose down attitude and collision with terrain with substantial damage.
- An R22 tail rotor was reported to be struck at 15 ft and low airspeed (during aerial mustering) by a large bird (brush turkey), resulting in vibration and yaw and a firm landing (after which a grass fire destroyed the helicopter).
- An R44 was reported to be struck by a medium-sized bird (whistling kite) at 200 ft and 60 kt, resulting in a loud bang and right yaw, failure of the tail rotor gearbox, and an emergency landing with substantial damage.
- An R44 tail rotor was reported to be struck by a medium-sized bird (kookaburra) while the helicopter was standing with rotors turning, resulting in no damage to the helicopter.
- An AW139 tail rotor was reported to have been struck by a small bird while the helicopter was taxiing, resulting in no damage to the helicopter.

Overall, of the 107 strikes involving normal category helicopters, 4 hit the tail rotor and 2 hit the tail area (overall 6 per cent). Of the 137 strikes involving transport helicopters, 1 hit the tail rotor and 2 hit the tail area (overall 2 per cent).

Helicopter birdstrikes overseas

A recent report by the US FAA (2017) provided data on birdstrikes involving civil helicopters in the United States during 2009–2016. For helicopters certified under Part 27 of the US Federal Aviation Regulations (normal category or maximum all-up weight up to 3,175 kg), there were 1,233 occurrences, with some strikes recorded as involving a bird hitting multiple parts of a helicopter. Most occurrences involved strikes to the windshield (47 per cent) or main rotor (30 per cent), with 4 per cent to the tail rotor or empennage.[36] For helicopters certified under Part 29 (transport category), there were 333 occurrences. Most occurrences involved strikes to the windshield (40 per cent) or main rotor (23 per cent), with 3 per cent to the tail rotor or empennage. Therefore, in terms of hits to the tail rotor or tail area, the US data was comparable to the Australian data for both normal and transport category helicopters.

As noted in *Fenestron tail rotor,* the EC120B manufacturer advised that it had no reports of a birdstrike to a tail rotor in any helicopter with a Fenestron tail rotor. However, there have been reports of other foreign objects affecting Fenestron tail rotors. Investigated occurrences involving such objects have noted that they typically result in significant vibration and/or noise.[37]

Bird population at Hardy Reef

The pontoons at Hardy Reef were in a Marine National Park zone, and all birds within the Great Barrier Reef Marine Park were protected. The large number of birds that habituated the pontoons

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34 Of the 301 birdstrike occurrences, 27 (9 per cent) involved helicopters with a Fenestron tail rotor. For occurrences where the part hit was known, 5 of the 222 occurrences involving helicopters with conventional tail rotors involved a strike to the tail rotor, and 0 of the 21 occurrences involving a Fenestron tail rotor involved a strike to the tail rotor.

35 For the purposes of birdstrike reporting and statistics, a small bird is up to and including 0.085 kg, a medium bird is more than 0.085 kg and up to 1.15 kg, a large bird is more than 1.15 kg and up to 3.65 kg, and a very large bird is more than 3.65 kg.

36 The proportion of birdstrikes that resulted in damage was not reported except for windshields (24 per cent and 14 per cent for Part 27 and Part 29 helicopters respectively).

37 For example, see the NTSB investigation reports WPR10LA481 (umbrella), GAA16LA056 (towel) and ERA16CA060 (fire extinguisher cover).

at Hardy Reef was a known hazard (Figure 19, see also *Helicopter landing site hazards*). The three main bird species that routinely landed and rested on the pontoons at Hardy Reef were:

- brown booby, weight to 1.3 kg and wingspan to 1.4 m (large)
- crested tern, weight to 0.4 kg and wingspan to 1.3 m (medium)
- common noddy, weight to 0.2 kg and wingspan to 0.9 m (medium).

The number of birds utilising the pontoons as a resting place varied according to the season (with numbers increasing during the wet season from November to April) and the tide. At low tide, the birds were generally absent from the pontoons feeding on exposed reef, and as the tide rose they would use the pontoons as a resting place. Therefore, there was some ability to predict the prevalence given the time of year and the tide. At the time of the accident, it was mid-tide and in the wet season.

Figure 19: Still images showing bird population at Hardy Reef pontoons

Excerpts from a video file taken 1036 on 26 March 2018 at about mid-tide.
Source: ATSB

Birdstrikes at or near Hardy Reef

Between the period 2008–2017, there was only two birdstrikes at Hardy Reef reported to the ATSB. One involved a floatplane during take-off, and the other involved a helicopter. The birdstrike to the helicopter involved an R44 and occurred on a pontoon just after the helicopter had landed. A small bird was reported to have impacted the main rotor blades resulting in no damage to the helicopter (except small scratches to the paint). As a result, the pilot contacted their operator, and the decision was made to suspend all commercial operations until the blade inspection could be conducted by a licenced aircraft maintenance engineer (LAME).

There were two other reported birdstrikes involving helicopters reported in the Hamilton Island area, including one at Hamilton Island Airport (bird flew into R44 tail rotor while helicopter standing with rotor turning) and one at Shute Harbour (an R44 striking a large bird during the climb resulting in minor damage to the fuselage).

Operator’s procedures for avoiding birdstrike

The operator’s operations manual covered birdstrikes and birdstrike avoidance, and stated:

> Birds pose a major problem to aircraft in parts of the country at various times of the year.

General advice on bird hazard management in the manual required pilots to:

> Where possible avoid areas of high bird concentration. Little can be done to make the aircraft more obvious except for displaying all possible lights…
>
> While most birds will dive to avoid an aircraft, their behaviour is unpredictable and unless ground staff are available to disperse them, it may be prudent to delay arrival or departure until they have moved on.

The operations manual also stated that:

> Adequate precautions shall be taken by the pilot to ensure that objects, animals and persons not essential to the immediate operation are clear of the total area of the … HLS during approach and take-off operations. In any event, the pilot of a Company aircraft shall not approach, take-off or manoeuvre within 30 metres of animals or persons not essential to the immediate operation.

The operations manual defined animals to include birds.

The operator advised that it was not possible to reduce the number of birds on the pontoons at Hardy Reef, and instead pilots would slow down and hover near the pontoon at the bottom of the approach to allow the birds time to disperse.

Hovering over water requires good power margins. Pilots reported that they would assess whether or not they had enough power to wait for the birds on approach to the pontoon. If the power margins were low, the pilot would manage this by progressing the helicopter at the slowest rate possible.

Pilots reported that the birds were habituated to both the pontoon and the helicopters, and some birds would remain as the helicopter approached. Birds that stayed on the pontoon would generally be grounded there as the downwash of the helicopter thwarted their ability to generate lift. Birds that were airborne would fly away from the helicopter. Pilots also reported that birds often returned to the pontoon while the helicopter was on the pad with rotors turning.

Operator's birdstrike frequency and reporting

As noted in *Helicopter birdstrikes in Australia*, all birdstrikes involving helicopters conducting charter operations had to be reported to the ATSB, including if the helicopter was standing with the rotors turning before or after a flight or between flights. The operator's operations manual stated:

> Any bird strike must be reported to ATSB using the Aviation Bird & Animal Strike Notification form.

During the period 2008–2017, there were no reports of birdstrikes to the ATSB involving the operator's helicopter fleet.

During interviews, the operator's pilots indicated that almost all pilots had experienced at least one birdstrike, almost always while the helicopter was standing on the pontoon with the main rotors turning. The chief pilot advised experiencing at least one birdstrike and that the operator's helicopters would have birdstrikes once or twice a year. Other pilots provided similar estimates of the rate of birdstrikes, with one pilot indicating that there were probably more strikes each year. None of the pilots was aware of any birdstrikes that had resulted in any damage to a helicopter.

The chief pilot advised that they did not expect pilots to report birdstrikes to the ATSB unless the helicopter was airborne at the time and damage to the aircraft had resulted. The operator did not know how many birdstrikes had occurred to its helicopters at Hardy Reef, or other locations, as they did not keep any record of birdstrikes (unless there was damage).

As noted in *Helicopter birdstrikes in Australia*, 44 of the helicopter birdstrikes between 2008–2017 involved helicopters that were standing with rotors turning. Some of these involved helicopters that were standing on pontoons similar to those used by Whitsunday Air Services. None of these 44 birdstrikes resulted in any known helicopter damage.

Maintenance requirements following a birdstrike

The EC120B manufacturer's aircraft maintenance manual (AMM) work card 05-50-00, 6-3 *Steps to be Taken After Impact on Blades - Main Rotor Blades* described an impact as including:

> a. Impact on a blade when the rotor turns is defined as when something hits a blade with sufficient force to cause the rotor speed to decrease suddenly.
>
> b. Impact on a blade when the rotor is stopped is defined as when something hits a blade during a ground operation.

It further stated:

An important hit is defined as an impact on the leading edge rotor in rotation.

A light hit is defined as an impact on the trailing edge or leading edge when rotor is at standstill.

If an important hit occurred, the maintenance inspection actions included but were not limited to:

a. Remove the damaged main rotor blade(s) (AMM 62-11-00,4-1).

b. Do the check of the damage main rotor blade(s) (AMM 62-11-00,6-1).

The same two initial steps were also required for a light hit.

The ATSB asked the helicopter manufacturer how a pilot could determine that, when the rotors were turning, that the rotor speed had decreased enough to warrant an inspection following a birdstrike. The manufacturer advised that due to the difficulties of a pilot reliably determining a decrease in rotor speed, the impact should initially be considered as an important hit. If no damage was identified during the blade inspection, the event could then be treated as a light hit. Based on this approach, the inspection for damage was to be carried out by a LAME due to the nature of the inspections involved.

The manufacturer advised that in relation to the tail rotor, due to the shrouded Fenestron design, it was protected from impact when stationary. If an impact occurred with the tail rotor blades in rotation, AMM work card 05-50-00, 6-4 *Steps to be Taken After Impact on the Tail Rotor Blades* required a detailed inspection to be carried out by a LAME.

As previously noted, the helicopter operator also operated R44 and Bell 206L3 helicopters to the pontoons. The inspection requirements for the R44 included:

- For a tail rotor strike, the required maintenance actions were to be performed by a LAME.
- For a main rotor blade strike the initial visual inspection could be performed by a pilot; if evidence of trailing edge buckling or bending was found then this was classified as a sudden stoppage and subsequent inspections had to be performed by a LAME.

The inspection requirements for the Bell 206L3 included:

- For a tail rotor or main rotor blade strike, if a sudden stoppage occurred with sufficient inertia to cause rapid deceleration then maintenance actions were to be performed by a LAME.
- If sudden stoppage could not be determined, a pilot could inspect the tail rotor or main rotor blades to determine damage; if visible damage was present, the required maintenance action had to be determined with the assistance of a LAME and possibly the manufacturer on a case-by-case basis.

Partly due to the remote nature of its pontoons, the operator required pilots to inspect the helicopter following a birdstrike. If the pilot was satisfied that there was no visible damage, they would fly the helicopter to a base with engineers available to carry out further inspections.

There was no specific guidance provided to pilots in the operations manual about the inspection requirements when an actual or potential sudden stoppage or significant rotor speed decrease occurred due to a birdstrike. The pilots did not have access to equipment such as a ladder or step to be able to assess visible damage to the helicopter's blades at the pontoon.

Survival factors information

Cabin layout

VH-WII had a standard cabin configuration for the EC120B with five seats. Pilot controls for the front left seat were removed and this seat was used as a passenger seat only. Figure 20 shows the inside of VH-WII.

Figure 20: Interior of VH-WII showing cabin layout

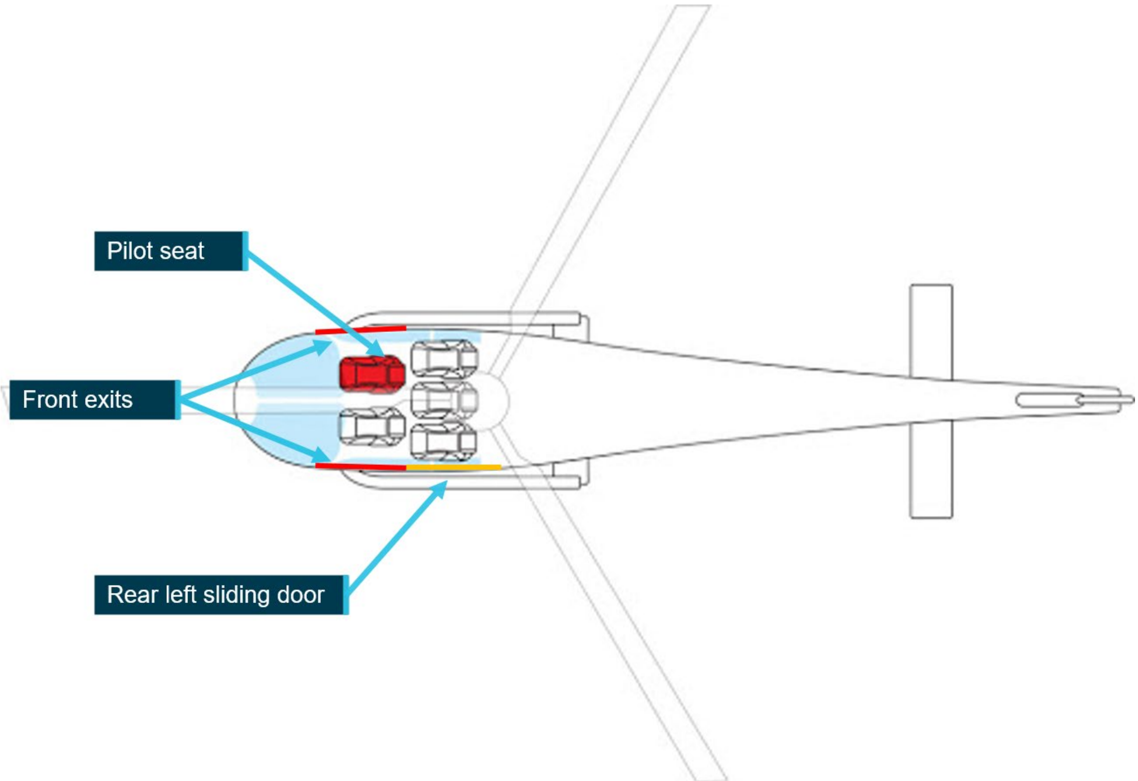
Source: Operator

Normal and emergency exits

General exit requirements

The EC120B aircraft had three doors, all of which could be used as both normal and emergency exits. These included a front right door, front left door and rear left sliding door (Figure 21).

Figure 21: Cabin plan layout showing exit locations



Source: ATSB

At the time the EC120B was certified,[38] its exits were assessed as meeting the requirements of the (European) Joint Aviation Regulation (JAR) 27.807 (*Emergency exits*). At the time of certification, this regulation stated:

> (a) *Number and location*. Rotor-craft with closed cabins must have at least one emergency exit on the opposite side of the cabin from the main door.
>
> (b) *Type and operation*. Each emergency exit prescribed in paragraph (a) of this section must--
>
> (2) Be readily accessible, require no exceptional agility of a person using it, and be located so as to allow ready use, without crowding, in any probable attitudes that may result from a crash;
>
> (3) Have a simple and obvious method of opening and be arranged and marked so as to be readily located and operated, even in darkness…

The ATSB requested information from the manufacturer about how it had been determined that the exits met the requirement to have a 'simple and obvious method of opening'. The manufacturer advised:

> By design the right and left front doors and sliding door are considered as emergency exits according to JAR 27.807. They can be opened easily from the inside and from the outside by only a simple and obvious action using the dedicated handles... There are also some markings and placards on door which described the procedure to open and close the door easily.

Operation of the exits

For normal operation, the front left and front right doors were hinged and opened outwards when their operating handle located inside was pulled upwards. These doors also each had an emergency jettison mechanism that could be used to completely release the door from the airframe. The operation of the jettison system required removing a perspex protective cover then

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38 The EC120B was certified in 1997, using the European Joint Aviation Regulation 27 as of May 1994.

pulling a handle (Figure 22) towards the ceiling; these actions released the pins that secured the door to the airframe and allowed the door to fall outwards.

Figure 22: Location and operation of the emergency jettison handle

Source: ATSB

The rear left sliding door did not have an emergency jettison mechanism; it was operated in the same way for normal operation and emergency operation. The interior operating handle for the sliding door was the same type as the operating handle used when normally operating the two front doors from the inside.

The ATSB examined the rear left sliding doors on three EC120B helicopters. It found in each case that to open the door from the inside required three actions:

- pull the operating handle upwards
- push the door outwards
- slide the door towards the rear of the helicopter.

If outward force was not applied (after lifting the handle), then the door could not be slid backwards, regardless of how much effort was applied during the sliding motion.

The manufacturer confirmed that outward pressure was required before the door could be slid rearwards. However, the manufacturer also stated that the rear attachment fittings of the door had spring-loaded pins that eased the door opening by shifting the door outwards when the handle was pulled up, although it noted that this spring effect may not be as strong as would be expected. In addition, the manufacturer advised that a ‘push out door’ effect was facilitated with a ‘normal’ operation of the door using ‘one continuous motion’. The manufacturer also subsequently stated its opinion that, if a passenger lifted the handle and then tried to slide the door rearwards without success, they would then naturally tend to push the door outwards before sliding the door rearwards

After receiving the manufacturer’s advice, the ATSB examined three additional EC120B helicopters.[39] The ATSB found the same results as its previous tests. The rear left sliding door could not be opened unless the occupant applied outward force after the handle was lifted up. This was the same regardless of whether the outward force was applied as a distinct action or as part of one continuous action when trying to open the door. The amount of force required to push the door out, before sliding the door rearwards, did not require exceptional effort.

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39 Overall, the six EC120B helicopters examined by the ATSB ranged in year of manufacture from 1999 to 2009. They were operated by four different operators.

Several experienced helicopter pilots, independent of the manufacturer and the operator, advised the ATSB that the EC120B rear left sliding door was a difficult helicopter door for passengers to open, in terms of understanding what to do rather than in terms of the force required. In addition, they had to specifically brief passengers of the need to push the door out (after the handle was pulled up and before the door was slid backwards).

The helicopter manufacturer advised that the EC130B4 door had a similar design and operation as the EC120B. The ATSB examined one EC130B4, and found there was a similar difficulty in opening the rear left sliding door, but less force was required to open the door. The manufacturer noted that a range of factors could influence the force required to open any particular door.

Visibility of the operating handles

As stated in *General exit requirements*, exits were required to be arranged and marked so that they could be readily located and operated even in darkness. In addition, JAR 27.1557 (*Miscellaneous markings and placards*) stated:

> (d) Emergency exit placards. Each placard and operating control for each emergency exit must be red. A placard must be near each emergency exit control and must clearly indicate the location of that exit and its method of operation.

The handles for the emergency release mechanisms on the front doors of the EC120B were red (Figure 22). EASA advised that, in the case of the rear left sliding door, there was no requirement for the operating handle to be a different colour to its surrounding, and that the position of the handle was indicated by the placard.

The operating handle for the rear left sliding door and the normal operating handle for the front two doors were flush with the surrounding door trim when in the closed position. The handles and the surrounding trim could be the same or different colours, depending on the interior chosen by the helicopter owner.

VH-WII's doors had a dark grey trim with black operating handles that were recessed into a black surrounding casing, similar to that shown in Figure 23.

Figure 23: EC120B interior showing the operating handles of the rear left sliding door and front right door

The above photographs are of another Australian registered EC120B, which had a similar trim colour to the accident helicopter.
Source: ATSB

Marking and instructions

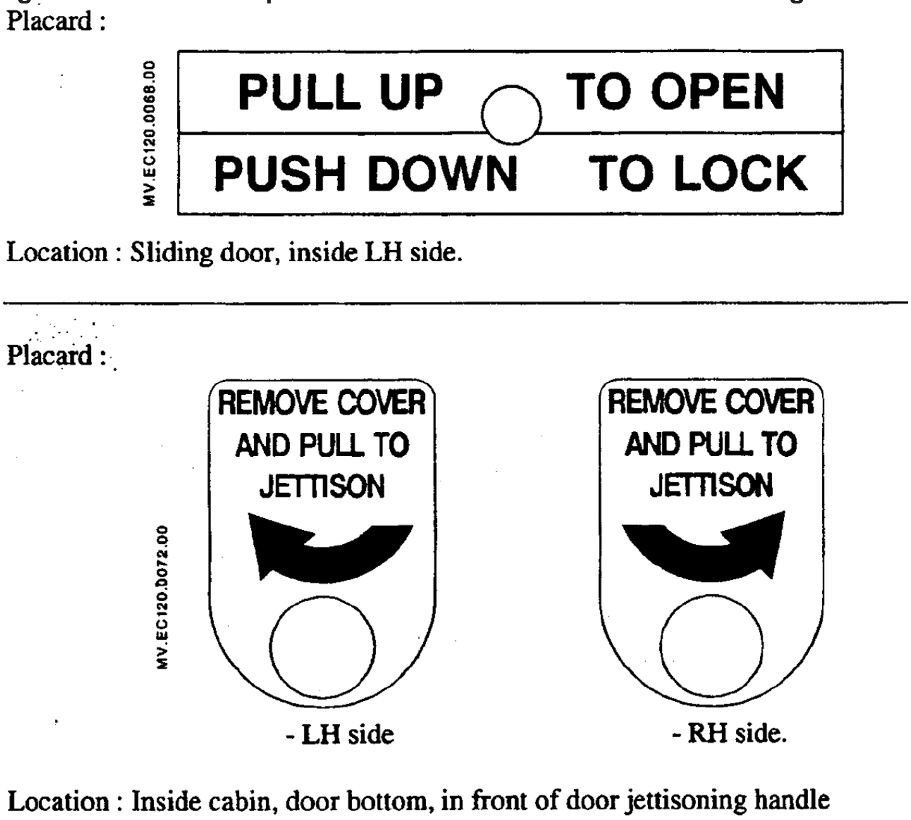
As noted above, JAR 27.1577 outlined requirements for emergency exit placards, stating they must be red and 'indicate the location of that exit and its method of operation'.

The helicopter manufacturer noted that FAA Advisory Circular AC 27-1 (*Certification of normal category rotorcraft*) provided guidance for meeting certification requirements. The manufacturer noted that in line with this guidance:

> …the rear left sliding door does not have an emergency jettison mechanism and is operated, in a normal or emergency situation, in the same "simple" and "obvious" way… There is no need for further information than the existing "PULL UP TO OPEN" placard as would be the case for an exit only used in an emergency such as the jettison of a door or window where the complete procedure is indicated on the placards.

In terms of the instructions for the operating handle of the rear left sliding door and the two front doors, the manufacturer's EC120B flight manual required that a placard stating 'PULL UP TO OPEN, PUSH DOWN TO LOCK' be placed next to the handle (Figure 24, top half). The emergency jettison mechanism for the two front doors had a different placard (Figure 24), bottom half).

Figure 24: Placard requirements as described in the EC120B flight manual



Source: Helicopter manufacturer

Civil Aviation Safety Regulation (CASR) Part 90 (*Additional airworthiness requirements*) outlined airworthiness requirements for Australian aircraft that were additional to the type certification basis. CASR 90.130 (*External doors*) required the following information to be clearly marked on the inside of a door:

> (a) the location of the handle, and
>
> (b) the operating instructions for the handle; and
>
> (c) the position of the handle when the door is properly locked, or another way of showing when the door is properly locked.

CASR 90.135 (*Emergency exits*) also required:

> Instructions showing how to open the emergency exit must be clearly marked on:
>
> (a) the inside of each emergency exit; and
>
> (b) if an emergency exit can be opened from the outside—on the outside of the emergency exit.

Colour of placards and markings

As noted in JAR 27.1557, emergency exit placards were required to be in red. The helicopter manufacturer stated that the EC120B's type design included the placards in the following colours:

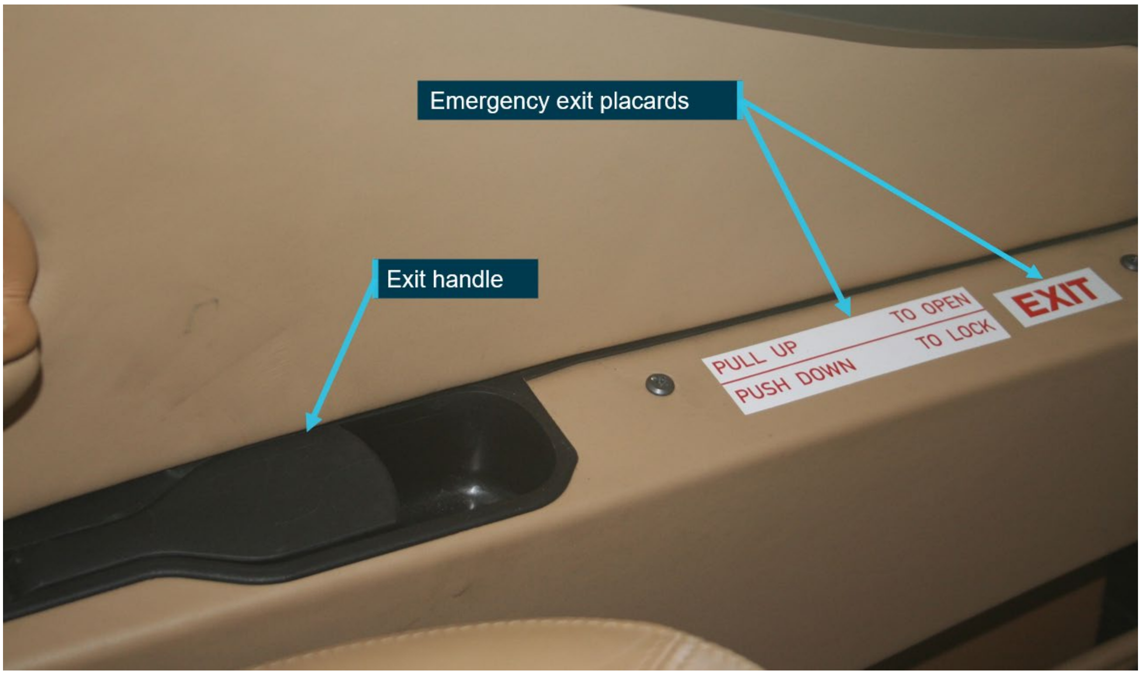
- left door jettison instruction – red marking, white background
- right door jettison instruction – red marking, white background
- left sliding door opening instruction – red marking, white background
- left sliding door 'EXIT' label – red marking on phosphorescent background.

Such placards were provided with a new EC120B helicopter, and if parts were ordered from the manufacturer's parts catalogue. The manufacturer advised that any change to the design of these markings was a change in type design, and required a certification process by the party making the change.

The helicopter manufacturer advised the ATSB that, as the rear left sliding was an emergency exit, this placard was required to be red text on a white background, like those in Figure 25. The manufacturer also advised that, because the use of the normal operating handles of the front two doors was not the means of emergency operation, the placards for the operating handles on those doors could be any colour.

For the task of replacing a placard, the EC120B maintenance manual referred to the EC120B flight manual. The flight manual showed the basic design of the placards, but it did not provide detail about the colour required for each placard. The manufacturer advised that the nature of the flight manual content could not be used as a reason for unapproved alteration of the design after delivery. The required placards were listed in the parts catalogue, but the descriptions in the parts catalogue also did not describe the colour of the placards (nor were they required to do so).

Figure 25: Manufacturer's exit markings for the EC120B rear left sliding door

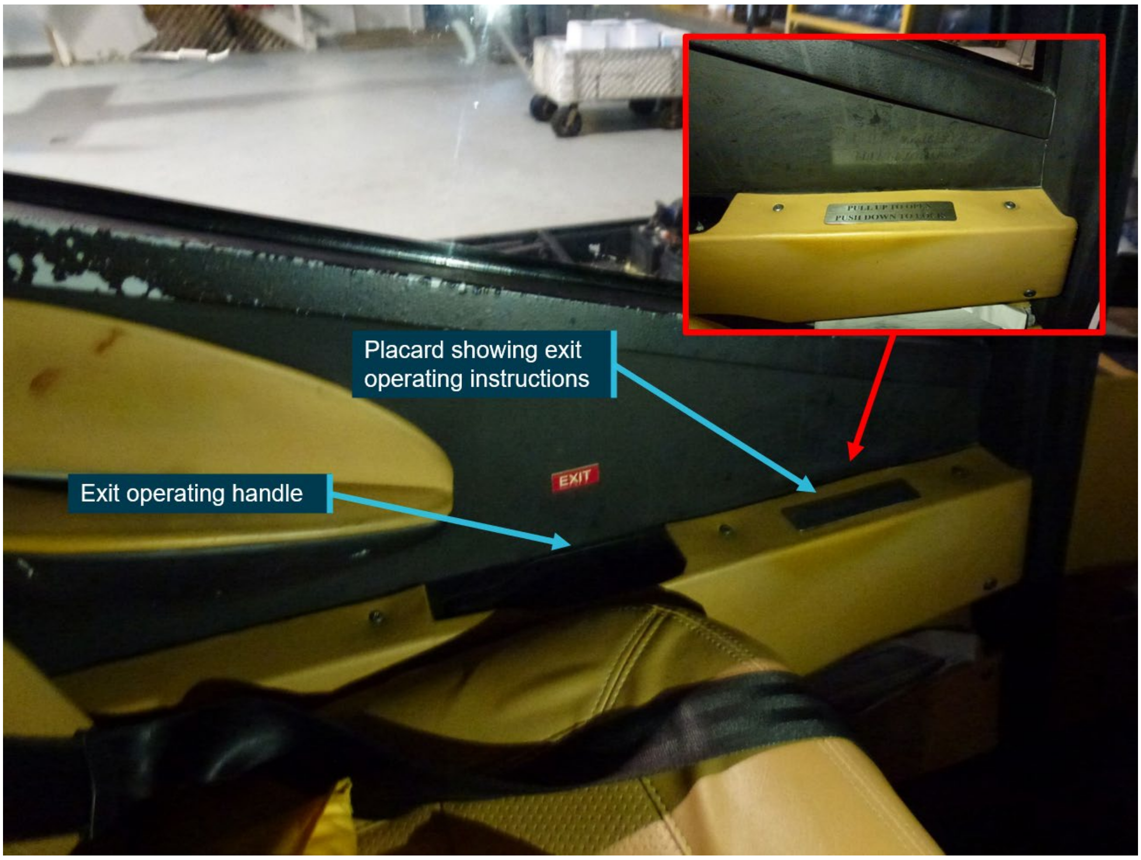


The above photographs are of another Australian registered EC120B, with emergency exit placards in the required colour scheme.
Source: ATSB

The ATSB examined the exit and door operating placards inside several EC120B helicopters and found a number of inconsistencies relating to the colour and placement of the instructions for the rear left sliding door. For example, the operator's other EC120B, VH-HIL (Figure 26), had markings on the rear left sliding door that had the correct wording but were not in the manufacturer's colour scheme (that is, red text on a white background). All three doors had the same colour placards (black text on a silver background). The same situation was found in one of the other five EC120B helicopters inspected by the ATSB.

Photos of VH-WII indicated that the placards for the normal operation of the front doors were placed just above the handle and were white text on a black background (Figure 27). No photo showing the rear left sliding door placard was available.

Figure 26: Emergency exit markings on rear left sliding door in VH-HIL



Source: ATSB

The emergency operation of the front two doors required the doors be jettisoned using the specific handle for that purpose. The manufacturer stated that the perspex cover of the jettison handles were to be marked with the words 'REMOVE COVER AND PULL TO JETTISON' (Figure 24). The cover also had an arrow that showed the direction to pull the handle (Figure 24).

The EC120B helicopters examined by the ATSB all had appropriate placards for the jettison handle of the front doors, including VH-WII (Figure 27).

The EC120B flight manual did not include an 'EXIT' sign placard. The information about placement of the 'EXIT' placards was contained in the parts catalogue only. Internal photos of VH-WII obtained by the ATSB showed 'EXIT' signs above the front exits, which had white text on a red background.

Figure 27: Photograph of VH-WII front right exit, showing the location of the normal and emergency (jettison) exit handles

Source: Image supplied, modified by the ATSB

Seatbelts

There were two different types of seatbelts in the EC120B:

- The two front seats, including the pilot seat, had a four-point harness, which included a shoulder restraint on both sides and a lap belt (Figure 28 left). Turning the rotating buckle released the harness.
- The rear passenger seats had an upper torso restraint (single diagonal shoulder restraint) and a lap belt (Figure 28 right). Lifting up the buckle released the seatbelt. The seatbelt operation was the same as on most large passenger aircraft.

Figure 28: Seatbelt mechanisms on EC120B VH-HIL front seats (left) and rear seats (right)

Source: ATSB

Passenger safety briefings

Regulatory requirements

Civil Aviation Order (CAO) 20.11 (*Emergency & life saving equipment & passenger control in emergencies*) stated an operator shall ensure all passengers are provided with an oral safety briefing before each take-off. The briefings were required to include (among other things) the use and adjustment of seatbelts, the location of emergency exits and the use of floatation devices (where applicable). There was no requirement to orally brief on the operation of the emergency exits. There was also no requirement to brief the brace position.

Civil Aviation Advisory Publication (CAAP) 253-2(0) (*Passenger safety information: Guidelines on content and standard of safety information to be provided to passengers by aircraft operators*) provided general guidance to operators about the content and presentation of information provided in both oral and written briefings. However, it did not include any specific information in the context of helicopter operations.

Operator pre-flight passenger safety briefing procedures

The operator's operation's manual stated:

> Before engine start, the pilot in command shall ensure that all hand baggage and other loose articles are safely stowed and that all passengers are clearly and audibly briefed in relation to the following:
>
> a) name of the crew;
>
> b) the use of seatbelts…and the appropriate method of fastening and adjustment. Also recommending that passengers keep their seatbelts fastened at all times in case of unexpected turbulence;
>
> c) no smoking requirements…;
>
> d) location and method of operation of the emergency exits including doors and other openings that could be used for that purpose;
>
> e) the procedures that will be followed in the event of an emergency evacuation of the aircraft;
>
> f) where applicable, the location of the life jackets or life rafts;
>
> g) the restrictions on the operation of personal electronic devices in flight;
>
> h) general details of flight time and other pertinent information.

The manual indicated that both pilots and authorised ground staff could conduct the safety briefings. There was no requirement to brief about the brace position prior to flight.

In most circumstances, prior to the pilot conducting a pre-safety briefing, the operator utilised a generic safety briefing video. The video informed passengers of the following safety information:

- the use and adjustment of one type of seatbelt
- the use of the headset on board the aircraft
- the instructions on when to remove the headset and seatbelts
- an instruction not to open the doors of the aircraft on arrival (as this would be done by crew members)
- the location and use of the life jacket
- the appropriate times to talk to the pilot
- other hazards specific to helicopters, such as not stepping on the floats and the correct way to approach the aircraft.

There was no demonstration of the aircraft exits in the video; however, the video advised passengers that the pilot would demonstrate the exits and that passengers should pay close attention to the demonstration.

There was no reference in the operator's documented procedures to the safety briefing video; however, the video was played to passengers in the lobby of the operator's terminal at Hamilton Island or during an accommodation transfer bus trip. The operator also reported having the video available in multiple languages.

The video included instructions on using one common aviation type seatbelt with an over-the-shoulder upper torso restraint (Figure 29). As there were a number of seatbelt variants, the operator's procedure required the pilot to instruct passengers on any seatbelt differences when the passengers reached the aircraft.

The chief pilot advised that, if the passengers did not see the video for any reason, such as when departing from the pontoon on their initial flight, the pilot would provide the information contained in the video in their safety briefing. When this occurred, it would include the use of and demonstration of the life jacket.

Figure 29: Still image of the aircraft seatbelt shown in the operator's safety briefing video

Source: Operator

Regardless of whether the passengers had seen the video or if the helicopter was being hot loaded, the chief pilot advised that the pilot must cover all parts of the briefing as documented in the operator's operations manual.

In addition to the pre-flight briefing and consistent with guidance material, the operator's operations manual contained procedures for several in-flight emergencies, and some of these required the pilot to tell passengers to adopt a brace position. No guidance was provided in the manual regarding appropriate brace positions for passengers wearing different types of seatbelts.

Passenger briefing practices

Interviews of the operator's personnel found that, after passengers had viewed the video, it was typical for the guest liaison officer and other staff to assist the passengers into the aircraft, fit their seatbelts, and assist them with their headsets. They would also take any passenger baggage and load it into the baggage compartment.

Personnel who loaded passengers onto aircraft stated that, after they loaded the passengers and fastened their seatbelts, they did not brief the passengers on how to use the seatbelts. They also did not provide any briefing on how to use the doors. They advised that the pilots would cover any information not covered in the video.

Pilots reported that, in a hot-loading scenario, they would brief the passengers once they were wearing their headsets inside the aircraft. Several pilots stated they would cover how to operate both the doors and the seatbelts during their safety briefing. Some pilots reported that, because the rotors were turning and they could not leave their seats, it was not always possible for them to physically show the passengers how to operate the doors or show them the unfastening and fastening of their seatbelts. One pilot advised that they would physically show the use of the front left seatbelt.

In comparison, when the engines were shut down, the pilots would collect the passengers from inside the terminal and brief the passengers at the helicopter. Pilots reported that, when they conducted this briefing at the helicopter, the passengers were physically shown the operation of the doors and the pilot assisted them with their seatbelts.

The pilot of the accident flight reported that they had only ever hot loaded passengers in the EC120B. They also reported being aware of a requirement to tell the passengers how to identify and use the helicopter doors, and would advise passengers that their emergency exit was the door closest to them and they were operated by lifting the handles up. The pilot stated that everything else was covered in the passenger safety briefing video, and they did not normally brief about how to operate the seatbelts. They did advise passengers not to talk during the initial stages when the pilot would be talking on the radio and that they would get back to them as soon as the helicopter was airborne.

Interviews with a number of the operator's pilots, including the chief pilot, confirmed that the emergency operation of the front exits of the EC120B (use of the jettison handle) was not communicated to passengers during a pilot's briefing. This was to prevent inadvertent operation during normal operations, which could cause damage to the helicopter door. This information was instead provided on the safety briefing card.[40]

Briefing for the accident flight

The rear left passenger had not previously flown in a helicopter before, and the rear right passenger had only flown in a helicopter many years before.

The pilot of the accident flight stated that they did not specifically point out the helicopter's doors to the passengers but provided their normal briefing (see above). The surviving passengers did not recall the pilot making any mention of the doors.

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[40] Another operator of EC120B helicopters advised that it would include this information in its verbal briefing to passengers but reported it had experienced an incident of inadvertent operation of the jettison handle, which had resulted in damage to the door.

The pilot, loading personnel and the surviving passengers did not recall anyone briefing the front left passenger regarding how to release or operate the four-point harness.

As indicated in *The occurrence - Loss of control and collision with water*, the pilot advised they had no time after the sudden left yaw started to conduct a briefing or warn the passengers that the helicopter would impact the water. The pilot also indicated that they had no time to direct the passengers to adopt the brace position.

Safety briefing cards

CAO 20.11 only required a safety briefing card for regular public transport and passenger charter flights in aircraft with a seating capacity of more than six (including crew). Although not required, the operator had chosen to have a briefing card available on each of its aircraft types, including the EC120B.

The operator provided the ATSB with a copy of a safety briefing card that was in use at the time of the accident (Figure 30). The card depicted was used for the EC120B, however the content on the card referred to the EC130 type helicopter, which has seven seats in its basic configuration, but the same type of life jacket, similar exit location, and similar exit operation as the EC120B.

Figure 30: Front page of the safety briefing card used by the operator for the EC120B helicopter

Source: Operator

The briefing card contained information in two languages and included pictorials. As well as information about how to safely approach and leave the helicopter, it included written instructions about the brace position. More specifically:

> **IN AN EMERGENCY**
>
> In the event of an emergency landing adopt the brace position. If you can reach the seat in front of you, cradle your head against it. If you can't reach the seat in front, put your head down and hug your knees.

This information was appropriate for passengers wearing a lap belt only (that is, not wearing an upper torso restraint or four-point harness as in the EC120B helicopter). At the time of the accident, CASA had not published specific guidance for brace positions, including for helicopter occupants. However, other organisations, such as Transport Canada and the US Federal Aviation Administration (FAA), had recently published guidance, including for helicopter occupants. For upper torso restraints, Transport Canada recommended to adopt an erect brace position with either the hands placed on the knees or holding the front edge of the seat (diagonal restraint) or arms crossed over the chest (four-point restraint) and the chin tucked down, resting on the sternum or in the space created between the arms.[41] The FAA offered similar advice, however it advised that it was not recommended to hold onto any part of the restraint system.[42]

The operator's briefing card also included information about operating the doors:

> **DOOR OPERATION**
>
> Normal door operations – lift black latch and then either push door open or slide door backwards.
>
> **EMERGENCY DOOR OPERATION**
>
> To jettison doors (front doors only) – Break plastic tab and pull lever in direction of arrow (which is always towards the roof of the aircraft)

There was text referring to the seatbelt, however this simply stated that the seatbelt was to be worn at all times.

The operator reported that safety briefing cards were available on VH-WII. The pilot could not recall if there were cards present on the helicopter, and they did not refer to any cards in their briefing. The surviving passengers did not recall seeing a safety briefing card.

Passengers requiring additional assistance in an emergency

CAO 20.11 required that a person requiring special attention because of illness, age or other temporary or permanent disability or incapacitation be 'given an individual briefing appropriate to the needs of the person in the procedures to be followed in the event of emergency evacuation'.

In terms of identifying persons that required special assistance, CAO 20.16.3 (*Air service operations – carriage of persons*) stated:

> 14.1 The operator of an aircraft must, as much as possible, identify any person on the aircraft who requires assistance due to sickness, injury or disability.
>
> 14.2 The operator and pilot in command of an aircraft must ensure that any person who requires assistance due to sickness, injury or disability is not seated where he or she could obstruct or hinder access to any emergency exits.
>
> 14.3 If a person who requires assistance due to sickness, injury or disability is carried on an aircraft, the operator and pilot in command must:
>
> (a) take all reasonable precautions to prevent hazards to other persons on the aircraft; and
>
> (b) ensure that there are procedures in place to enable particular attention to be given to any such passenger in an emergency; and
>
> (c) ensure that individual briefings on emergency procedures are given to any such person in accordance with Civil Aviation Order 20.11.

The operator's procedure reiterated the regulatory requirements, in so far as it required the pilot in command to identify as much as possible (during loading) any person that due to sickness, injury or disability may require additional assistance. It also required that this person be briefed as per the requirements of the CAO.

The operator's pilots and other staff reported that they carried passengers with special needs on their charter flights to Hardy Reef, and the chief pilot advised that in some cases this was the only way less mobile passengers could see the Great Barrier Reef. Although not documented, the operator's expectation was that passengers would provide information on any special

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[41] Transport Canada (2016) Advisory Circular (AC) No. 700-036, *Subject: Brace for Impact Positions for all Aircraft Occupants.*

[42] Federal Aviation Administration (2016), Air Carrier Operations Bulletin 1-94-17, *Brace for impact positions.*

requirements during the booking process. There was no prompt for passengers to provide this information during the booking process.

In terms of advice to pilots about passengers with special requirements, some pilots reported that they would be advised by radio prior to the flight, and others said that any special requirements would be noted on the flight manifest or, if there was someone with a less serious impairment, they would notice when the passenger got to the aircraft. Ground staff advised that they would assess the passenger on sight, if they had not received any special requests during booking.

The passengers on the accident flight did not report that they were unfit or required any special assistance. However, the passenger seated in the front left seat was wearing a brace on their right arm, which was due to an injury obtained during the days prior to the accident. The pilot and other staff members recalled that this passenger had a noticeable right arm impairment and that it took some additional time for the passenger to get into the helicopter and put their headset on. Neither the pilot or other staff members provided this passenger with any additional briefing regarding their four-point harness or the operation of the front left door.

Staff members also noted that the rear middle passenger was slow walking out to the helicopter, and needed some assistance getting into the helicopter, but that this passenger’s movement seemed appropriate for their age.

Life jackets

The life jackets worn by the passengers were a twin chamber pouch type life jackets manufactured by Eastern Aero Marine (EAM). They met the Australian requirements for constant-wear life jackets.

The life jackets were fitted around the waist of the passengers prior to departure, and they were designed to be able to be removed from the pouch and donned with one hand. The passengers received information about how to use their life jackets in the pre-flight safety video. The pilot wore a vest-style constant-wear life jacket, which contained a personal locator beacon in a pouch.

Emergency floats

CAO 20.11 paragraph 5.3.1 required:

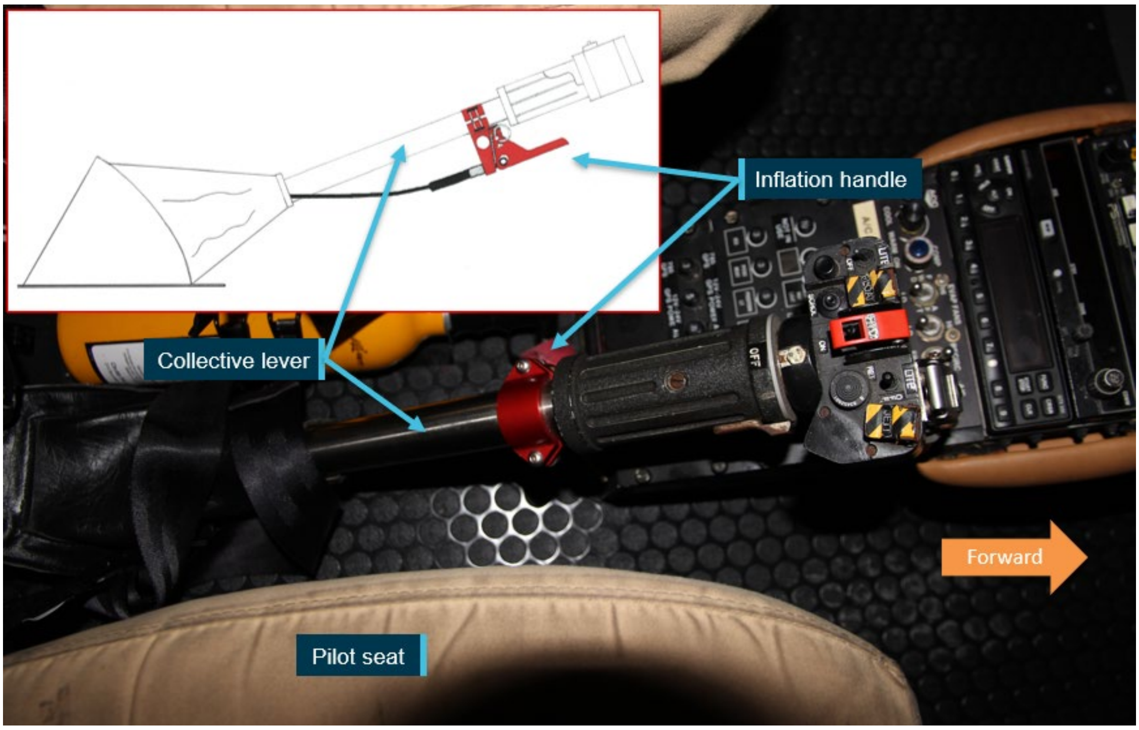
> A single engine helicopter engaged in passenger carrying charter operations shall be equipped with an approved flotation system whenever the helicopter is operated beyond autorotative gliding distance from land…

The EC120B was not certified for ditching. However, the helicopter could be fitted with an emergency floatation system to aid with keeping the helicopter upright and in adequate trim to permit a safe and orderly evacuation.

VH-WII was fitted with a Dart Aerospace emergency floatation system. This aftermarket system was installed in accordance with an FAA-approved supplemental type certificate. The floats were designed to be used in the case of an emergency landing on water.

The floats were not automatic and needed to be armed (by removing a locking pin) and then activated via a trigger on the collective handle (Figure 31). Activation of the system released compressed helium, which inflated the float assemblies attached to the skids of the helicopter. The inflation took about 3 seconds.

Figure 31: Collective-mounted float activation handle



Source: ATSB and DART Aerospace installation instructions, annotated by the ATSB

The pilot of the accident flight reported that their normal practice was to arm the system (remove the pin) when loosening the friction locks on the controls at the start of a flight, and to replace the pin when fastening the friction locks again after landing.

The pilot recalled removing the pin at the start of the accident flight. They also stated that they knew how to activate the floats, but did not have time to do so during the accident sequence.

Ditching or emergency landing on water

The flight manual supplement for the float system fitted to VH-WII required the floats to be inflated before contact with water in the event of an emergency landing. The supplement instructed pilots to conduct a normal or an autorotative landing to the water into wind with a touchdown speed of 10 kt.

The emergency procedures section of the operator's operations manual contained the actions and considerations for flight crew in the event of a ditching. Among other things, these included:

> Flight crew should never take for granted that people already know how to exit a helicopter no matter how much care has been taken in the passenger briefing…
>
> The pilot should keep commands simple and concise, since it is likely that passengers will cease to listen much beyond the initial order to evacuate…
>
> Ensure you know the location of, and how to use, ALL exits... If possible, allow passengers to practice opening the exit(s) before engine start up.
>
> Being underwater and possibly upside down can cause orientation problems. Once the movement and turbulence of the ditching has subsided, then you may still need to help passengers establish positive situational awareness so that they can determine up from down…
>
> Locate the exits in relation to your seatbelt buckle. If the exit is on your right while upright then it will still be on your right in the event the helicopter comes to rest inverted. No matter how disorienting an accident, as long as your seatbelt is fastened, your relationship to the exit(s) remains the same…

Documented were additional instructions if the helicopter began to roll before all occupants had evacuated, which included:

a) take a normal breath as the helicopter begins to roll and locate the seat belt buckle;

b) remain strapped in until all motion has ceased;

c) locate the door handle or emergency exit handle relative to the seat buckle;

d) release the seatbelt and open door/emergency exit;

e) evacuate by following your hand out the exit;

f) locate the ELB [emergency locator beacon] and activate immediately.

In addition, the operator's procedures stated:

> If the helicopter lands controlled or uncontrolled into the water, attempt to activate the pop out floats if the helicopter is so equipped;
>
> (i) If float activation is unsuccessful, the helicopter may float for a short period of time or sink, depending on the damage caused to the cabin area during the ditching.
>
> (ii) If float activation is successful, or the helicopter has fixed floats, there exists a high probability that the helicopter will float either upside down or on its side:
>
> **therefore, passenger extraction is not only necessary, but paramount in all situations.**

The passengers on the accident flight were loaded into the helicopter while the rotors were turning and did not have an opportunity to practice operating the exits. The passengers advised that they did not receive any information about how to evacuate if the helicopter landed on water, aside from the use of the life jacket and that the helicopter had an emergency pop-out float system.

Helicopter underwater escape training (HUET)

Helicopters that ditch onto water usually roll inverted and then rapidly sink, due to the weight of the engine(s) being at the top of the helicopter, close to the main rotor. HUET is a training course that utilises a simulator to train crewmembers in underwater escape procedures. The training incorporates scenarios that involve escape from a helicopter cabin that has submerged and inverted in water, including operating various types of exits. The training also covers the use of life jackets in such scenarios.

There was no regulatory requirement for pilots of passenger charter flights to have undertaken or maintain currency in HUET. The operator required pilots to have a current HUET qualification at the commencement of employment, however there was no requirement to then complete the training on an ongoing basis. The operator used a pilot's HUET qualification to fulfil a regulatory requirement in CAO 20.11 for pilots to demonstrate proficiency in the use of a life jacket in water. Following that demonstration, and as per the CAO requirements, the pilots would demonstrate the use of the life jacket without being required to do so in water.

The pilot of the accident flight had completed HUET prior to being employed by the operator. To maintain currency they had organised and completed a HUET course in August 2017. That HUET course was a generic course that covered a range of subject matter including the use of life-saving equipment such as life jackets. The life jackets utilised in the course were the same as those provided to passengers in larger airlines, which was different to the constant-wear vest type life jacket used by the pilot.

Research related to passenger escape from a helicopter

Research conducted by Brooks and others (2008) showed that key factors reducing survival rates in civilian helicopter accidents into water were:

- inadequate pre-flight briefings
- very little warning time for preparation before the accident
- inadequate breath holding ability in cold water
- darkness and disorientation
- difficulty locating and jettisoning exits

- hampered escape due to debris.

One of the recommendations from the research was that crew and passengers be briefed on what to expect if a helicopter lands on water; that is, that it will likely invert, capsize and sink, and they should be prepared to make an underwater escape with very little warning.

In 1998, the Canadian Safety of Air Taxi Operations Task Force (SATOPS), which was formed within Transport Canada, produced a report on the air taxi sector.[43] The report contained a similar recommendation and suggested industry action, namely:

- a recommendation that Transport Canada develop a brochure outlining underwater egress procedures that air operators can provide to their passengers and clients
- industry action that required floatplane pilots and helicopter pilots operating over water to include information on underwater egress procedures in the passenger briefing.

Following the recommendation, Transport Canada developed brochures *TP12365 Seaplane/Floatplane - A Passenger's Guide* and *TP4263B Safety around Helicopters* designed to be used for briefing passengers travelling on floatplanes and helicopters. Both brochures covered information about what to do in emergencies including a ditching and the brace position. Although both brochures covered the topic, the floatplane brochure contained more detailed information about underwater egress.

Other research has indicated the importance of the brace position and emergency exit illumination to increase the chances of survival when landing on water in a helicopter. For example, Brooks (1989) highlighted that the brace position increases survival by:

- reducing the strike envelope of the arms, legs, and head on the cabin contents
- stabilising the survivor in the seat and minimising disorientation during and immediately after impact (particularly during an accident with smoke/fire or sudden in-rushing water)
- (specifically for underwater escape) minimising the profile of the body to in-rushing water, which further increases disorientation
- presenting a smaller human target area to flying debris
- providing the survivor with a good physical reference from which to rapidly re-orient and rationally consider what escape path to take.

Although training and briefings that explain what to do if the helicopter lands on water and the cabin submerges can greatly reduce egress fatalities, it cannot entirely solve the problems of darkness, disorientation, and lack of visibility through bubbles and debris. At the time of the Brooks paper (1989), there had been considerable research on underwater lighting, however manufacturers and operators were yet to implement any changes as a result. Research by Ryack and others (1986) concluded that the smallest back-lit letter readable underwater at night was 3 inches (7.6 cm) high. During bright daylight underwater, the smallest printed black letters on a metallic background that could be read were 2.25 inches (5.7 cm) high. Overall, the researchers concluded it was not feasible to use printed instructions underwater.

Other research by Kinney and others (1967) found that the optimum colours for marking hatches/exits were:

- fluorescent orange for rivers, harbours and other turbid bodies of water, with non-fluorescent colours of good visibility being white, yellow, orange and red

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[43] The air-taxi sector includes those Canadian air operators covered under Subpart 703 of the Canadian *Civil Aviation Regulations* (CARs) who utilise the following type of aircraft for air transport service or aerial work involving sightseeing operations: single engine aircraft, multi-engine aircraft other than turbo-jet powered aeroplanes with a maximum take-off weight of 8,618 kg or less and a seating configuration of fewer than nine, multi-engine helicopters flown in visual flight rules by a single pilot, and any other aircraft specifically authorised.

- fluorescent green and orange for coastal waters of mediocre clarity and white, with yellow and orange being the best non-fluorescent
- fluorescent green and white for clear waters.

The most difficult colours to see were grey and black.

In November 2020, EASA released a comprehensive report that comprised a literary review on the topic of helicopter underwater escape, consolidating previous research. The report highlighted the problems that can be experienced during underwater escape and reinforced that issues still existed that had not been adequately addressed. These included, but were not limited to: a recommended brace position for helicopter occupants utilising upper torso restraints, disorientation, and problems associated with visibility under water and emergency exit useability.[44]

Medical and pathological information

Passenger background information

The passenger seated in the front left seat was 65 years old. They were taking a number of medications at the time of the accident, including some that may cause drowsiness. Aside from the pre-existing right arm injury, that occurred 2 days prior to the accident, the passenger was reportedly fit and well.

The rear middle passenger was 79 years old. They were reported to have had a heart condition, which required the use of medication.

As noted in *The occurrence - Evacuation*, both of these passengers were reported to be unconscious after the impact and after they were assisted from the helicopter.

Post-mortem examination

The post-mortem examination reports stated that the ‘direct cause’ of death for the front left passenger and the rear middle passenger was drowning, with the ‘antecedent cause’ for both passengers being a helicopter accident. Another antecedent cause for the front seat passenger was a head injury (to the left side of the head). The post-mortem examination of the rear middle passenger also noted that they had ischaemic heart disease (including severe coronary artery atheroma and evidence of a previous heart attack).[45]

The deceleration forces did not exceed human tolerance and the structure (survivable space) remained relatively intact. Given these circumstances, the ATSB engaged an aviation medical expert to review the available information to determine if the injuries sustained by the deceased passengers affected their ability to escape.

The medical expert found that the head injury sustained by the front left passenger was of sufficient force to have led to unconsciousness. The injury was very likely sustained during the impact sequence, and more likely from contact with the door or door pillar rather than the instrument console. The expert also noted that, had the passenger been conscious, the effect of the head injury, the pre-existing arm injury and medications used by this passenger would have also influenced their ability to egress the helicopter.

With regard to the rear middle passenger, the medical expert noted that the passenger had sustained an injury to the left side of the head, although noted that it was less likely that they were rendered unconscious by that injury. They also stated that advanced stage coronary artery disease would have put this passenger at very significant risk of a heart attack when confronted with the emergency. The expert indicated that both the head injury and the coronary artery disease could have contributed to the passenger drowning.

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44 European Union Aviation Safety Agency (2020), Research report, *Underwater escape from helicopters*.

45 If a heart attack occurs immediately before death, there will generally be insufficient time for relevant changes to be detectable in a post-mortem examination.

Regulatory oversight

The Civil Aviation Safety Authority (CASA) was responsible, under the provisions of Section 9 of the *Civil Aviation Act 1988*, for the safety regulation of civil aviation in Australia and of Australian aircraft outside of Australia. Section 9(1) stated the means of conducting the regulation included:

> (c) developing and promulgating appropriate, clear and concise aviation safety standards;
>
> (d) developing effective enforcement strategies to secure compliance with aviation safety standards…
>
> (e) issuing certificates, licences, registrations and permits;
>
> (f) conducting comprehensive aviation industry surveillance, including assessment of safety-related decisions taken by industry management at all levels for their impact on aviation safety…

The two primary means of oversighting a specific operator's aviation activities were:

- assessing applications for the issue of or variations to its AOC and associated approvals (including approvals of key personnel)
- conducting surveillance of its activities, including level 1 surveillance events (such as systems audits) and level 2 surveillance events of shorter duration and narrower scope (such as site inspections and ramp checks).

Detailed discussion of CASA's processes for oversighting passenger charter operators for the period up to 2017 was provided in a recent ATSB report into a fatal Cessna 172 accident.[46] That report (released in October 2019) identified that, although the Cessna 172 operator's primary activity since July 2009 was passenger charter flights to beach aeroplane landing areas (ALAs), regulatory oversight by CASA had not examined the operator's procedures and practices for conducting flight operations at these ALAs. The ATSB investigation also identified the following safety issue:

> The Civil Aviation Safety Authority's procedures and guidance for scoping a surveillance event included several important aspects, but it did not formally include the nature of the operator's activities, the inherent threats or hazards associated with those activities, and the risk controls that were important for managing those threats or hazards.

The ATSB issued a safety recommendation (AO-2017-005-SR-026) to CASA in October 2019 to address the safety issue, and this recommendation was closed in March 2020 after CASA outlined the safety actions it had taken and was taking to address the issue. A similar safety issue was also previously identified in another ATSB investigation.[47]

During the period from 2013 until the time of the 21 March 2018 accident involving VH-WII, CASA conducted two scheduled level 1 surveillance events of Whitsunday Air Services (fixed wing and helicopter operations combined). These events were conducted in 2014 and 2017, with the latter being a 'health check' conducted in December 2017. CASA also conducted several level 2 surveillance events. One of the level 2 surveillance events was in response to a specific accident,[48] two events in response to complaints, and others were conducted when interviewing candidates for the position of head of aircraft airworthiness and maintenance control. None of the surveillance events specifically examined the following topics:

- helicopter operations to the pontoons at Hardy Reef
- bird hazard management at Hardy Reef
- passenger loading and safety briefings.

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[46] ATSB ASO-2017-005, *Collision with terrain following an engine power loss involving Cessna 172M, VH-WTQ, 12 NM (22 km) north-west of Agnes Water, Queensland, 10 January 2017.*

[47] ATSB AO-2009-072 (reopened), *Fuel planning event, weather-related event and ditching involving Israel Aircraft Industries Westwind 1124A, VH-NGA, 6.4 km WSW of Norfolk Island Airport, 18 November 2009.* (Released in November 2017.)

[48] AO-2017-110, *Partial engine power loss and ditching involving Robinson R44, VH-WRR, 49 km N of Hamilton Island Airport, Queensland, on 8 November 2017.*

The surveillance events and authorisation holder performance indicator questionnaires completed by CASA inspectors about twice per year did not identify any significant concerns in relation to the operator.

Safety analysis

Introduction

Just prior to landing on a pontoon at Hardy Reef, the pilot of an EC120B helicopter, registered VH-WII, decided to conduct a go-around. During the go-around, the helicopter yawed unexpectedly and rapidly to the left. Although the pilot attempted to arrest the yaw, this was not successful. The helicopter descended and impacted the water. It then rolled to the right and the cabin submerged.

This analysis first considers factors that reduced the flight's safety margin. It then discusses the decision to conduct a go-around when in close proximity to the pontoon, the execution of the go-around, potential explanations for the rapid yaw to the left, and the pilot's response to the rapid yaw. It also discusses contextual factors that potentially influenced the pilot's performance during this period.

In addition, the analysis discusses a number of additional safety factors identified during the investigation, which relate to pilot training and consolidation, aircraft loading, and management of bird hazards. Given that this was a survivable accident but two of the five occupants did not survive, the analysis also discusses a number of aspects related to survival factors.

Factors influencing the flight's safety margin

A number of factors combined to reduce the safety margin associated with conducting the flight to the pontoon, particularly if a go-around was initiated very late in the approach.

Firstly, there was a reduced power margin available to the pilot on the final approach to the pontoon. This was due to:

- The aircraft was overweight on departure from Hamilton Island. Being overweight on departure meant that when the pilot reached the pontoon the helicopter was heavier than it should have been. Although it was below the maximum allowable weight when operating at the pontoon, it was close to this maximum allowable weight.
- The helicopter's engine power output was close to the lowest allowable limit for the helicopter type.
- The pilot was required to use high power to make a slow final approach in order to disperse birds from the pontoon.

In summary, the helicopter was probably at or close to maximum continuous power towards the end of the approach, in a helicopter that many pilots have stated has less available power than similar types. In addition, the pilot pulled power to the red line (maximum take-off power) when they decided to go around, increasing the torque and, with it, the amount of right pedal required.

Secondly, consistent with the operator's normal practice, the pilot was attempting to conduct a left turn onto the intended landing position at the pontoon, with the wind being about 20 kt from the right of the intended position. The operator advised that a left turn into the right crosswind reduced the magnitude of right pedal input (and therefore power) required when making the turn. However, the disadvantage of turning left into a right crosswind for a helicopter with a main rotor that rotated clockwise is the reduced availability of an into wind escape route after the turn had commenced.

In its 2019 safety information notice, the helicopter manufacturer advised against conducting left turns at low airspeed, especially in performance limited conditions. The right crosswind landing with a left turn to the intended landing position increased susceptibility of an unanticipated left yaw if the left turn was not effectively controlled. If this left yaw continued toward a downwind position, there was a significant risk of a sudden increase in rate of turn and loss of control.

Finally, although legally qualified to conduct the flight, the pilot was inexperienced on the helicopter type, and the opportunity provided for consolidating their skills on the helicopter type was limited (see *Pilot experience and consolidation on the EC120B* below).

Overall, with the exception of departing Hamilton Island over the maximum allowable weight, these factors were within the relevant regulatory requirements or limits for the flight, and it is noted that some of these factors may be a common feature of many helicopter operations. However, the combination of these factors in this case resulted in a reduced safety margin for the final approach and landing, and particularly for a go-around at a late stage in the approach. If the combination of these factors (or many of these factors) had not existed, then it is likely that the pilot would have been able to more effectively manage the landing and conduct a go-around (if required).

Go-around

Decision to go-around

The pilot reported experiencing a high workload during the final approach. When a message appeared on the vehicle engine multifunction display (VEMD) the pilot decided to conduct a go-around to allow time to diagnose the problem.

The pilot recalled that they had commenced the left turn to the intended landing position and the helicopter was about 20 ft above the water (pilot eye height) and just over the pontoon when the VEMD message occurred. They stated there were no problems with the position or performance of the helicopter at that time. Analysis of a photograph taken by the rear right passenger (image 0620) indicated the helicopter reached a height of about 15 ft above water (passenger eye height), with the helicopter's skids just over the edge of the pontoon and at a height of about 7 ft above the pontoon deck. Both passengers also reported that the helicopter had come close to or possibly touched the pontoon prior to the go-around.

Although the exact nature of the VEMD message could not be determined, none of the possible VEMD messages required immediate action. Accordingly, if the helicopter was in an appropriate position to continue the landing, the ideal option at that stage would have been to continue the landing.

Nevertheless, the decision to conduct a go-around is understandable and justified if a pilot believes that any element of the system, including the helicopter, the landing site or even the pilot, is not correctly configured or will not remain correctly configured for landing. A go-around is considered a normal procedure and, although it is not often required, with appropriate training, planning and preparation it should not result in increased risk.

The operator's pilots stated that the normal decision point for continuing a landing would be at about 200 ft above mean sea-level on final approach. At 200 ft, if a missed approach or go-around was required, the airspeed and altitude of the helicopter would allow the pilot to comfortably achieve best rate of climb speed (Vy) and establish a controlled positive rate of climb in the desired heading, within the power margins available.

With enough height, a go-around conducted prior to arrival at the pad could be made without an increase in power required. By allowing the helicopter to accelerate to reach Vy by descending, aerodynamic properties of the helicopter can be used to reduce the power required to fly away.

In this case the go-around did not commence until the helicopter was just over the pontoon and had commenced the left turn in a right crosswind. At this point, achieving Vy and a positive rate of climb required significantly more power and aircraft management.

Execution of the go-around

When the pilot made the decision to go-around, they were in the process of turning the helicopter left into the intended landing position, with the helicopter at a low height and airspeed and with a right crosswind. The pilot's intended go-around path was to the right and into wind.

However, the available evidence indicates that the helicopter continued to yaw to the left after the go-around was initiated. More specifically:

- The pilot estimated the helicopter being about 20–30° right of the intended landing heading when the VEMD message occurred and they decided to initiate the go-around.
- Analysis of the photograph taken by the rear right passenger when the helicopter was close to the pontoon (image 0620) showed that the helicopter was oriented about 0–15° right of the intended landing heading. This indicates the helicopter had yawed further left than the pilot's estimated position when the go-around was initiated.
- The passengers both reported that the helicopter was yawing to the left as it was climbing during the initial stages of the go-around. Their impression was that the pilot was turning around to land on the pontoon from the other side.
- Analysis of another photograph taken by the rear right passenger (image 0621) showed that the helicopter had yawed further left at least 10–20°, and up to 60°, as well as climbed, during the 8 seconds after image 0620 was taken.
- To conduct a go-around into wind from a position with low height, low airspeed, a right crosswind, high all-up weight and limited available power, would require forward-right cyclic input to drive the main rotor into wind, which would be the desired direction of travel. With power limiting the amount of right pedal available, that manoeuvre would expose the helicopter to airflow from the right, causing the cabin to tip to the right. It is probable that this would have been perceivable to those on board as an uncomfortable slide to the right on their seat as the helicopter climbed away in unbalanced flight. This was inconsistent with the passengers' recollections.

The helicopter was not recovered and could not be examined. However, based on the available information, there was no indication that a technical fault with the helicopter or its relevant systems contributed to the ongoing left yaw during the initial stages of the go-around.

The most likely reason for the helicopter yawing left during the go-around was the pilot applying insufficient right pedal input during this period, and the contextual conditions were conducive to this being the case. More specifically:

- The pilot reported that the go-around was conducted by climbing away from the pontoon. To climb would have required the use of increased power, which would have resulted in an increased rate of left yaw unless the pilot applied significant right pedal input (requiring even more power).
- The pilot reported keeping the power at or close to maximum take-off power during the go-around, and therefore they had limited power available to correct the yaw. As the helicopter kept yawing further left, it would have reached the point where applying sufficient right pedal to arrest the yaw and then yaw right would have meant exceeding engine limitations. Based on the available evidence, there were no indications an exceedance occurred after the go-around was initiated.
- Arresting the left yaw required the pilot to promptly apply significant right pedal input of more than 75 per cent. The pilot's description of events did not include mention of applying significant right pedal input during the initiation of the go-around sequence (and prior to the rapid yaw to the left). It is also worth noting that the pilot had recently been advised by the chief pilot to be gentle on the pedals to avoid exceeding engine limitations.
- There have been several previous accidents where pilots have not applied sufficient right pedal input during left turns at low height and low airspeed in EC120B or similar helicopters, resulting in an unanticipated developing yaw to the left (and ultimately a rapid left yaw and loss of control). In many of these accidents, the pilots involved had a low level of experience on the helicopter type or similar types with a Fenestron, similar to the pilot involved in this accident.
- Associated with their low level of experience on the helicopter type, the pilot was experiencing a very high workload during the go-around sequence, which could have contributed to a delay

in applying sufficient right pedal input or the ability to control the helicopter (see also *Factors influencing pilot performance* below).

In summary, during the go-around from just above the pontoon, with about a 20 kt crosswind from the right, the helicopter yawed slowly to the left while climbing, and the pilot very likely did not apply sufficient right pedal inputs to correct the developing yaw while attempting to direct the helicopter into wind.

The investigation could not fully explain why the pilot believed the helicopter turned to the right during the go-around, inconsistent with the other available evidence. A person's memory about a sequence of events during a serious incident or accident can be affected by a range of factors, including their workload, the complexity of the events, the pace at which the events occur and interference from other sequences of events that may occur before and after the sequence of interest. Even if many of the events are recalled, the memory of the sequence in which they occurred may not be accurate (Davis 2001).

Rapid left yaw

Nature of the rapid left yaw

The pilot and passengers all reported that, soon after the go-around commenced, the helicopter yawed suddenly and rapidly to the left. The passengers reported that this occurred after the helicopter had climbed and yawed some way to the left. The pilot recalled that it occurred when the helicopter reached about 40 ft above the water and had an airspeed of about 35–40 kt.

The pilot reported hearing and feeling a thud through the helicopter's controls at the same time the helicopter yawed suddenly to the left. The passengers did not report hearing or feeling anything distinctive at the time.

The ATSB considered a range of potential explanations for the rapid yaw to the left, including:

- birdstrike or other foreign object damage to the tail rotor
- technical failure
- developing yaw due to insufficient right pedal input.

Birdstrike or other foreign object damage to the tail rotor

There were undoubtedly many birds present on the pontoon during the helicopter's approach. The ATSB also notes that the pilot believed that, in hindsight, the thud and sudden yaw was indicative of a birdstrike to the tail rotor. In relation to this scenario:

- If a birdstrike had resulted in the sudden yaw, it would have had to cause significant damage and/or blockage to the tail rotor or related parts. The tail rotor on the EC120B rotates at around 4,500 RPM, and any significant damage to a blade or other part of the tail rotor system is likely to lead to noticeable ongoing vibrations and noise rather than only a single 'thud'.
- Birdstrikes involving tail rotors are rare events, with only about 5 per cent of strikes occurring to the tail rotor or tail area, and not all such strikes resulting in an effect on helicopter operation. Furthermore, according to Airbus Helicopters, Fenestron tail rotors, with their smaller, enclosed rotor, are designed to reduce the likelihood of birds or other foreign objects from contacting the tail rotor. The manufacturer also stated that there had been no reports of a birdstrike to a Fenestron tail rotor.
- A slow moving helicopter is less likely to hit (or be hit by) a bird than a faster moving helicopter, particularly the parts of the helicopter than can easily be seen by a bird, such as the fin surrounding the Fenestron as opposed to the rotating main rotor. The pilot reported that the sudden yaw to the left occurred when the helicopter had an airspeed of 35–40 kt. However, it should be noted that the pilot based this estimate of airspeed on their perception of travel over the water rather than using the airspeed indicator. The pilot's perception of airspeed may have occurred when the helicopter was travelling downwind with a tailwind of up to 20 kt.

- None of the helicopter's occupants reported seeing a bird approach the helicopter during the go-around or seeing any evidence of a bird having been hit by the tail rotor. However, even if a birdstrike to the tail rotor occurred, there would not always be visible indications to the occupants within the helicopter, particularly if they were then exposed to an emergency event that diverted their attention.
- There were no reports from the helicopter's occupants or the first responders of debris around the helicopter before it sank. However, it is acknowledged that those involved would have had their attention focussed on the rescue during this period.

The investigation could not determine what led to the 'thud' perceived by the pilot. It is possible that it was something associated with the rapid left yaw, such as shifting cargo or baggage, or potentially an unrelated event.

In addition to birds, other foreign objects could be ingested into the tail rotor system and lead to a rapid left yaw. A small number of such events have occurred with helicopters with a Fenestron. However, they typically produce other noticeable symptoms to a pilot (such as loud noises or vibration). In addition, a foreign object would more likely be ingested closer to the ground than where the helicopter was when the rapid yaw occurred.

Without being able to examine the helicopter, it is not possible to completely rule out a birdstrike. However, based on the available evidence, the ATSB considers that it is unlikely that a birdstrike or other foreign object impact with the tail rotor resulted in the helicopter's rapid left yaw.

Technical failure

The helicopter was not recovered and could not be examined. However, a review of the helicopter's maintenance records indicated there had been no significant problems with the helicopter that would affect engine power or control of direction. Two recent items of maintenance, the generator replacement and VEMD sensor inspection, would not have potential to affect the helicopter in a way that control would be lost.

In addition, there were no reports of any other noticeable problems related to the helicopter's engine power or control of direction during the flight or at the time of the accident. None of the pilot or passenger accounts reported any warning lights, alarms or other noises that might be expected with a critical component failure (or any caution lights indicating the potential for a component failure). As already noted, the thud reported by the pilot was not reported by the passengers, and was not accompanied by any other symptoms.

Failures or malfunctions of the tail rotor system could result in a rapid left yaw. However, any such failure that would produce a rapid left yaw would most likely also be associated with other symptoms, such as vibrations and noises (potentially before and after the failure). There was also no indication reported by the pilot of a problem with the anti-torque pedals being jammed or loose, which would occur with some types of failures involving the tail rotor system.

In addition, an engine failure would have more than likely resulted in a rapid yaw to the right due to the direction of the rotation of the main rotor blades (as well as various warning or caution messages).

Overall, based on the available information, there was no indication that a technical failure or malfunction with the helicopter or its relevant systems contributed to the rapid left yaw experienced during the go-around. However, without being able to examine the helicopter, it is not possible to completely rule out such a scenario.

Developing yaw due to insufficient right pedal input

As already discussed, based on the passenger's accounts and photographic analysis, the helicopter was yawing left following commencement of the go-around. The helicopter's nose would have continued going left unless the pilot promptly applied significant right pedal input, and the right pedal input required would have kept increasing as the situation deteriorated. If the helicopter reached a downwind position, then a sudden, rapid acceleration in yaw to the left would have occurred; the nature of which would be similar to that described by the pilot and passengers.

Although the available photographs showed that the helicopter had yawed left during the go-around sequence, there were no photographs taken after image 0621 and therefore no images that showed the helicopter reached a downwind position before the rapid yaw. However, the passengers' impressions were that the pilot was attempting to approach the pontoon from the other side, which is consistent with the helicopter yawing towards a downwind position.

When compared to other scenarios such as birdstrike or a technical failure of the tail rotor, it is very likely that the reason for the rapid left yaw was that the pilot did not apply sufficient right pedal input during the go-around, resulting in an ongoing left yaw until the helicopter was heading downwind.

Response to the rapid left yaw and loss of control

The correct response to an unanticipated rapid yaw is to apply full opposite right pedal. The operator's procedure was consistent with this requirement, as was guidance provided by the training organisation that conducted the pilot's type rating training.

Similarly, guidance information provided by the helicopter manufacturer advised pilots to apply immediate and significant right pedal and not hesitate to apply full right pedal input if required. The manufacturer's subsequent guidance issued in 2019 acknowledged that, in a power-limited situation, applying full right pedal would likely lead to an over-torque of the helicopter's engine, but such a situation would be preferable to a loss of control.

The pilot stated that, although they could not specifically recall their anti-torque pedal inputs, they believed they would have applied significant right pedal following the rapid left yaw. However, as noted above, full right pedal input would have been required to arrest the yaw and regain control. If full right pedal input had been immediately applied and sustained, then it is likely that the yaw would have subsided, and an engine limitation would have been exceeded. Overall, the ATSB concluded that it was very likely that the pilot did not apply immediate, full and sustained right pedal input in response to the rapid left yaw.

It is possible that the pilot did not apply full right pedal input as they wanted to avoid over-torquing the engine. It is also possible that by this stage the pilot considered that applying right yaw was having limited effect.

In contrast to procedures and guidance, the pilot reported attempting to fly out of the turn by increasing airspeed and following the helicopter's nose to the left, while simultaneously lowering the collective to arrest the sudden, unanticipated and rapid yaw to the left. At the time the pilot probably believed it was possible to fly out of the spin that ensued. If the helicopter could be accelerated away to a cruise speed, the vertical fin would provide thrust, and the requirement for right pedal would be reduced. This would bring the helicopter back under control. However, although lowering the collective will slow the turn, this can only be done if there is a sufficient height to recover (or if intending to land or ditch). When the collective was lowered the rotation slowed, but did not stop, and the helicopter descended towards the water.

In the very limited time available after recognising that they were going to contact the water, the pilot attempted to flare and level the helicopter. The pilot did not conduct a controlled ditching by closing the throttle to further reduce the yaw, deploying the helicopter's floats, and cushioning the landing by lifting the collective. If such actions had been conducted, they would have resulted in a more controlled entry into the water and a possible reduction in passenger injury; if the floats had deployed, the helicopter may still have rolled to the side and inverted but it would not have sunk.

Factors influencing pilot performance

Pilot experience and consolidation on the EC120B

There was no evidence to indicate that the pilot's performance during the approach, go-around and response to the rapid left yaw emergency was affected by fatigue, a medical issue or similar factors. Although the passengers had been waiting for some time prior to the departure from Hamilton Island, there was also no indication that the pilot was experiencing a notable amount of time pressure prior to or during the flight. However, the investigation examined in detail the potential effects of experience and consolidation of skills, workload, time pressure and surprise.

Acquiring new skills, such as learning to fly a new aircraft type, requires training and practice. As the amount of experience increases, generally a person's proficiency will increase, and performing tasks will become more automated and require less attention or mental resources (Wickens and others 2015, Stothard and Nicholson 2001). The person will then have more capacity to monitor situations and perform other tasks, and respond to unusual, abnormal or emergency situations.

Many factors can influence the processes of consolidating and then retaining skills. In general, the more practice the better, and the shorter the time interval between practicing a task and performing a task then the better the performance. Skills are also better retained if they are 'overlearned', rather than practiced just to the level of being proficient (Arthur and others 1998).

Another potential aspect that can influence the development of proficiency is interference from other similar tasks. In general, being experienced on one helicopter type will provide some transfer of training benefit when developing skills on a new helicopter type. However, in some cases previous experience can delay the development of some skills (known as proactive interference), as can conducting previously-learned tasks between learning a new task and then performing that task again (known as retroactive interference) (Wickens and others 2015).

In this case, the pilot had a significant amount of experience on the R44 and Bell 206L3 helicopter types, and significant experience landing on the operator's pontoons, before transitioning to the EC120B type. The pilot had also met the minimum requirements for obtaining the EC120B rating (including 3.6 hours flight time) and for conducting passenger charter flights, including 5.6 hours in command under supervision (ICUS). The accident occurred soon after obtaining the rating and ICUS, minimising the potential for skill decay.

However, the pilot had accumulated only 11.0 hours in command on the EC120B. Although the pilot would have achieved some level of consolidation of many aspects of flying the EC120B during this period, the amount of consolidation would have been reduced by conducting 16.1 hours on Bell 206L3 helicopters during the same period. Some of the notable differences between the helicopters were the main rotors blades rotating in a different direction, the Fenestron on the EC120B, and the nature of the electronic displays and VEMD on the EC120B. Although the pilot had done nine previous landings on pontoons in an EC120B during this period, not all of these would have involved a left turn into a right crosswind.

Overall, the pilot's ability to conduct normal operations in the helicopter would have been developing through practice, although some tasks would have still required more conscious effort than a pilot who had more experience on type. In addition, the pilot's ability to respond to various unusual, abnormal or emergency situations would have been less well developed, and they would still have had less spare mental processing capacity during some tasks.

The pilot reported being unfamiliar with the helicopter type and was experiencing a high workload in the period leading up to the decision to go-around, and this workload would have been very high during the go-around. Workload refers to the interaction between a specific individual and the demands associated with the tasks they are performing. In this case, the workload was associated with the pilot's limited consolidation on type and the nature of the task demands (and the safety margin available) at the time.

High workload leads to a reduction in the number of information sources an individual will search, and the frequency or amount of time these sources are checked (Staal 2004). It can result in an individual's performance on some tasks degrading, tasks being performed with simpler or less comprehensive strategies, or tasks being shed completely (Wickens and others 2015).

In this case, when the VEMD message appeared just prior to landing, the pilot was probably still at the stage of having to process all such messages consciously in order to determine their significance. They had not previously been exposed to a VEMD message in flight, and could not promptly and fully interpret its significance. A pilot with more experience or consolidation on type, and therefore more spare capacity or experiencing less workload, would have probably recognised that the message was not important and they could have landed rather than go around.

The pilot's limited level of consolidation on the EC120B also probably contributed to problems during the go-around. Although go-arounds are considered a normal procedure, they are rarely performed tasks, particularly when conducted very close to landing. Although the pilot recalled conducting one go-around in an EC120B, it is unlikely that it was conducted in the same type of situation as occurred during the accident flight.

One specific aspect of the pilot's transition to the EC120B may have affected the go-around response. The pilot reported that when flying the EC120B, when close to the ground, they were managing pedal settings by sight (noting the effects each pedal input made while looking outside the helicopter). For a go-around to be conducted most efficiently and effectively, a pilot must anticipate the pedal displacement required for the go-around and apply the correct amount of pedal before waiting to see the noticeable secondary effect of the collective input. However, it is known that people will revert to previously learned responses under time pressure or stress (Stahl 2004). Accordingly, it is possible that the pilot may have used previously learned responses for the R44 and Bell 206L3 for a go-around and initially applied left pedal inputs before realising the problem (visually) and then applying right pedal input. Any delay in applying the correct pedal input would have exacerbated a developing yaw situation.

In summary, although the pilot had met the relevant requirements for conducting the flight, their low level of experience on the EC120B and having to fly another (and technically different) type while accumulating this experience contributed to them having a low level of consolidation on the helicopter type. This limited consolidation contributed to the pilot having a high workload during the final approach and a very high workload during the go-around. This would have limited their capacity to detect and assess any problem during the go-around, and also probably influenced the fluency or proficiency with which specific control actions were conducted.

Stress, time pressure and surprise

Associated with the rapid yaw to the left, it is likely that the pilot was experiencing stress and time pressure. In addition to the effects of high workload noted above, some commonly reported effects of stress and/or time pressure include focusing on cues that are perceived to be the most salient or threatening (Burian and others 2005, Wickens and others 2015). Working memory and the ability to perform complex calculations is impaired (Burian and others 2005), and the ability to retrieve facts (or 'declarative knowledge') from long term memory is affected (Dismukes and others 2015). People can also act more impulsively (Dismukes and others 2007).

In this particular case, it is likely that the pilot did not have a full understanding of the helicopter's situation when the rapid left yaw occurred. Based on their recollection of the event sequence, the pilot may have been unaware that the helicopter was entering a downwind position and was still travelling at a slow airspeed.

Related to stress and time pressure are the concepts of surprise and expectancy. In general, if a person is not expecting an emergency or abnormal event to occur, their response to the situation will often be slower and more variable. This effect has been demonstrated in several research studies involving experienced pilots (for example, Casner and others 2013, Landman and others 2017), and is more likely to occur to pilots who have less experience with a particular situation.

In addition to the general effects of stress, time pressure and surprise, there is often probably an influence associated with a pilot knowing that ditching a helicopter will lead to adverse outcomes, such as the submersion of the helicopter and potentially rolling inverted even with the floats deployed in open water. They may instinctively believe (often incorrectly) that following the nose around and attempting to fly out of the spin from a low height will have no or fewer adverse outcomes.[49]

In relation to adverse outcomes, research has shown that when a person is faced with two options that are framed as losses (or with adverse outcomes), they tend to be risk seeking (Kahneman 2011). That is, rather than selecting a loss option that is certain but has a low loss magnitude, people will tend to select a loss option with less likelihood but higher loss magnitude. However, research on the extent to which time pressure influences the tendency to be risk seeking for losses is unclear, and there has been very little research that has examined the influence of this risk seeking tendency in emergency situations.

In summary, the pilot was undoubtedly faced with a very difficult situation. They had limited options available, all of which were likely to result in some adverse consequences, and very limited time to make a decision. Ultimately, the decision to try and fly out of the yaw by following the nose to the left was probably not the option with the lowest risk. However, the pilot's decision making during the event was consistent with the known effects of stress, time pressure and surprise on human performance.

Operator's processes for transitioning pilots to new helicopter types

There were no specific regulatory requirements for the operator to have provided any additional consolidation after the pilot achieved the minimum ICUS time. For many types of transitions to a new single-engine helicopter type, and for many operations, further consolidation may not be necessary. However, for some types of transitions and operations, further consolidation would be effective in reducing safety risk.

As previously discussed, a number of other factors combined to reduce the safety margin associated with conducting an approach to a right crosswind landing at the pontoon for an EC120B, particularly in this case given the higher than normal weight of the helicopter. In addition, given the nature of the differences between the EC120B and the pilot's previous types, combined with the type of operation, further consolidation would have helped increase the safety margin available.

It is important to recognise that the operator had a system for ensuring pilots had significant experience landing on pontoons with the R44 before progressing to the Bell 206L3, and then progressing to the EC120B and then EC130. However, the process of transitioning to the EC120B still provided an elevated risk. Many pilots who had undertaken the same transition were probably vulnerable to problematic handling if they encountered an unexpected event at a critical time or had to go around during a right crosswind landing.

This elevated risk could have been reduced in many different ways, such as providing a dedicated period of only flying the EC120B before flying other types again, flying a certain period with reduced weights (and higher safety margins), and/or flying a dedicated period with into wind landings. The investigation identified that another operator which conducted similar types of operations had incorporated such consolidation activities into its operations for pilots transitioning

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49 This is similar to the decision following a partial power loss after take-off in a small aeroplane, whereby landing straight ahead may result in some aircraft damage but is safer than turning back to the runway (unless a pre-determined safe height had been reached before turning back).

to an EC120B. Although that operator's consolidation processes were informal, they indicate the potential for operators to introduce processes, in addition to the minimum regulatory requirements, to reduce the risk of an identified (and identifiable) hazard.

In summary, the operator had limited processes in place to ensure pilots with minimal time and experience on a new and technically different helicopter type had the opportunity to effectively consolidate their skills on the type required for conducting the operator's normal operations to pontoons. This limitation resulted in the pilot of the accident flight having a low level of consolidation on the EC120B when attempting to conduct a task that already had a minimal safety margin due to a number of other factors.

The extent to which air transport operators of small aircraft are utilising consolidation activities above the minimum regulatory requirements, either formally or informally, was not determined in this investigation. There was no regulatory guidance available for determining appropriate levels of consolidation for pilots, and it would be very difficult to specify such levels as they would need to vary for different type transitions in different contexts.[50] Nevertheless, this accident has demonstrated the importance of operators, as part of their safety management processes, considering skill consolidation during and following the ICUS phase and providing as much consolidation as possible to reduce the risk of transitioning to a new aircraft type. This is particularly relevant for types with significant differences to those a pilot has previously flown and for operations with reduced safety margins.

Loading procedures and practices

Flying a helicopter overweight can lead to early degradation of aircraft components, but can also lead to problems with helicopter control in flight. Inaccurate load calculations and subsequent weight differential can lead to a situation where the performance of an aircraft is below what would otherwise be expected.

In this case, the helicopter was about 25 kg over the maximum all-up weight on take-off from Hamilton Island. It was within its maximum all-up weight limit on arrival at the pontoon and at the time of the accident but was close to its limit. Although a 25-kg lighter helicopter would have improved the safety margin and assisted the pilot with managing the go-around at the pontoon, it is not possible to state that this by itself would have prevented the accident.

Contributing to the helicopter being overweight at take-off was the use of passenger-volunteered weights for weight and balance calculations. The passengers had been asked by the operator to provide their weights when booking. The operator had calibrated scales available to weigh passengers and baggage at Hamilton Island and another base. However, the operator's process was to only weigh passengers if the guest liaison officer noticed a discrepancy when the passengers checked in, or the pilot noticed a discrepancy when the passengers arrived at the helicopter. However, in situations where passengers were hot loaded (as in the case of the accident flight), pilots only received individual passenger weights after the passengers were boarding the helicopter. The opportunity for the pilot to make a reliable assessment was therefore limited.

Research has found that people tend to underestimate the weights of themselves and others. Further, people are less accurate at estimating the weight of others than they are of themselves.[51] This can make it challenging for staff to detect a discrepancy between a passenger's volunteered weight and their actual weight on the day of a flight. In this case, one of the passengers weighed

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[50] CASA also reinforced this point in its guidance related to determining flight crew competency requirements with the introduction of CASR Part 133 for air transport operators in helicopters in December 2018 (see *Safety issues and actions: Operator consolidation processes for flight crew*).

[51] For example, see Ramos and others (2009), Reed ad Price (1998), Sahyoun and others (2008) and Shapiro and Anderson (2003).

10 kg more than their volunteered weight. A similar situation occurred with another recent accident in Australia,[52] and the use of volunteered weights is common in charter operations in Australia.

At the time of the accident there was no regulatory requirement in Australia for operators of smaller charter aircraft to weigh passengers and their baggage, although guidance in Civil Aviation Advisory Publication (CAAP) 235-1(1) stated that was the best method for small aircraft. Guidance provided by regulatory authorities in other countries was similar. However, regulatory agencies in other countries (such as New Zealand, Canada and the United States) also provided guidance on the use of passenger-volunteered weights, which was an accepted or alternative method to obtain actual weights. These regulatory authorities either required or recommended that, when passenger-volunteered weights were used, operators added 4 or 4.5 kg to the weight provided. Comparatively, there was no such guidance in the Australian CAAP.

In addition to the passenger weights, the weight of baggage and other items was not effectively considered for the accident flight. The chief pilot advised that they normally used a standard amount of 20 kg to account for such items, but the pilot did not appear to use such an allowance for the accident flight. If such a margin was used, it would have effectively allowed for all the baggage and other items, except for the 13.6 kg portable APU, which the pilot estimated to be only 5 kg.

The ATSB did not conduct a detailed examination of the weight at take-off of the operator's other flights. However, the previous flight conducted in the helicopter from Hamilton Island also probably departed Hamilton Island above the maximum all-up weight, with a weight similar to the accident flight. Given that the operator conducted many EC120B flights with four passengers and more fuel than the accident flight from Hamilton Island to Hardy Reef, it is likely that many of these flights were close to the maximum all-up weight on take-off. In addition, guest liaison personnel were able to allocate passengers with a combined weight of 350 kg to the EC120B, significantly more than the accident flight. Therefore, the operator needed a robust system to ensure that its consideration of passenger and baggage weights was effective.

In summary, although the operator had calibrated scales available for use at two of their check-in locations, they were not routinely used to ascertain actual passenger and/or baggage weights. Instead, the operator's personnel relied on passenger-volunteered weights (without an additional allowance) and only weighed passengers when the volunteered weights were perceived to be inaccurate. A more robust system would be to actually weigh the passengers and their baggage, and, when this could not be achieved, adding a reasonable allowance to each volunteered weight.

Bird hazard management

As already noted, it is unlikely that the helicopter's rapid left yaw and loss of control was related to a birdstrike to the tail rotor. However, there were undoubtedly many birds present on the pontoon during the helicopter's approach. Depending on tides and seasonal factors, this problem also existed for a significant proportion of the operator's operations, which presented a hazard that needed to be managed. However, the operator had not conducted a formal risk analysis of the hazard to ensure that appropriate risk controls were identified and then their effectiveness could be monitored.

Ideally the best way to minimise risk is to eliminate the hazard, and it is recognised that in this case there was no practicable option for removing the birds. Instead, the operator was relying on pilots approaching the pontoons slowly in order to disperse as many birds as possible. Such a practice increased pilot workload and the helicopter power required at a critical phase of flight, reducing the safety margin. Formal consideration of such aspects could have enabled the

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52 ATSB AO-2017-118, Collision with water involving a de Havilland Canada DHC-2 Beaver aircraft, VH-NOO, at Jerusalem Bay, Hawkesbury River, New South Wales, on 31 December 2017.

operator to consider whether its risk controls for such operations, including pilot consolidation on type, were therefore appropriate.

Based on the information provided by pilots, birdstrikes probably occurred at the operator’s Hardy Reef pontoons multiple times per year. It seems that most (if not all) of them involved birds impacting the main rotors when a helicopter was standing on the pontoon with rotors turning. In general such birdstrikes involve less risk than in other phases of flight (particularly if they involve small birds). However, some risk was still present, which was exacerbated by the practice of the operator’s pilots of leaving the helicopter controls to escort passengers on the pontoon from and to the helicopter with the rotors turning.

Unfortunately, the operator’s actual number or rate of birdstrikes could not be determined as the operator kept no records of these occurrences. It therefore had limited awareness of how many had occurred, the nature of any patterns or trends, or the effectiveness of any mitigators that were being applied. By not recording and analysing such occurrences, the operator therefore reduced its ability to accurately assess the ongoing hazard associated with birdstrikes at the pontoons.

The operator also did not ensure birdstrike occurrences were reported to the ATSB, even though there was a requirement under the Transport Safety Investigation Regulations 2003 to report any such occurrences involving passenger charter flights, and the operator’s operations manual also reinforced the reporting requirement. This limited the ability of other agencies to be aware of the potential hazard and any associated trends. Limitations with the operator’s reporting processes also restricted the ability of the regulator to be aware of the significance of the hazard when it was conducting its oversight activities.

In addition to problems with risk assessment and recording and analysing birdstrike occurrences, there were also potential limitations with the operator’s maintenance practices following a birdstrike at the pontoon. The EC120B manufacturer advised that if there was a sudden decrease in main rotor speed due to a birdstrike or other impact then an inspection must be carried out by a licenced aircraft maintenance engineer (LAME). Similar procedures were applicable to the Bell 206L3, whereas the procedures for the R44 only required inspection by a LAME if visual damage was identified.

The operator relied on pilots conducting inspections following any birdstrike at the pontoons. However, pilots did not have any ladders or steps available at the pontoons, which would be required to conduct a full inspection of a helicopter’s main rotor blades. In addition, even though birdstrikes were not an infrequent occurrence, there was no guidance in the operator’s operations manual for pilots to conduct visual inspection tasks and consider what to do if they could not be certain whether a sudden stoppage had occurred (for example, if they were not at the helicopter controls at the time).

In summary, there was often a significant number of birds located on the pontoons at Hardy Reef used by the operator. However, the operator did not have a process to systematically manage the risk of birdstrikes. It had not conducted a formal risk assessment of the hazard, was not effectively documenting and analysing its birdstrike occurrences, and had provided limited guidance to pilots about what to do if an actual or suspected birdstrike occurred.

Emergency exit design and placarding

The ability for a passenger to quickly and easily identify the location of the nearest or most suitable exit, identify the location of the handle for operating the exit, and be able to open the exit, is critical in an emergency. This is especially important in a helicopter accident on water where it is likely that the helicopter will invert and the cabin will become submerged.

Research supports the importance of a door design that allows a person to identify how to use a door without the use of signs or placards (Norman 2013), and accordingly the operating handle for an emergency exit should be designed so that it is easy to identify and the method of operating a door is obvious. Norman noted the problems with many types of doors, and noted the following when discussing the usability of car door handles:

> …The outside door handles of most modern automobiles are excellent examples of design. The handles are often recessed receptacles that simultaneously indicate the place and mode of action. Horizontal slits guide the hand into a pulling position; vertical slits signal a sliding motion. Strangely enough, the inside door handles for automobiles tell a different story. Here, the designer has faced a different kind of problem, and the appropriate solution has not yet been found. As a result, although the outside door handles of cars are often excellent, the inside ones are often difficult to find, hard to figure out how to operate, and difficult to use.

The rear left sliding door of the EC120B was classified as an emergency exit, and certification requirements stated that emergency exits had to have ‘a simple and obvious method of opening’. However, the ATSB identified several concerns with the design of this door, including:

- The design of the recessed handle meant that, for many people, it would not be intrinsically recognisable as a handle. It was also not similar to handles that most passengers would be used to (such as those on most road vehicles), particularly for a door that requires a sliding action.
- The handle was the same colour as its surrounding and was generally not a salient colour. In some helicopters, such as VH WII, the handle and its surrounding were also a similar colour as the door trim, making it more difficult to determine the purpose of the components.
- The location of the handle was indicated by the nearby placement of a placard, which had red text on a white background. Although such a placard may help a passenger locate a handle (and overcome the problems listed above) in some situations, the helicopter was often used with inexperienced helicopter passengers on overwater flights. There were no additional features to make the handle distinctive, such as emergency lighting to show the location of the handle or the use of a salient colour, particularly in darkness and/or underwater.
- The door required three actions to open it from the inside: pull the handle up, push the door outwards, and then slide the door back. The ATSB’s examination of six EC120B helicopters found that all three actions were required, regardless of whether they were done as distinct, separate actions or applied in one continuous movement. If the second action (push the door out) did not occur, the door would not open.
- When a vehicle door is required to be slid instead of opened inwards or outwards, the handle will generally be positioned and/or oriented such that the required actions are intuitive. However, the handle on the EC120B rear left sliding door was operated by pulling it up (which was the same as for the normal operating handles of the two front doors); the nature of the handle did not indicate the other actions required to open the sliding door.
- The placard next to the operating handle stated ‘PULL UP TO OPEN’ and ‘PUSH DOWN TO LOCK’. Although this placard clearly specified the first action required for opening the door, there was nothing in the placard or the nature of the door or handle’s design that indicated it was a sliding door and there was a need to push the door out before sliding it rearwards.

The ATSB acknowledges that the EC120B’s exits were certified as meeting the relevant regulatory requirements at the time, and that the manufacturer believes that the door is simple and obvious to operate. The manufacturer has also advised that, in its opinion, users will naturally tend to push the door out if they are having difficulty sliding the door rearwards after they have lifted the handle. Although this may occur in some cases, the ATSB notes that, when people are under high levels of stress, they will often tend to persevere or continue with an action or plan of action (Wickens and others 2013). In addition, the ATSB also notes that independent, experienced helicopter pilots have identified that, based on their experience, the EC120B rear sliding door is a difficult helicopter door for passengers to open (in terms of how to open the door rather than the force required).

There is no doubt that passengers on such aircraft should be briefed about how to operate the emergency exit nearest to them. Nevertheless, passengers may not always pay attention to or recall the content of safety briefings when required, and any such briefing will be much more effective if a door is simple and obvious to use.

Overall, based on the available evidence, the ATSB has concluded that the rear left sliding door was not simple and obvious to use, particularly for a person who has not been specifically instructed about all the required actions.

In the case of this accident involving VH-WII, the rear left sliding door was initially not submerged; therefore, it was the most suitable emergency exit for the passenger sitting next to that door, as well as others in the rear of the helicopter. However, the passenger seated in the rear left seat (next to the exit) reported actively searching for but not being able to locate the door's operating handle, and therefore could not open the door. The ATSB was not able to confirm whether the placard for the rear left sliding door of VH-WII was the appropriate colour and in the required location; the operator's other EC120B helicopter had a placard that was not in the manufacturer's required colour scheme (that is, red text on white background).

After a period of time, the rear right passenger found the door handle, by touch, when searching for something to hold on to. They were then able to open the door, and they reported having no difficulty opening the door. However, the ATSB notes that this passenger would have been in an unusual position when trying to open the door; that is, out of their seat in a helicopter on its right (lower) side reaching upwards to the left door. A passenger in a normal seated position next to the exit could have significant difficulty trying to open the door unless they knew and remembered to push the door out before sliding, regardless of how much effort they applied.

In summary, there were multiple aspects of the design of the rear left sliding door on the EC120B that increased the difficulty of both locating and using the door's operating handle. In this case, the design limitations contributed to the delay in the rear seat passengers being able to locate the operating handle, and therefore exit the helicopter.

Passenger safety briefings

Briefing about exits

Research shows that drowning is the greatest risk in a helicopter accident into water. This is because it is likely that the helicopter will invert and the cabin will be submerged. Except for operations involving marine pilots or the offshore oil and gas industry, passengers on charter flights over water are rarely briefed on the specifics of what is likely to happen and what they should do in a helicopter ditching. However, if people are provided with correct and complete information, including a briefing on the exit, its location, and orientating themselves before take-off, their survival rate will likely be increased. This was supported by recommendations issued in a recent Transport Canada report that passengers be provided with a special briefing or briefing leaflet if they were going to be travelling on an overwater flight in a helicopter. The actions required in an accident on water, particularly in a helicopter, need to be swift and without hesitation. Having no knowledge of what to do puts people at risk if an emergency was to occur.

At the time of the accident, there was no specific regulatory requirement for an operator of an aircraft with six or less persons on board to provide information to passengers about how to operate the exits. For those with over six persons, the operation of the exit only had to be covered in a safety briefing card. Research conducted by the National Transportation Safety Board (NTSB)[53] and the ATSB[54] found that passengers tend not to look at the safety briefing card, and even if passengers do look at the card not all of them will understand the instructions provided. The NTSB also found that passengers believed that the safety briefing should include information

[53] National Transportation Safety Board 2000b, 'Safety Study: Emergency Evacuation of Commercial Airplanes', NTSB/SS-00/01 PB2000-917002, Washington DC, USA.

[54] Australian Transport Safety Bureau 2004. 'Public Attitudes, Perceptions and Behaviours towards Cabin Safety Communications', ATSB Research and Analysis Report., Canberra, Australia

on how to operate the exits and escape slides (when fitted). As it cannot be guaranteed that a passenger will attend to and understand the information provided on a safety briefing card, it should only be used as a supplement to the oral briefing and not the primary source of safety information provided.

The passengers on the accident flight had viewed the operator's safety briefing video prior to flight and had therefore seen much of the legally required information in the video. However, this video did not include any information about the exits.

Due to conflicting reports, the ATSB could not determine if the operator's passenger safety briefing cards were located on VH-WII on the day of the accident. Even if the passengers had reviewed the briefing card, the information contained on the card would not have provided the passengers with information about the location of the exit operating handles in the context of the helicopter. Reference to the exits on the card only showed the handles and did not show where they were located. All the required actions to operate the rear left sliding door exit were also not on the briefing card.

The operator's operations manual required pilots to ensure that passengers were briefed on how to locate and operate the exits. The section of the manual on ditching also advised pilots to allow passengers to practice opening the doors before engine start up (which was not applicable to flights when passengers were hot loaded). However, the operator provided no instructions to pilots about what actions to advise passengers about how to open the rear left sliding door.

The pilot of the accident flight reported that they normally only briefed passengers on the location of the exits and that the method of opening the handles was to lift the handles. They did not specifically point to the location of the handles or ensure that passengers could open the exits. Although some of the operator's other pilots stated that they would normally brief passengers on how to use the normal operating handles (lifting up to open), passengers were not shown how to open the doors and this instruction would not generally be sufficient to ensure passengers could open the rear left sliding door (that is, explaining the need to pull the operating handle up, push the door outwards and slide it back). Passengers were also not briefed on the emergency jettison operation for the front doors.

Pilots reported that passengers were normally hot loaded. They also reported that their briefing procedure when the rotors were not turning included physically showing the passengers how to operate the exit and the seatbelts. If such a practice was used by ground personnel when passengers were hot loaded, it would have assisted the surviving passenger seated next to the rear left exit to find the operating handle more easily.

The information contained in the operator's manual in relation to what to do in a ditching would have been beneficial to the passengers prior to the flight, as when an emergency occurs there is generally little or no time to provide additional instruction. On this occasion the helicopter rolled right immediately after impact and instructions to the passengers were not possible.

With regard to the accident flight, there were conflicting accounts about the briefing the pilot provided; the pilot stated that the passengers were advised that the doors could be opened by lifting the handle and the passengers could not recall receiving any information. Regardless, the location of the handles were not specifically pointed out to the passengers, and the passengers were also not instructed in all the actions required to open the door.

In summary, ensuring that passengers are provided with a briefing on how to open the emergency exits is very important in the event of an emergency, particularly for an aircraft such as the EC120B when the location of the door handles is not obvious and the method for opening the rear left sliding door after lifting the handle is not obvious. However, the passengers on the accident flight did not receive specific information about the location of the operating handles of the emergency exits on the day of the accident, or how to open the door.

Briefing about seatbelts

In addition to being able to open exits in the emergency, it is vital that passengers are able to undo their seatbelts in an emergency. It was a regulatory requirement and an operator requirement for personnel to ensure passengers were briefed on how to use their seatbelts.

Although the passenger safety video included information on one type of seatbelt (consistent with that used in the rear seats of the helicopter), the mechanism shown was completely different and not relevant to the front left passenger's four-point harness. The release mechanism for the front left seatbelt was relatively simple, however it would generally not be one that most passengers would have encountered before, unless they were from an aviation background.

Ultimately, the front left passenger was never briefed on how to use their four-point harness, significantly increasing the risk of them not being able to evacuate the helicopter in a timely manner (if they were conscious). It is acknowledged that in an emergency when a quick exit is required (particularly when orientated upside down or sideways and/or in the dark), even if a passenger is briefed on a particular task, they may still have difficulty performing the task.

For example, the rear left passenger also advised that they had some difficulty operating their seatbelt and they had been provided with instruction in the video about this seatbelt, and they would have used a similar seatbelt before on airline aircraft. Nevertheless, ensuring passengers are briefed is essential, and this is even more important when the seatbelt is different to what a passenger may be used to. Ideally each passenger should be asked to demonstrate that they know exactly how to release their seatbelt, particularly for overwater flights.

Briefing about the brace position

All the occupants on the accident flight were wearing upper torso restraints (over the shoulder harnesses), which provide protection against head and upper body injuries, primarily for forward-facing impacts. The three surviving occupants had no head injuries, while the two that were unable to escape had head injuries: one severe (front left passenger) and one minor (rear middle passenger). Although there are several complicating factors, it is likely that the front passenger's head injury significantly compromised their ability to escape and the rear passenger's head injury may have affected their ability to a lesser degree.

There was no requirement at the time of the accident for the operator to brief passengers about the brace position, and no such briefing was provided. The brace position on the operator's safety briefing card used on the EC120B depicted passengers bending forward. However, as the EC120B was fitted with upper torso restraints in both the front and the rear, this depicted brace position would not have been the most appropriate. Rather, a suitable brace position would have involved remaining in an upright erect position with the arms either crossed across the body, placed in the lap or holding onto the edge of the passenger's seat, and the chin lowered to the passenger's chest.[55]

The investigation could not determine what positions the front left or rear middle passengers adopted at the time of impact. There was also insufficient information available to determine whether a protective brace position, if adopted, would have prevented their head injuries.

Nevertheless, ensuring passengers of all air transport flights are provided with briefings that include the brace position is important for reducing future risk. This is particularly the case for aircraft seats without upper torso restraints, but is still relevant when seats are fitted with upper torso restraints. A recent ATSB investigation report has noted that the Civil Aviation Safety

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55 There is conflicting guidance about where to place the hands for the brace position in a helicopter with upper torso restraint, therefore all recommended positions for the hands are described.

Authority (CASA) has now required that the passenger safety briefing for all air transport flights include the brace position.[56]

Passengers with reduced mobility

The passenger in the front left of the helicopter had an obvious arm injury indicated by an arm brace. However, this passenger was not asked about what assistance might be required in an emergency. Such an individual briefing would ensure that a crewmember has been made aware of any special needs of the passenger in an emergency. As the pilot and the passenger on this occasion had not verbalised a plan of what to do, they were less prepared if an emergency was to occur.

If the front left passenger had maintained an ability to escape following the impact, the injury to their arm would mean that they might have had more difficulty operating the seatbelt mechanism and/or exiting the helicopter. Without speaking to the passenger about the best way to assist in an emergency, the extent of any limitation or assistance required was not assessed.

The operator's written procedure for the briefing of passengers with reduced mobility was consistent with the regulatory requirements. However, if a passenger had an impairment or illness and this had not been self-disclosed or was not obvious, the operator would not routinely provide a briefing or inquire about any additional assistance required. The operator was relying on the passenger self-reporting a requirement to staff members. This meant that, in the case of the passengers on the day of the accident who were unaware that they should disclose any information, the passengers were treated as if no injury existed.

Passenger movement around the pontoons

The ATSB investigation identified that it was common practice for the operator's pilots to leave the controls of their helicopter, while the rotors were turning and the friction locks were applied, to escort passengers to and from the helicopter on the pontoons. The operator's process at the time allowed this to occur in certain conditions, such as the helicopter being parked into wind and the wind strength not exceeding 15 kt (conditions that were not common at the pontoons).

Although not related to this accident, such a practice is associated with risks to the passengers, including passengers being (briefly) in the helicopter without the pilot, the potential for birds or wind to destabilise the rotor system as it is turning, and the friction locks not being fully effective, or the collective control is moved resulting in the helicopter moving around the pontoon in an uncontrolled manner. Leaving the controls is considered a hazardous practice and should not be a practice that is adopted to gain efficiencies during turn-around or to minimise shutdowns and restarts. The preferred option should always be to have a pilot at the controls whenever the engine is running and the rotors are turning.[57]

CASA did permit the practice whereby a pilot could leave the controls of the helicopter while the rotors are turning in certain circumstances. This included if the practice was essential for safety to the helicopter or persons in the vicinity. CASA clarified that this exemption did not include the loading and unloading of passengers under normal circumstances. This practice was also not consistent with the requirements and/or guidance from helicopter manufacturers.

Regulatory oversight on helicopter operations

Previous ATSB reports have noted that regulatory oversight processes will always have constraints in their ability to detect problems. In particular, there is restricted time and limited resources available for these activities. Regulatory surveillance by CASA is therefore a sampling

[56] ATSB AO-2017-005, Collision with terrain following an engine power loss involving Cessna 172M, VH-WTQ, 12 NM (22 km) north-west of Agnes Water, Queensland, 10 January 2017 See also safety issue AO-2017-005-SI-07, *Requirements for briefing the brace position in small aircraft.*

[57] FAA helicopter flying handbook (FAA-H-8083-21B), *Chapter 8 ground procedures and flight preparations.*

exercise, and cannot examine every aspect of an operator's activities, nor identify all the limitations associated with these activities.

Nevertheless, in two previous investigations, the ATSB noted that CASA's processes for scoping surveillance events did not formally include the nature of the operator's activities, the inherent threats or hazards associated with those activities, and the risk controls that were important for managing those threats or hazards.

In the case of Whitsunday Air Services, CASA had undertaken a significant number of surveillance events in the years leading up to the March 2018 accident. CASA was aware that a significant part of the operator's operations involved overwater helicopter flights to reef pontoons. Such operations over water would typically be associated with significant hazards that had to be effectively controlled. However, none of CASA's surveillance events focussed on topics such as helicopter operations at the pontoons, bird hazard management, passenger safety briefings, and passenger control at the pontoons.

Given that the underlying problem associated with the scoping of surveillance events was extensively discussed in a recent ATSB investigation (AO-2017-005), further discussion was not considered necessary in this report. As noted above, as part of that investigation, the ATSB issued a safety recommendation (AO-2017-005-SR-026) to CASA in October 2019, and this recommendation was closed in March 2020 after CASA outlined the safety actions it had taken and was taking to address the issue. In addition, the Australian National Audit Office (ANAO) commenced an audit in April 2021 into planning and conduct of CASA's surveillance activities.

Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition 'other findings' may be included to provide important information about topics other than safety factors.

Safety issues are highlighted in bold to emphasise their importance. A safety issue is 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 operating environment at a specific point in time.

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

From the evidence available, the following findings are made with respect to the loss of control and collision with water involving a Eurocopter EC120B, registered VH-WII, that occurred at Hardy Reef, 69 km north-north-east of Hamilton Island Airport, Queensland, on 21 March 2018.

Contributing factors

- The safety margin associated with landing the EC120B helicopter on the pontoon at Hardy Reef was reduced due to a combination of factors, each of which individually was within relevant requirements or limits. In addition to the pilot's low level of experience and consolidation on the helicopter type, these factors included: [58]
  - The helicopter was close to the maximum allowable weight.
  - The helicopter's engine power output was close to the lowest allowable limit for the helicopter type.
  - The pilot was required to use high power to make a slow approach in order to disperse birds from the pontoon.
  - Consistent with the operator's normal practice, the pilot was intending to turn left into a 20 kt right crosswind when landing (in a helicopter with a clockwise-rotating main rotor system). Although a left turn required less power than a right turn, it increased the susceptibility of an unanticipated left yaw if the left turn was not effectively controlled.
- While yawing the helicopter left into the intended landing position, the pilot elected to conduct a go-around; during this go-around from just above the pontoon, the helicopter yawed slowly to the left, and the pilot very likely did not apply sufficient right pedal to correct the developing yaw or conduct the go-around into wind.
- Following a period of ongoing yaw to the left (towards a downwind position), there was a sudden and rapid yaw to the left.
- In response to the unanticipated rapid yaw to the left, the pilot lowered the collective and it is very likely that they did not immediately apply full and sustained opposite (right) pedal input.
- In the limited time available after the unsuccessful action to recover from the unanticipated rapid left yaw, the pilot did not deploy the helicopter's floats and conduct a controlled ditching.
- The pilot had 11.0 hours experience in command on the EC120B helicopter type, and had conducted 16.1 hours in another and technically different helicopter type (Bell 206L3) during the period of acquiring their EC120B experience, limiting their ability to consolidate skills on the new type.

[58] Many of these factors, if listed as a separate finding, would probably not meet the definition of a contributing factor.

- Associated with their limited consolidation on the helicopter type, the pilot was experiencing a high workload during the final approach and a very high workload during the subsequent go-around.
- **Although the operator complied with the regulatory requirements for training and experience of pilots, it had limited processes in place to ensure pilots with minimal time and experience on a new and technically different helicopter type had the opportunity to effectively consolidate their skills on the new type to the level required for conducting the operator's normal operations to pontoons.** (Safety issue)

Other factors that increased risk

- Due to an inaccurate assessment of passenger weights and cargo, the helicopter was about 25 kg over the maximum all-up weight on departure from Hamilton Island.
- **Although the operator had calibrated scales available for use at two of their check-in locations, they were not routinely used to ascertain actual passenger and/or baggage weights. Instead, the operator's personnel relied on passengers' volunteered weights (without an additional allowance) and only weighed passengers when the volunteered weights were perceived to be inaccurate.** (Safety issue)
- **There was often a significant number of birds located on the pontoons at Hardy Reef used by the operator. However, the operator did not have a process to systematically manage the risk of birdstrike. For example:**
  - **The operator had not conducted a formal risk assessment of the bird hazard at the pontoons.**
  - **The operator did not record birdstrike occurrences, which reduced its ability to accurately assess the ongoing hazard associated with birdstrikes at the pontoons. Birdstrike occurrences were also not notified to the ATSB (as required).**
  - **The operator did not provide guidance or appropriate equipment to enable pilots to effectively conduct visual inspections following an actual or suspected birdstrike at the pontoons.** (Safety issue)
- Although the passengers were shown a safety briefing video, and the pilot provided a short safety briefing in the aircraft:
  - The passengers were not provided information on the location of the exit operating handles or all the key steps required to open the emergency exits.
  - The passenger in the front left seat was not provided any information on how to use their seatbelt (a four-point harness).
  - The front left passenger was wearing a brace on their arm and was observed having difficulty boarding the helicopter by multiple staff, but they did not receive any additional briefing information about what to do in an emergency.
- The passenger seated next to the rear exit was unable to locate the exit operating handle during the emergency, and as a result the evacuation of passengers was delayed until another passenger was able to open the exit.
- **There was no requirement for operators of passenger transport flights in aircraft with six or less seats to provide passengers with a verbal briefing, or written briefing material, on the method for operating the emergency exits.** (Safety issue)
- **Due to multiple factors, the design of the rear left sliding door (emergency exit) on the EC120B helicopter was not simple and obvious to use unless the occupant was provided with specific instructions about how to operate the exit. In particular:**
  - **the door required three actions to open (pull handle up, push door out, slide door back), and the second action was not indicated in either the design of the handle or the placard next to the handle**

  - **the design of the inside handle was such that its purpose may not have been readily apparent to many users.** (Safety issue)
- **The operator's system used to identify passengers with reduced mobility and/or required additional safety briefing information relied on passengers self-reporting a problem.** (Safety issue)
- **It was common practice for the operator's pilots to leave the controls of their helicopter, while the rotors were turning and the friction locks applied, to escort passengers to and from the helicopter.** (Safety issue)
- Although the operator's primary helicopter activity was conducting charter flights to pontoons at Hardy Reef, regulatory oversight activity by the Civil Aviation Safety Authority had not specifically examined the operator's procedures and practices for conducting operations to these helicopter landing sites.

Safety issues and actions

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues. The ATSB expects relevant organisations will address all safety issues an investigation identifies.

Depending on the level of risk of a safety issue, the extent of corrective action taken by the relevant organisation(s), or the desirability of directing a broad safety message to the aviation industry, the ATSB may issue a formal safety recommendation or safety advisory notice as part of the final report.

All of the directly involved parties were provided with 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 initial public version of these safety issues and actions are provided separately on the ATSB website, to facilitate monitoring by interested parties. Where relevant, the safety issues and actions will be updated on the ATSB website as further information about safety action comes to hand.

Operator consolidation processes for flight crew

Although the operator complied with the regulatory requirements for training and experience of pilots, it had limited processes in place to ensure pilots with minimal time and experience on a new and technically different helicopter type had the opportunity to effectively consolidate their skills on the type required for conducting the operator's normal operations to pontoons.

Issue number:	AO-2018-026-SI-01
Issue owner:	Whitsunday Air Services
Transport function:	Aviation: Air transport
Current issue status:	Closed – Adequately addressed
Issue status justification:	The ATSB is satisfied that the action introduced by the operator, particularly the requirement to undertake 20 hours on type prior to conducting crosswind landings at pontoons, will reduce the risk of this safety issue.

Proactive safety action taken by the Whitsunday Air Services

Action number:	AO-2018-026-NSA-065
Action organisation:	Whitsunday Air Services
Action status:	Closed

In February 2021, Whitsunday Air Services (WAS) advised the ATSB that it believed that the safety issue should be considered a regulatory standards matter rather than one applicable to the operator.

The operator also advised it had introduced a safety management system (SMS) and also implemented several additional processes for pilots on new type helicopters since the accident. These included:

1. ICUS [in command under supervision] reporting system
2. ICUS Supervising pilot is approved by the Chief Pilot for ICUS operations
3. The supervising pilot must have formal training … conducting flight operations and emergencies from the Co-pilot seat.
4. Into wind operations only on Pontoons allowed for a minimum of 20 hours on type. Crosswind landings approved by the CP after 20 hours at the CPs discretion.
5. WAS Operation Manual, Pontoon operation guide section expanded (3A3.5.4)
6. Standard operating procedures (SOPs) for each type helicopter

Proactive safety action taken by the Civil Aviation Safety Authority

Action number:	AO-2018-026-NSA-070
Action organisation:	Civil Aviation Safety Authority
Action status:	Closed

In December 2018, CASA issued Civil Aviation Safety Regulation (CASR) Part 119 (*Australian air transport operators—certification and management*) and CASR Part 133 (*Australian air transport operations—rotorcraft*).

CASR Part 119 outlined safety management system requirements for air transport operators (including operators of charter flights in single-engine helicopters). CASR Part 133 outlined flight crew training and checking requirements for air transport operators of helicopters.

More explicitly, CASR 133.415 (*Assignment of flight crew to different multi-engine rotorcraft*):

> A rotorcraft operator's exposition must include the following:
>
> (a) a description of the circumstances in which the operator may assign a flight crew member to duty on 2 or more different multi-engine rotorcraft;
>
> (b) the combinations of different rotorcraft that a single flight crew member may be assigned to duty on by the operator;
>
> (c) the flying experience, checks and training that a flight crew member must gain or complete, while the flight crew member is employed by the operator, before being assigned to duty on 2 or more different multi-engine rotorcraft…

There were no similar requirements introduced for single-engine helicopters, other than in command under supervision (ICUS) requirements, which were effectively the same as those previously in place. However, the acceptable means of compliance (AMC) for the requirement to ensure flight crew were competent (CASR 133.375) stated:

> The training and checking regulations require a minimum level of competence for flight crew operating under this Part. Part 61 of CASR and its MOS stipulate minimum competence standards for holders of pilot licences and ratings. An operator is required to ensure that the competence of their flight crew is at least at this level.
>
> Regulation 133.375 provides that an operator must have assessed the crew member as being competent to perform the duties assigned to them. These regulations are not meant to be a one-size-fits-all set of regulations and it is imperative that operators formulate their own specific set of equal or better standards after thorough assessment of their operational characteristics. Appropriate use of training needs analysis with input from the SMS will be crucial in this development. Operations identified by the SMS as having a higher degree of difficulty may require higher training or checking standards than set out in these regulations.

Requirements for verbally briefing passengers on emergency exits

There was no requirement for operators of passenger transport flights in aircraft with six or less seats to provide passengers with a verbal briefing, or written briefing material, on the method for operating the emergency exits.

Issue number:	AO-2018-026-SI-02
Issue owner:	Civil Aviation Safety Authority
Transport function:	Aviation: Air transport
Current issue status:	Closed – Adequately addressed
Issue status justification:	The ATSB notes that the requirement for briefings is limited to those seated in emergency exit rows, even for small aircraft, but overall is satisfied that the safety action taken by the Civil Aviation Safety Authority has reduced the risk of this safety issue.

Proactive safety action taken by the Civil Aviation Safety Authority

Action number:	AO-2018-026-NSA-056
Action organisation:	Civil Aviation Safety Authority
Action status:	Closed

On 10 October 2018, the Civil Aviation Safety Authority (CASA) issued *Cabin safety bulletin 12 - General aviation passenger briefings*.[59] The purpose of the bulletin was to '…provide guidance on how to conduct a briefing to increase passenger situational awareness and enhance any response to an emergency or abnormal event within the passenger-carrying environment'.

The background section stated:

> Survivors of aircraft accidents have provided anecdotal evidence as to the importance of their recollection of information concerning the correct operation of aircraft equipment such as exits, the location of emergency equipment and how to adopt the brace position for impact. Adequately briefed passengers, who understand how to help themselves, will assist in the quick and successful evacuation of an aircraft.

The bulletin provided guidance for briefings of small aeroplanes, helicopters and hot air balloons. For helicopters, the bulletin included the following information

> Pre-flight briefing
>
> - Seat belt fastening, tightening, releasing procedures.
> - Importance of using a shoulder harness where fitted.
> - Location and operation of doors and emergency exits.
> - Location and operation of emergency equipment such as the emergency locator transmitter, survival kit, first-aid kit, fire extinguisher and any other safety equipment.
> - Location and use of life jackets, including fitment and when to inflate.
> - No smoking.
> - Remain in the seat unless given permission to move.
> - Do not distract the pilot during take-off, manoeuvring or landing.

In addition to the bulletin, in December 2018, CASA revised its passenger safety briefing guidance and produced the Civil Aviation Advisory Publication (CAAP) 253-02 v2.0 (*Passenger safety information: Guidelines on content and standard of safety information to be provided to passengers by aircraft operators*). The update to the original CAAP included information specific for helicopter operations and included the information that had been produced in the cabin safety bulletin.

Proactive safety action taken by the Civil Aviation Safety Authority

Action number:	AO-2018-026-NSA-057
Action organisation:	Civil Aviation Safety Authority
Action status:	Closed

In December 2018, CASA issued Civil Aviation Safety Regulation (CASR) Part 133, applicable to air transport operations in helicopters. CASR 133.240 stated that the operator and the pilot in command were required to provide passengers with a safety briefing, instructions or demonstrations in accordance with the requirements prescribed by the Part 133 Manual of Standards (MOS). This same requirement was mimicked for both small aeroplanes (in Part 135) and large air transport (in Part 121).

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59 The full bulletin, and other CASA cabin safety bulletins, is available on the CASA website at www.casa.gov.au/aircraft/standard-page/cabin-safety-bulletin.

In December 2020, the Civil Aviation Safety Authority Part 133 MOS came into effect. The MOS required that the following information be provided to passengers before take-off (among other things):

> (6) Subject to subsection (7), a specific safety briefing must be provided directly to any passenger on the flight who is seated in an emergency exit row, which outlines what to do if it becomes necessary to use the exit.
>
> (7) Subsection (6) does not apply if:
>
> (a) a crew member who has been assigned to the flight is seated in a crew station adjacent to the exit; and
>
> (b) the crew member has been assigned emergency evacuation responsibilities for the exit in accordance with the operator's exposition…
>
> (9) A safety briefing that addresses the following matters must be given…
>
> (f) where the emergency exits are located…

The MOS also stated that the safety briefing could be given orally, by audio presentation, by video presentation or by a combination of these methods.

CASR part 133.235 also required that, if a helicopter had a maximum operational passenger seat configuration of more than two, a safety briefing card must be available for each passenger. The MOS also required that the safety briefing card contain the following:

> (f) where the emergency exits are located and how to use them…

Similar requirements were outlined in the Part 135 MOS for air transport operations in small aeroplanes.

In May 2021, CASA released a multi-part Advisory Circular (AC), AC 121-10, AC 133-07 and AC135-11 v1.0 (*Passengers seated in emergency exit row seats*) applicable to both aeroplanes and helicopters that provided additional guidance about the briefing requirements for those passengers allocated to an emergency exit row seat.

Design of the EC120B rear left emergency exit

Due to multiple factors, the design of the rear left sliding door (emergency exit) on the EC120B helicopter was not simple and obvious to use unless the occupant was provided with specific instructions about how to operate the exit. In particular:

- the door required three actions to open (pull handle up, push door out, slide door back), and the second action was not indicated in either the design of the handle or the placard next to the handle
- the design of the inside handle was such that its purpose may not have been readily apparent to many users.

Issue number:	AO-2018-026-SI-03
Issue owner:	Airbus Helicopters
Transport function:	Aviation: Air transport
Current issue status:	Open - Safety action pending
Issue status justification:	To be advised

Response by Airbus Helicopters

As already indicated in the report, Airbus Helicopters advised that it believes the operation of the rear left sliding door was 'simple and obvious' and it did not consider that the design of the door was a safety issue. It also advised that, as in the case for a seatbelt, the description of the door operation is part of, and the responsibility of, the pre-flight briefing.

Comment by the ATSB

The ATSB acknowledges that the helicopter manufacturer has a different opinion regarding this safety issue, and in ongoing correspondence with the ATSB has reiterated its view that the rear left sliding door is simple and obvious to use. For reasons already outlined in the report, the ATSB disagrees.

The ATSB understands that over 700 EC120B helicopters were manufactured, and that many of these would still be used in passenger transport operations (as well as additional EC130B4 helicopters with a similar door). The ATSB also acknowledges that modifying the door or handle design after manufacture would be difficult (although ultimately the best solution); however, it also recognises that there are other options available to reduce the risk of the safety issue, such as modifying the placards and/or providing safety information to operators. Accordingly, the ATSB considers that it is appropriate to issue the following recommendation.

Safety recommendation to Airbus Helicopters

The ATSB makes a formal safety recommendation, either during or at the end of an investigation, based on the level of risk associated with a safety issue and the extent of corrective action already undertaken. Rather than being prescriptive about the form of corrective action to be taken, the recommendation focuses on the safety issue of concern. It is a matter for the responsible organisation to assess the costs and benefits of any particular method of addressing a safety issue.

Recommendation number:	AO-2018-026-SR-073
Responsible organisation:	Airbus Helicopters
Recommendation status:	Released

The Australian Transport Safety Bureau recommends that Airbus Helicopters takes safety action to address the safety issue associated with the design of the rear left sliding door on the EC120B helicopter to ensure that, as best as possible, the door is simple and obvious to use and/or passengers are provided with sufficient instructions so that it is simple and obvious to use.

Passengers with reduced mobility

The operator's system used to identify passengers with reduced mobility and/or required additional safety briefing information relied on passengers self-reporting a problem.

Issue number:	AO-2018-026-SI-04
Issue owner:	Whitsunday Air Services
Transport function:	Aviation: Air transport
Current issue status:	Closed – Partially addressed
Issue status justification:	The operator has provided more information about when and how the pilot in command must seek to identify those passengers who may require an additional safety briefing, however the operator had the same system in place at the time of the accident, whereby the operator relied on the pilot in command to identify the passengers which in some cases would be as they were boarding the aircraft as was the case on the day of the accident. Therefore the ATSB has assessed the safety issue as partially addressed.

Proactive safety action taken by the Whitsunday Air Services

Action number:	AO-2018-026-NSA-066
Action organisation:	Whitsunday Air Services
Action status:	Closed

The operator advised that their operations manual has been updated to include the requirement for the pilot in command to identify passengers who may require additional assistance and therefore an additional briefing. They advised that the identification of these passengers would be the pilot in command's responsibility and occur at reservation, by observation and when the pilot in command asks if the passenger is able to assist in an emergency. The operator also advised that additional advice has been provided to ground staff and pilots about the positioning of children and passengers with mental and physical disabilities in seats other than emergency exits where possible.

Proactive safety action taken by the Civil Aviation Safety Authority

Action number:	AO-2018-026-NSA-071
Action organisation:	Civil Aviation Safety Authority
Action status:	Closed

In May 2021, CASA released a multi-part Advisory Circular (AC), AC 121-09, AC 133-06 and AC135-10 v1.0 (*Carriage of special categories of passenger*) applicable to both aeroplanes and helicopters that provided additional guidance about the identification and management of passengers with reduced mobility, including briefing requirements. The guidance also provided categories of passengers with reduced mobility and seating considerations for each type.

Operator helicopter loading practices

Although the operator had calibrated scales available for use at two of their check-in locations, they were not routinely used to ascertain actual passenger and/or baggage weights. Instead, the operator's personnel relied on passengers' volunteered weights (without an additional allowance) and only weighed passengers when the volunteered weights were perceived to be inaccurate.

Issue number:	AO-2018-026-SI-05
Issue owner:	Whitsunday Air Services
Transport function:	Aviation: Air transport
Current issue status:	Closed – Adequately addressed
Issue status justification:	The ATSB is satisfied that the safety action taken by the operator has reduced the risk of this safety issue.

Proactive safety action taken by the Whitsunday Air Services

Action number:	AO-2018-026-NSA-059
Action organisation:	Whitsunday Air Services
Action status:	Closed

In January 2019, the operator's operations manual was updated and required that all items and passengers must be weighed by the company and that these weights will be used on the aircraft load sheet:

> **2B3.2 Load Control**
>
> CAR 235 CAO 20.16.1
>
> The calculation of weights for all passengers and cargo carried in Company aircraft shall be in accordance with this Section. All weights shall be recorded before the aircraft is loaded.
>
> NOTE: *All items and passengers must be weighed by the Company and only those weights used on the load sheet.*
>
> **2B3.3 Passenger Weight**
>
> Load calculations for all Company operated aircraft shall be made using actual weights for all passengers and baggage.

The operator advised in February 2021 that the reservation system used by the operator would automatically add an additional five per cent to the body weight provided by the passenger. Also, the operator advised that all passengers are now weighed prior to departure as per its operations manual.

Operator management of birdstrikes

There was often a significant number of birds located on the pontoons at Hardy Reef used by the operator. However, the operator did not have a process to systematically manage the risk of birdstrike. For example:

- The operator had not conducted a formal risk assessment of the bird hazard at the pontoons.
- The operator did not record birdstrike occurrences, which reduced its ability to accurately assess the ongoing hazard associated with birdstrikes at the pontoons. Birdstrike occurrences were also not notified to the ATSB (as required).
- The operator did not provide guidance or appropriate equipment to enable pilots to effectively conduct visual inspections following an actual or suspected birdstrike at the pontoons.

Issue number:	AO-2018-026-SI-06
Issue owner:	Whitsunday Air Services
Transport function:	Aviation: Air transport
Current issue status:	Closed – Partially addressed
Issue status justification:	The ATSB notes that no additional action has been taken to reduce the concentration of birds at the pontoons, and that there are limited options available for reducing this concentration. However, given the location and the operational environment that the operator conducts flights (where all bird species are protected), the ATSB is satisfied that the safety action taken by the operator has reduced the risk of the safety issue.

Proactive safety action taken by the Whitsunday Air Services

Action number:	AO-2018-026-NSA-058
Action organisation:	Whitsunday Air Services
Action status:	Closed

In January 2019, Whitsunday Air Services updated its operations manual to include additional information related to the management of birdstrike, more specifically:

> **2B1.14 Bird/Animal Avoidance** In areas of known bird/animal hazards pilots are to plan, where possible, the route that will avoid large concentration of birds or animals.
>
> When taking evasive manoeuvres to avoid hitting a bird or animal the pilot must ensure the avoiding action does not place the aircraft in greater danger.
>
> If contact is made or suspected with a bird or animal land as soon practicable. The aircraft cannot be flown until the procedures in Volume 5A12 are carried out the and the aircraft is cleared for flight.
>
> **2B1.14.1 Preventative Strategies**
>
> To prevent or reduce the consequences of a bird strike, the flight crew should:
>
> a) Discuss bird strikes during take-off and approach briefings when operating at places with known or suspected bird activity.
>
> b) Be extremely vigilant if birds are reported in the area.
>
> 2B1.14.2 Bird Strike Detection
>
> a) **Visual**: Birds seen in close proximity to the aircraft or colliding with the aircraft, bird remains on windshield, cracked windshield.

b) **Aircraft**: Vibration of airframe or engine, thrust loss, increased drag, abnormal aircraft handling characteristics.

c) **Auditory**: Noise of strike or noise attributed to resulting damage: engine surging, compressor stalls, aerodynamic noise from damage.

If contact is made or suspected with a bird or animal land as soon practicable. The aircraft cannot be flown until the procedures in Volume 5A12 are carried out the and the aircraft is cleared for flight.

NOTE: *Any bird strike must be reported within 72 hours as a routine reportable matter to the ATSB using the Accident or Incident Notification Form www.atsb.gov.au/mandatory/asair-form.aspx?*

In February 2021, the operator also advised that it had undertaken the following safety actions:

1. Inspection of blades after a bird strike included in Maintenance training for each pilot

2. Safety management system and reporting system implemented with an appointed safety manager and safety team

3. Line pilots trained by the approved ICUS company pilot on Pontoon operations including bird avoidance procedures.

Pilots leaving the controls of the helicopter

It was common practice for the operator's pilots to leave the controls of their helicopter, while the rotors were turning and the friction locks applied, to escort passengers to and from the helicopter.

Issue number:	AO-2018-026-SI-07
Issue owner:	Whitsunday Air Services
Transport function:	Aviation: Air transport
Current issue status:	Closed – Partially addressed
Issue status justification:	The ATSB notes that the operator has now specified that control friction locks are not considered a suitable means of locking a control. The ATSB also notes that, according to the operator's procedure, pilots should not be leaving the controls of a helicopter, with rotors turning, unless the helicopter was pointed into wind and the wind strength was less than 15 kt. Nevertheless, the ATSB is still concerned that the operator's procedures will allow pilot to leave the controls of a helicopter to escort passengers, even though CASA has advised that is not a suitable reason for doing so.

Proactive safety action taken by the Whitsunday Air Services

Action number:	AO-2018-026-NSA-064
Action organisation:	Whitsunday Air Services
Action status:	Closed

In January 2019, the operator provided a revised operations manual. The manual still allowed pilots to leave the controls of a helicopter to escort passengers to and from a helicopter, under the same conditions as previously. However, an additional note in the manual was included, which stated:

Control frictions do not meet the requirement of a control lock.

In February 2021, the operator advised that it did not consider this aspect to be related to the accident, and it did not provide any further safety action.

Safety action not associated with an identified safety issue

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. All of the directly involved parties are invited to provide submissions to this draft report. As part of that process, each organisation is asked to communicate what safety actions, if any, they have carried out to reduce the risk associated with this type of occurrences in the future. The ATSB has so far been advised of the following proactive safety action in response to this occurrence.

Additional safety action by Whitsunday Air Services

Update to training of pilots and ground personnel

In January 2019, the operator advised the ATSB about the introduction of an additional requirement for pilots to complete an emergency procedures quiz every 3 months covering various procedures documented in the operations manual and flight manual and specific to the helicopter types that they fly.

Prior to the accident, ground personnel including guest liaison officers were trained in accordance with the operator's operations manual, however this was not formalised and there were no assessment requirements for these personnel documented. The operator advised in January 2019 that it had now formalised these processes, with a requirement for a 'ground handling proficiency check'.

Recruitment processes for flight crew

The operator advised in January 2019 that they had added an additional requirement for new pilots entering the organisation to undertake aptitude testing, including a personality profile. Set levels are to be met in certain areas of the testing, with those found to be unsuitable, not progressed into a position with the organisation.

Revised passenger safety briefing

Following the accident, Whitsunday Air Services revised its passenger safety briefing video to include all types of seatbelts (including the four-point harness) and the location and operation of the emergency exits on all of their helicopter types. The operator also updated its passenger safety briefing cards, which included brace position suitable for use when utilising an upper torso restraint as well as all of the information contained in the safety briefing video.

The operator also advised that the revised passenger briefing videos are utilised at the operator's two fixed bases and for the passengers who are returning from the Hardy Reef pontoons. In circumstances where the video is unavailable, the operator carries a demonstration life jacket for briefing purposes. In addition, the operator confirmed that pilots are trained to physically brief passengers on the operation of the aircraft seatbelts and the emergency exits.

HUET training

In February 2021, the operator advised that all pilots on all aircraft types were now required to undertake recurrent helicopter underwater escape training (HUET) courses.

Additional safety action by Civil Aviation Safety Authority

In December 2018, CASA issued Civil Aviation Safety Regulation (CASR) Part 133, applicable to air transport operations in helicopters. In December 2020, the Part 133 Manual of Standards (MOS) came into effect. It required that pilots operating flights, that required life jackets to be carried, to undertake HUET during initial training and at intervals no more than 3 years.

Additional safety action by Airbus Helicopters

Airbus Helicopters issued Safety Information Notice 3297-S-00 (*Unanticipated left yaw (main rotor rotating clockwise), commonly referred to as LTE*) in July 2019. This notice outlined a detailed explanation of the phenomenon of unanticipated yaw due to insufficient pedal application. In addition, the notice provided detailed advice regarding the circumstances where unanticipated yaw can occur and the importance of applying full opposite right pedal if it occurs. The notice also stated that, for helicopter with a clockwise-rotating main rotor system, to prefer (as much as possible) yaw manoeuvres to the right, especially in performance-limited conditions. The full notice is provided in Appendix B.

General details

Occurrence details

Date and time:	21 March 2018 – 1537 EST	
Occurrence category:	Accident	
Primary occurrence type:	Collision with water	
Location:	72 km north-north-east of Hamilton Island Airport	
	Latitude: 19º 50.03' S	Longitude: 149º 18.02' E

Aircraft details

Manufacturer and model:	Eurocopter EC120B	
Registration:	VH-WII	
Operator:	Whitsunday Air Services	
Serial number:	1603	
Type of operation:	Charter–Passenger	
Activity:	Commercial air transport–Non-scheduled, Passenger transport charters	
Departure:	Hamilton Island Airport	
Destination:	Hardy Reef HLS	
Persons on board:	Crew – 1	Passengers – 4
Injuries:	Crew – 1 (minor)	Passengers – 4 (2 fatal, 2 minor)
Aircraft damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the pilot and surviving passengers
- the operator and the chief pilot of Whitsunday Air Services
- the Civil Aviation Safety Authority
- the Queensland Police Service
- the helicopter manufacturer
- the maintenance organisation for VH-WII
- Airservices Australia
- some of the operator's other helicopter pilots
- Microflite training organisation
- other EC120B operators
- Cruise Whitsundays
- photographs taken on the day of the accident.

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Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section 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 following directly involved parties:

- the pilot of the accident flight
- the operator (Whitsunday Air Services)
- the helicopter manufacturer (Airbus Helicopters) and the French Bureau d’Enquêtes et d’Analyses pour la sécurité de l’aviation civile (BEA)
- the Civil Aviation Safety Authority (CASA).

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

Appendices

Appendix A – Analysis of photographs taken during flight

Introduction

During the helicopter's downwind leg, base leg, approach and go-around, the rear right passenger took five photographs. All of the photographs were taken by a Canon EOS 6D Mark II digital SLR camera with a Canon EF 24–70 mm f/2.8 II USM lens. Details of these photographs are summarised in Table A1.

Table A1: Image details

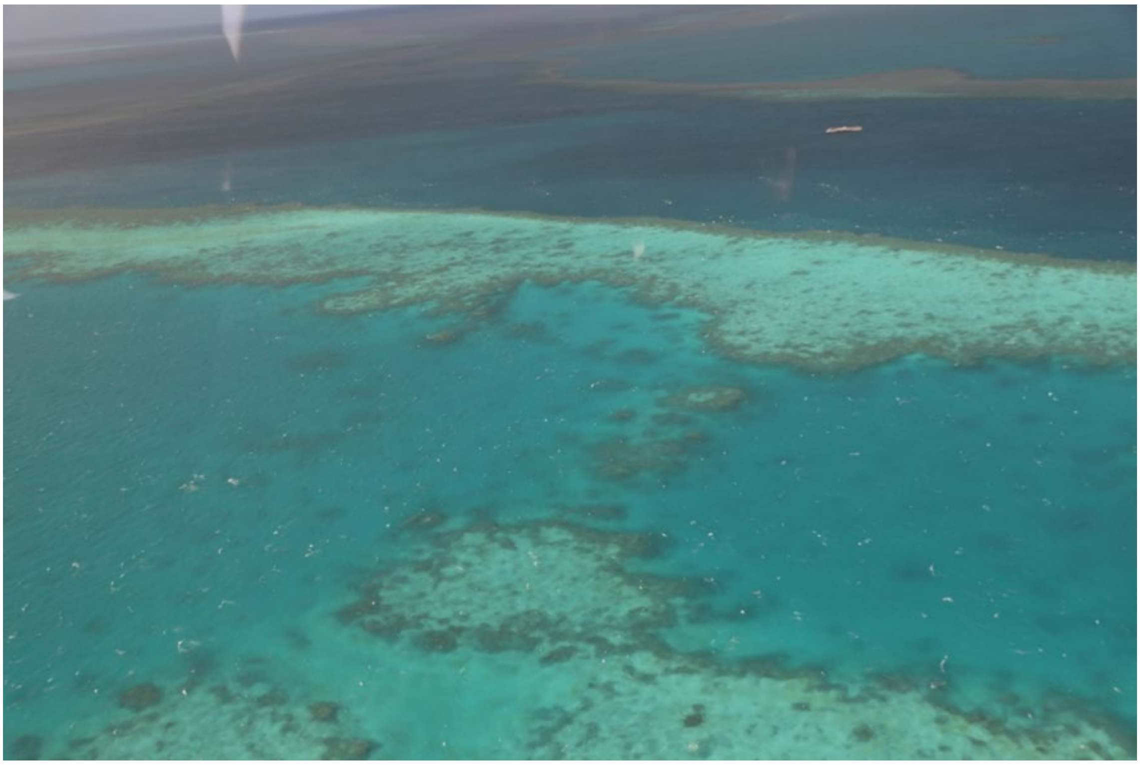
Image	Local time	Description
0617	1535:03	On the downwind leg, taken through the right side window; shows reef features and the northern pontoon (Figure A1). Focal length 38 mm.
0618	1535:19	During the turn on to base leg, taken through the right side window; shows reef features, the sky, rainbow, southern pontoon and Reefworld (Figure A2). Focal length 35 mm.
0619	1535:45	On the base leg, taken through the front windscreen over the pilot's shoulder; shows the northern and southern pontoons. Insufficient clarity for analysis. Focal length 24 mm.
0620	1536:36	Close to and over the northern pontoon, taken through the right side window; shows the sky, a rainbow, reef and part of the northern pontoon (Figure A3). Focal length 25 mm.
0621	1536:44	During the go-around, taken through the right side window; shows the sky, rainbow and reef features. No part of northern pontoon is visible (Figure A4). Focal length 44 mm.

The information in Table A1 includes details from the image exchangeable image file format (EXIF) data for the image number, time and focal length of each image. The EXIF data times have been converted into local time from the time zone from where the passenger rented the camera for the trip. Based on a comparison with other sources, they were considered a reasonable approximation of the actual times. The photographs are reproduced in Figures A1 though A5 below.

The ATSB conducted a detailed analysis of the photographs to establish the northern pontoon position and orientation, and the helicopter position and orientation at the time of the last two photographs.

The passenger reported that they intended to photograph the rainbow with the last two images (0620 and 0621). Between the first and the second image, the passenger was adjusting the camera position to minimise reflections from the helicopter's windows. The passenger recalled that both images were taken prior to the helicopter commencing the sharp (uncontrolled) yaw to the left, which occurred a short time after the helicopter had commenced climbing away from the pontoon. The two images were taken 8 seconds apart and contain similar parts of the sky and reef features.

Figure A1: Image 0617 showing northern pontoon



Source: Helicopter passenger

Figure A2: Image 0618 showing southern pontoon and Reefworld

Source: Helicopter passenger

Figure A3: Image 0619 showing both pontoons

Source: Helicopter passenger

Figure A4: Image 0620 taken when close to and over the northern pontoon

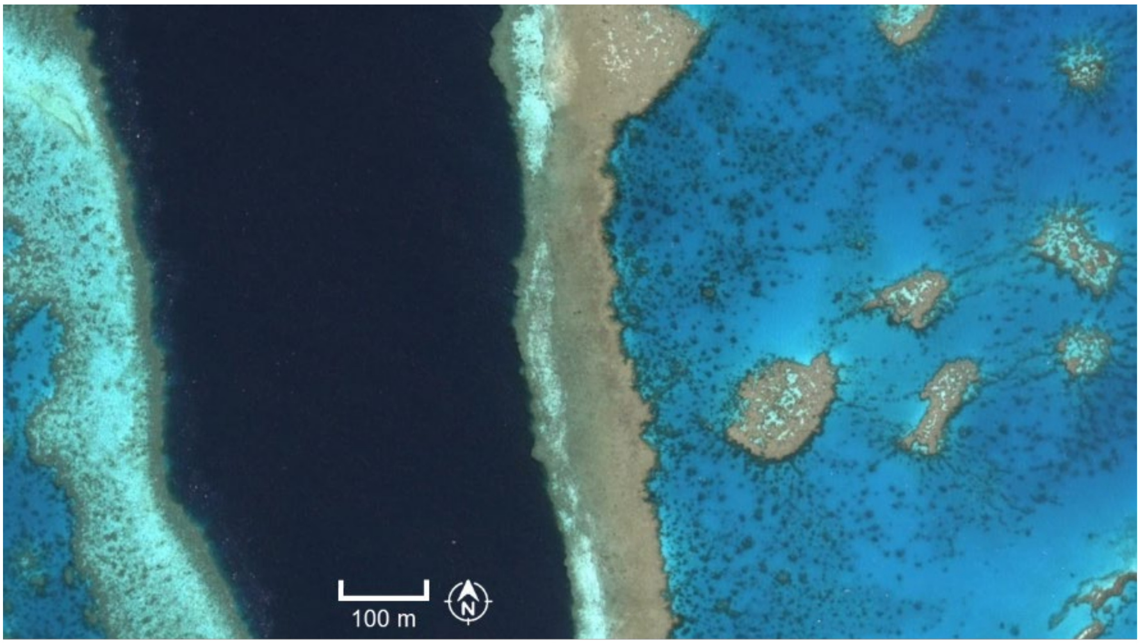
Source: Helicopter passenger

Figure A5: Image 0621 showing similar reef features and sky as image 0620

Source: Helicopter passenger

Overhead images from Google Earth were used to match, locate and measure reef features (Figure A6). In some cases, the camera's sensor dimensions, image size in pixels, and the recorded lens focal length setting were used to calculate angles from the camera's optical axis (assumed to be the centre of the image) to visible features.

Figure A6: Overhead image from Google Earth showing reef features used in image analysis



Source: Google Earth, annotated by ATSB

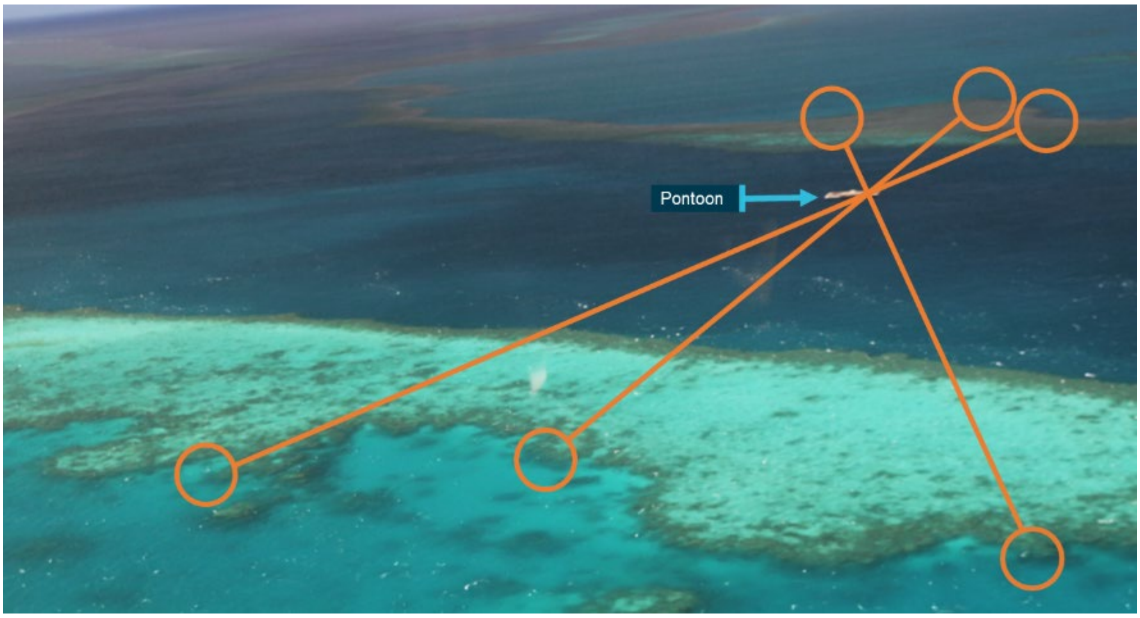
The images showed low level cumulus clouds to the west and good visibility. A broad rainbow to the west indicated light rain in that direction, although there was no rain apparent in the immediate vicinity of the helicopter. The sea state indicated a wind speed and direction that was consistent with weather forecasts and observations.

Pontoon position

The ATSB reviewed satellite images from Google Earth and other sources, and also reviewed the location of the northern pontoon as recorded by the Queensland Police Service and the ATSB in the days after the accident. These sources indicated that the pontoon's location moved with the effects of tide and wind, consistent with the nature of its single mooring. No other images or information about the pontoon's location close to the time of the accident could be obtained.

To estimate the position of the pontoon at the time of the accident, the ATSB used image 0617, which showed the pontoon in the channel and some of the reef on each side. The pontoon's relative position between pairs of reef features was established using straight lines (Figure A7), and its absolute position was determined by aligning the same features in overhead photographs using Google Earth. This analysis focused on the southern (upwind) end of the pontoon, which was the end being used by the pilot for the intended landing.

Figure A7: Reef feature pairs (orange circles) and crossing lines used to locate the northern pontoon's position



Source: Google Earth and ATSB

Pontoon orientation

The northern pontoon's orientation was estimated using a variety of methods. The best source of information was image 0617. The long edges of the pontoon were well defined, but their orientation could not be directly referenced with straight lines to identifiable reef features. The short edges of the pontoon were not as well defined but could be directly oriented to reef features. By comparing the pontoon's edges with the angles of lines between identifiable reef features it was estimated that the short edges were aligned at about 55° (to the nearest 5°).

A similar approach to analysing the southern pontoon in image 0618 indicated that pontoon's short edge was oriented at about 60° (to the nearest 5°), and an analysis of the northern pontoon in image 0620 using perspective lines indicated an orientation of about 60° (to the nearest 5°). It is likely that both pontoons were orientated fairly similarly.

Overall, the ATSB estimated that the orientation of the short edge of the pontoon was about 55–60° and the long edge was therefore oriented about 145–150°. This was broadly consistent with the expected alignment of the pontoon's long axis with the wind and the fact that at the time of the accident the tide was close to midway between high tide and low tide (minimising the effect of tidal flow on the pontoon's orientation).

Images of the pontoon and helicopter position throughout this report use a pontoon orientation of 58°. Helicopter position over pontoon in image 0620

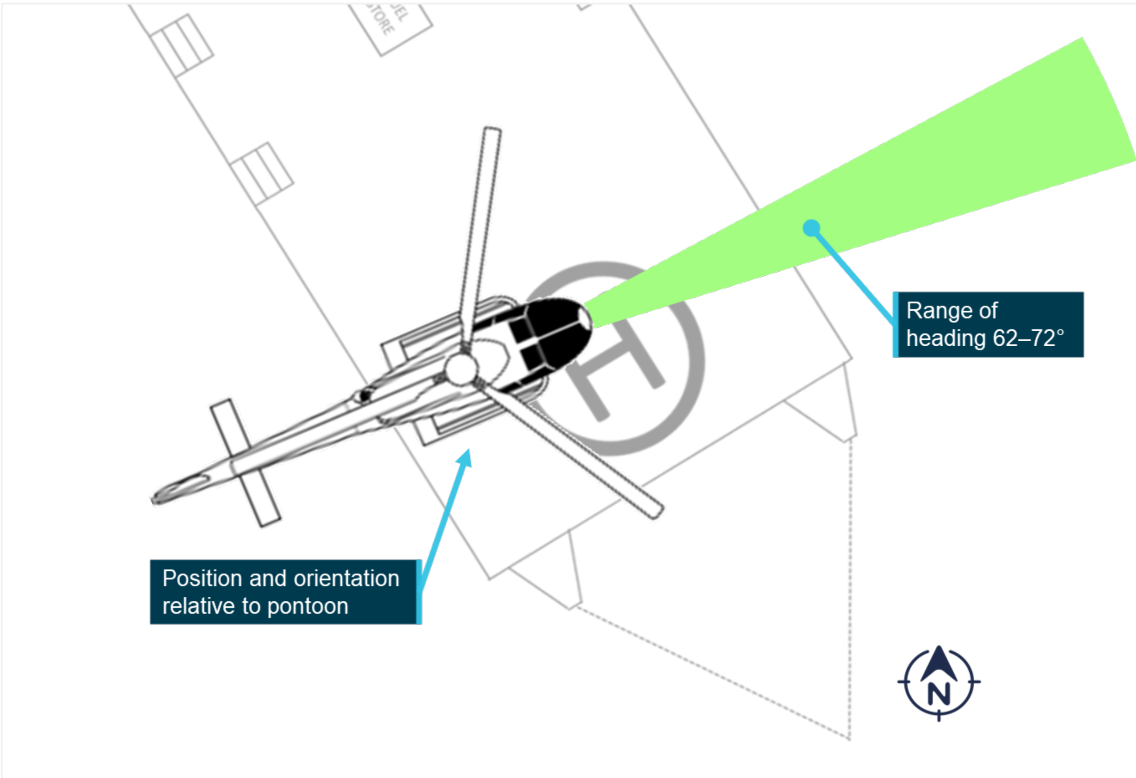
The shape and dimensions of the grid pattern on the pontoon were used to perform perspective analysis of image 0620 (constructing parallel lines that converge to a vanishing point, and using properties of those lines to establish the camera's position relative to them). This established the camera's location and orientation relative to the pontoon. This information was also used to verify the estimated pontoon orientation.

Using this method, the camera position in image 0620 was estimated to be about:

- 3.7 m from the south-east edge of the pontoon (nearest short edge)
- 6.1 m from the north-east edge of the pontoon (nearest long edge)
- 15 ft above the water and 12 ft above the pontoon deck.

Using the likely camera position within the helicopter, the helicopter's position was estimated to be as shown in Figure A8. The camera was estimated to be about 5 ft above the helicopter's skids. Therefore, the helicopter's skid height was estimated to be about 7 ft above the pontoon deck (10 ft above the water). The estimated orientation of the helicopter is discussed below.

Figure A8: Estimated helicopter position and orientation relative to the pontoon



Source: ATSB. Helicopter plan view: Richard Ferriere.

Camera orientation for images 0620 and 0621

Images 0620 and 0621 showed a rainbow to the west. The centre of a rainbow is always in the opposite direction to the sun from the observer's position, so the sun's position at that time can be used to determine the direction in which the camera is pointing.

At the time, the sun's azimuth was 285.5°, so the centre of the rainbow was at 105.5° relative to the camera. The angle from the camera's optical axis to the rainbow in image 0620 was 12° to the left, which meant that the camera was oriented to about 117°. The angle from the camera's optical axis to the rainbow in image 0621 was 4° to the right, which meant that the camera was oriented to about 102°.

Camera orientation relative to the helicopter in images 0620 and 0621

A pillar was visible on the left of image 0620 and was identified as the pillar between the front and rear windows on the right side of the helicopter. Colour enhancement of the image showed a clear reflection of the pilot's head, the central windscreen pillar, and the rotor brake lever above and between the front seats (Figure A9).

Figure A9: Colour enhancement of image 0620, rotated to level the horizon, showing reflections and window pillar used to estimate helicopter orientation

Source: Passenger photograph, modified by the ATSB

Analysis of the relative angles to those objects provided a limited range of possible camera angles relative to the helicopter, which was confirmed during tests involving another EC120B helicopter. The ATSB concluded that the camera was probably oriented 45°–55° to the right of the helicopter's longitudinal axis.

Since the camera was oriented to a heading of about 117°, the helicopter was therefore probably aligned to 62–72° at the time image 0620 was taken. Given that the pontoon's short edge was oriented 55–60°, this meant that the helicopter was oriented slightly to the right of the intended heading for landing when the image was taken.

As noted above, the passenger moved the camera to minimise the amount of reflection when taking images of the rainbow. Image 0620 shows a significant amount of reflection whereas image 0621 shows no reflection. The image also did not show a pillar between windows.

Tests conducted involving another helicopter found that image 0621 had to be taken through the window that was right of the pillar shown in image 0620. EXIF data showed it was also taken with a longer focal length (44 mm compared to 25 mm), and therefore had a narrower field of view.

After considering these aspects, tests conducted involving another EC120B helicopter indicated that image 0621 had to have been taken with the camera oriented more than 35° to the right of the helicopter's longitudinal axis to avoid the pillar.

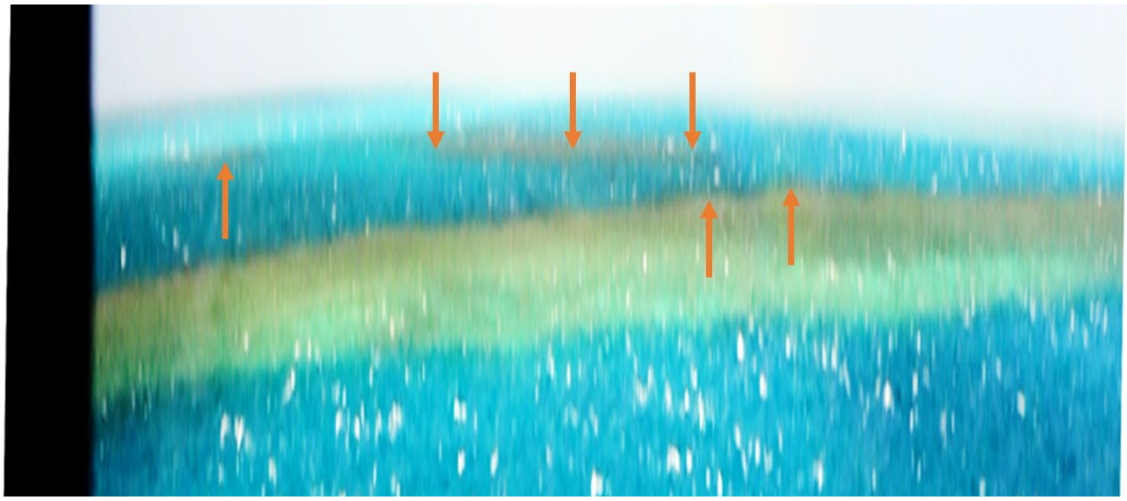
However, it was not possible to take images near this angle without a clear reflection being in the image. Further testing indicated that the camera was probably oriented at least 50° to the right of the helicopter's longitudinal axis in order to eliminate any reflection. This meant that, at the time image 0621 was taken, with the camera oriented to a heading of about 102°, the helicopter was probably oriented to the left of 52°. This was at least 10–20° left of the helicopter's orientation of 62–72° in image 0620 taken 8 seconds earlier.

The helicopter could have turned further left during this period. ATSB trials indicated that it was difficult for a person in the rear-right seat to take a steady, well-aimed photograph out the side window with a comparable camera with the camera pointing more than about 90° to the right of the helicopter's longitudinal axis. Therefore the camera could have been oriented anywhere between 50° to 90° right of the helicopter's longitudinal axis. This meant that the helicopter could have rotated anywhere from 10° to 60° further left during the 8-second period between images 0620 and 0621.

Helicopter position in images 0620 and 0621

Image 0620 captured a strip of reef in the distance. By vertically stretching this part of the image and enhancing the colours, the ATSB were able to identify several reef features (Figure A10).

Figure A10: Rotated, vertically-stretched and colour-enhanced portion of image 0620



The black bar to the left is the window pillar. Arrows show location of some of the reef features that were used throughout the analysis.
Source: Passenger photograph, modified by the ATSB

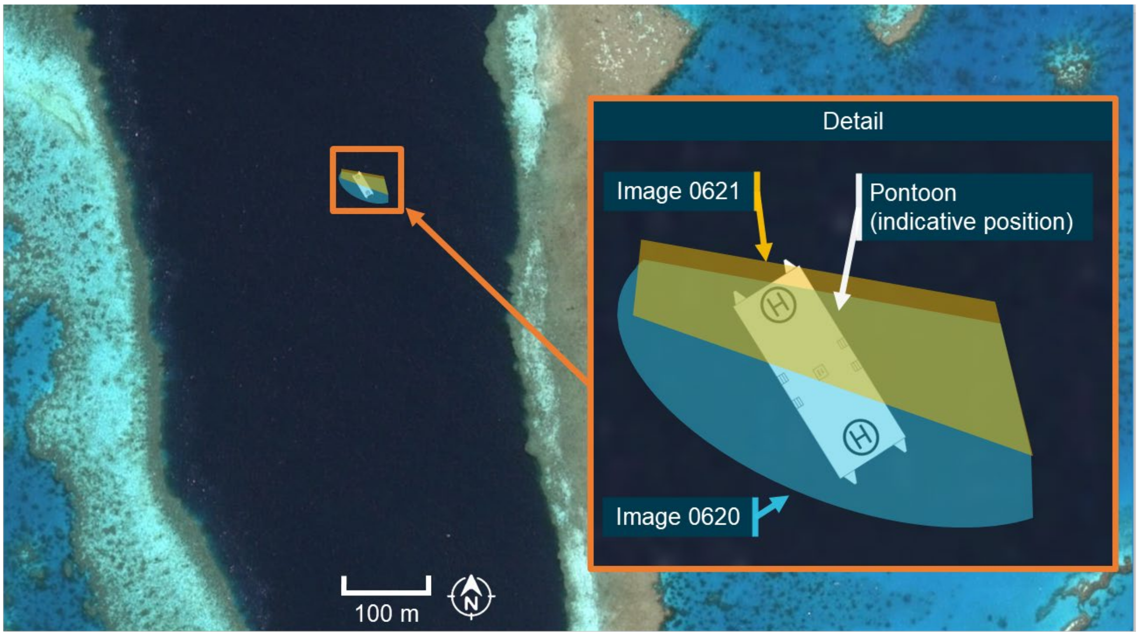
By applying several analysis methods that used the feature locations from Google Earth and their relative locations in the image, the ATSB confirmed that the camera location matched the previously-estimated pontoon location and estimated helicopter position relative to the pontoon. These analysis methods included:

- mapping features that aligned along the camera's optical axis in an overhead view, providing a line along which the camera must have been located
- identifying and mapping features located near the edges of the image, and comparing with the camera's field of view
- geometric analysis to determine the azimuth and elevation from the camera to each of the identified reef features and then overlaying the azimuth angles on the overhead view
- alignment of the rainbow with identified reef features.

Figure A11 shows the estimated absolute position of the helicopter using these analysis methods for image 0620 (in orange), as well as the estimated absolute position and orientation of the pontoon using methods described earlier in this appendix.

The helicopter's location at the time of image 0620 (when the helicopter was over the pontoon) was close to the position of the pontoon that was estimated from image 0617).

Figure A11: Representation of estimated helicopter and pontoon locations at the time of image 0620 (blue) and helicopter location at the time of image 0621 (orange)

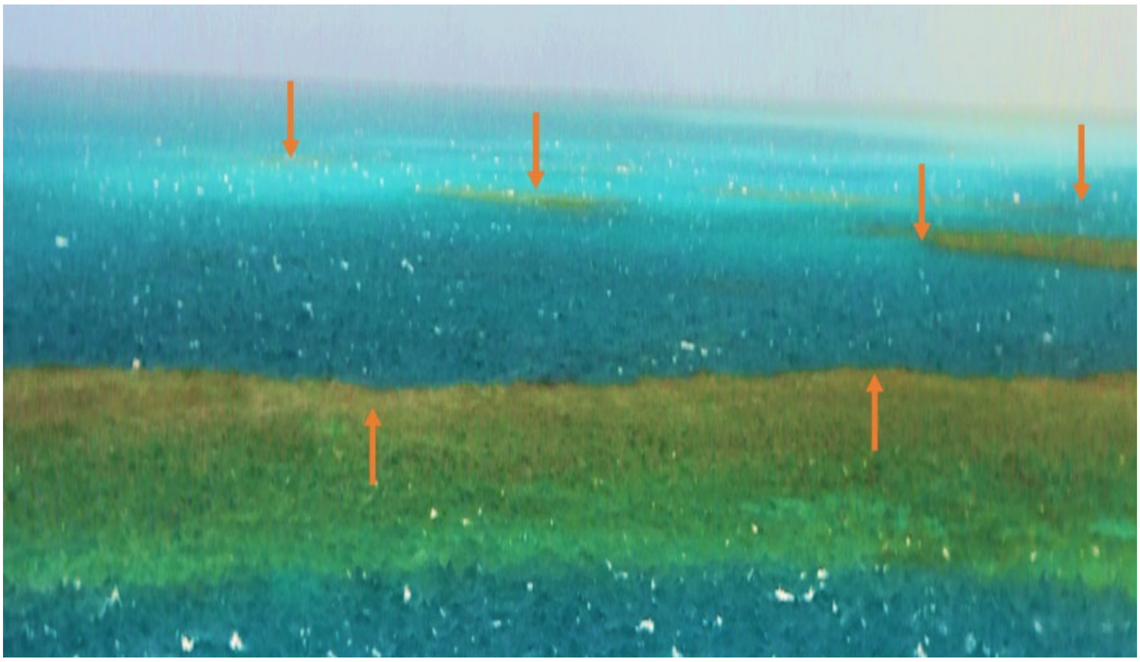


It is not possible to show the combined results of the analyses in a simple way or with a high degree of accuracy. Accordingly, the diagram is intended as representative only.
Source: ATSB and Google Earth

Image 0621 was taken at a longer focal length and greater height than image 0620, so the reef features were clearer (Figure A12). This image was analysed using the same methodologies as for image 0620, as well as the following additional analyses:

- perspective analysis, similar to that used to determine the helicopter's position relative to the pontoon in image 0620 but using reef features
- alignment of various reef features, which permitted limits to be placed on the helicopter's position
- comparison of the alignments with image 0620 to establish any relative movement
- use of the inscribed angle theorem to plot several possible camera loci based on the observed angle between feature pairs.

Figure A12: Vertically stretched and colour-enhanced portion of image 0621



Arrows show location of some of the reef features that were used throughout the analysis.
Source: Passenger photograph and ATSB.

The better feature definition of image 0621 enabled the investigation to establish a somewhat smaller area for the helicopter's position than for image 0620 (see the blue area in Figure A11). At the time image 0621 was taken, the helicopter was probably within the northern part of the area established for image 0620. These analyses indicate that the helicopter took a northerly or north-easterly track in the 8 seconds between when the two images were taken.

Helicopter height in images 0620 and 0621

Trigonometric analysis of the depression angles from the horizon to the identified features and the estimated distances to the features indicated that the camera was 6–12 ft above sea level at the time of the first image. Compared with the likely more accurate height estimates from perspective analysis of the pontoon grid (15 ft), trigonometric analysis gave a slightly lower height. This could be due to the inherent uncertainties of this method (the angles involved are less than 1° and highly susceptible to error).

To correct for systemic effects, the relative depression angles were compared between images 0620 and 0621 and indicated that the second image was probably taken at a height about 2.2 times that of the first, or 33 ft above sea level. A least-squares fit of the depression angles indicated that the probable height of the camera at the time image 0621 was taken was 30–40 ft above sea level.

Summary

In summary, analysis of image 0620 indicated that it was taken when the helicopter was probably:

- at a location within or close to the blue shape in Figure A11
- about 15 ft above sea level or 12 ft above the pontoon (camera height) with the helicopter's skids about 10 ft above sea level and 7 ft above the pontoon
- oriented on a heading of 62–72°.

Analysis of image 0621, taken about 8 seconds after image 0620, indicated that it was taken when the helicopter was probably:

- at a location within or close to the yellow shape in Figure A11

- north and/or east of the location where image 0620 was taken (about 10–25 m depending on track)
- higher than at the time of the first image, with the camera height about 30–40 ft above sea level and the skid height about 25–35 ft above sea level
- oriented 10–60° to the left of the orientation of the helicopter at the time of image 0620.

Appendix B – Airbus Helicopters Safety Information Notice

AIRBUS HELICOPTERS

No. 3297-S-00

SAFETY INFORMATION NOTICE

SUBJECT: GENERAL

Unanticipated left yaw (main rotor rotating clockwise), commonly referred to as LTE

For the attention of	

AIRCRAFT CONCERNED	Version(s)	
	Civil	Military
EC120	B	
AS350	B, BA, BB, B1, B2, B3, D	L1
AS550		A2, C2, C3, U2
AS355	E, F, F1, F2, N, NP	
AS555		AF, AN, SN, UF, UN, AP
EC130	B4, T2	
SA365 / AS365	C1, C2, C3, N, N1, N2, N3	F, Fs, Fi, K, K2
AS565		MA, MB, SA, SB, UB, MBe
SA366		GA
EC155	B, B1	
SA330	J	Ba, L, Jm, S1, Sm
SA341	G	B, C, D, E, F, H
SA342	J	L, L1, M, M1, Ma
ALOUETTE II	313B, 3130, 318B, 318C, 3180	
ALOUETTE III	316B, 316C, 3160, 319B	
LAMA	315B	
EC225	LP	
EC725		AP
AS332	C, C1, L, L1, L2	B, B1, F1, M, M1
AS532		A2, U2, AC, AL, SC, UE, UL
EC175	B	
EC339		KUH/Surion

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AIRBUS HELICOPTERS

No. 3297-S-00

Background

Unanticipated yaw is a flight characteristic to which all types of single rotor helicopter (regardless of anti-torque design) can be susceptible at low speed, dependent usually on the direction and strength of the wind relative to the helicopter.

This characteristic was first identified and analyzed in relation to OH-58 helicopters by the US Army, who coined the description "loss of tail rotor effectiveness (LTE)" even though the tail rotor always remained fully serviceable. It is not linked to any failure and has nothing to do with the full loss of tail rotor thrust.

Where this type of unanticipated yaw situation is encountered, it may be rapid and most often will be in the opposite direction of the rotation of the main rotor blades (i.e. left yaw where the blades rotate clockwise). Swift corrective action is needed in response otherwise loss of control and possible accident may result.

However, use of the rudder pedal in the first instance may not cause the yaw to immediately subside, thus causing the pilot to make inadequate use of the pedal to correct the situation because he suspects that it is ineffective when, in fact, thrust capability of the tail rotor available to him remains undiminished. "Loss of tail rotor effectiveness" is not, therefore, a most efficient description as it wrongly implies that tail rotor efficiency is reduced in certain conditions.

Understanding unanticipated yaw is important to avoiding it, particularly as it appears to continue to be a contributing factor to some accidents. Therefore, this notice gives detailed information on when the situation may arise, why the tail rotor may wrongly appear to be ineffective, and how to respond in order to maintain full control / recover.

How does Unanticipated Left Yaw occur?

The explanation can be found in a diagram/curve which charts pedal position according to helicopter heading relative to true wind direction (while at trim and in hover). Such a curve exists for each combination of weight, altitude, temperature and wind speed.

An example is provided in **Figure 1**. The well-known critical azimuth, which gives the smallest pedal margin, corresponds in this Figure to about +90° heading (wind coming from the left hand side with respect to the helicopter).

The blue curve corresponds to hover trim conditions. From there, when right pedal is added (i.e. the pedal position moves above the blue curve) the helicopter yaws to the right, and when left pedal is added it yaws to the left (the pedal position moves below the curve).

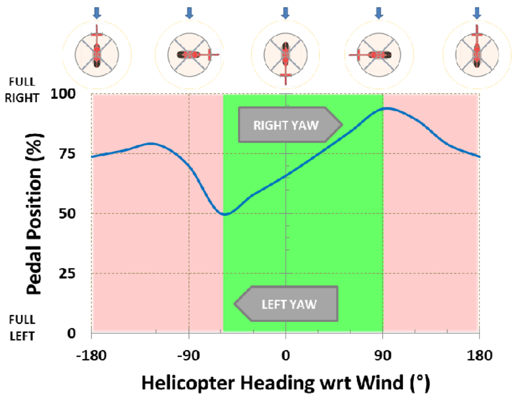

Figure 1: Example of hover pedal curve

Where a headwind is present (green area in **Figure 1**) the helicopter is stable in yaw. If a gust alters the heading of the helicopter, from 0° to -10° for example, the pedal position is now above the curve (the heading was brought to -10° with the pedal position that existed at 0°). The helicopter yaws right until it crosses the trim curve, which happens at the initial 0° heading. Shifted away from the trim position, it comes back to it.

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On the opposite side of Figure 1 the red area represents an area of a yaw instability. When the helicopter is shifted from its trim position, it moves further away until a stable headwind condition is found. This tailwind instability is well known by helicopter pilots who are aware that yaw must be very carefully controlled when the wind approaches from behind (tailwind).

Stabilizing surfaces are installed downstream of the center of gravity. The tail rotor and the fin have this role and are well located for forward flight conditions. In a tailwind, however, their position on the helicopter is not ideal. As a result, they cause yaw instability.

This can be managed as long as the pilot is aware of the wind direction relative to the helicopter. It becomes more difficult when information about wind direction and strength is not available, especially when yaw maneuvering is required. The pilot can reach the lower limit of the stable range (about -60° heading in **Figure 1**) without much advance warning and, as a result, switch from experiencing stable yaw behavior to fully unstable yaw behavior. This can give the pilot the feeling that the helicopter rotates of its own accord - even if though it is the result of his control inputs and the consequence of the change of wind heading on tail rotor thrust.

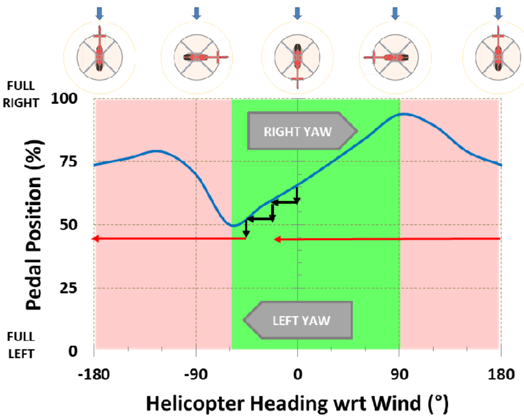

Figure 2: Starting an Unanticipated Left Yaw

This is illustrated in the graph in **Figure 2**. Starting from 0° wind heading, a left pedal step is made (indicated by a vertical black arrow). This brings the control position below the trim curve and the helicopter therefore rotates to the left until it crosses the trim curve, where it stops. In headwind conditions, pedal provides an attitude command : a control step mainly produces a heading step.

A second left pedal step is included in **Figure 2**. It has a similar effect to the first pedal step, leading to a second heading step.

When a third left pedal step is made with the same amplitude, the same heading change in the order of -20° can be anticipated, but unexpectedly this third step brings the pedal position below the lowest point of the pedal curve. This means a nose-left rotation will occur, as indicated by a red arrow. As the trim curve is never reached, however, rotation of the helicopter (i.e. spinning) will not stop unless right pedal is added. On the basis of the previous behavior of the helicopter, a -20° heading step with a limited yaw rate was expected. On the third pedal step, however, spinning is reached, with strong yaw acceleration. This is the "*uncommanded rapid yaw rate which does not subside of its own accord*" which defines unanticipated yaw.

The gap between the current pedal position (red arrow) and the blue trim curve gives an indication of the encountered yaw rate. In the **Figure 2** example, after passing the minimum of the blue curve (about -60° heading), that gap increases drastically. It is not due to a pedal input, but to a trim position that is moving away. The pilot has no indication of this changing trim position and the resulting yaw acceleration is therefore wrongly perceived as being uncommanded, attributable to some external factor.

This is not the only way unanticipated yaw can start. Under-monitoring of the helicopter's yaw axis behavior while at low speed in tailwind conditions can lead to the same result. It would depend on the direction of the initial wind disturbance and should be equally distributed between right and left rotations. The same problem demonstrated in **Figure 2** can also appear on the other side of the stability range (circa +90° heading). The unanticipated yaw developing there can only be to the right.

Most instances of unanticipated yaw which lead to accidents are to the left when the main rotor rotates clockwise. This shows that the main problem is not a tailwind or wind in the vicinity of the critical azimuth, where the pedal coming close to the 100% stop gives a clear warning. The main problem area for unanticipated left yaw is on the other side of the stability range, when the pedal position is much more benign.

Why does the tail rotor appear to be ineffective?

Following unanticipated left yaw occurrence depicted in **Figure 2**, three recovery strategies have been plotted in **Figure 3**. Here, the pilot is assumed to have been caught unaware by the helicopter's behavior and reacted late in the vicinity of a -90° heading.

No control input (as shown by the red line), or a very small control input based on the tail rotor efficiency as perceived prior to the event, is not an option for the pilot. It cannot stop the yawing.

A large and slow input (as shown by the yellow line) can zero the yaw rate, but halting it will occur quite late. The trim curve is only crossed 270° after the step input. This can appear to be a very long time to any pilot who does not appreciate what is happening. This is why the tail rotor can seem ineffective: large but slow inputs make a clearly visible effect only at the end of a 360° rotation.

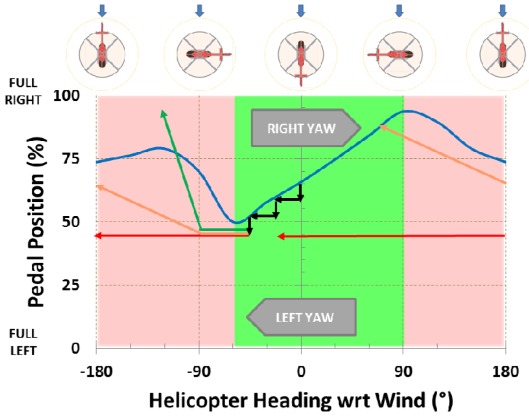

Figure 3: Recovering from an Unanticipated Left Yaw

A large and rapid input is represented by the green line. The yaw stops much more quickly, but the trim is found in the unstable tailwind range. The heading must be closely monitored and headwind conditions recovered as soon as practicable. For example, in one accident recorded by video, a decreasing yaw rate could be seen, followed by further acceleration, indicating that the pilot seemed to have been unknowingly affected twice by unanticipated yaw.

The key feature of an unanticipated left yaw recovery is large amplitude right pedal input. Recovery may not be immediate, but will occur if the pilot persists in maintaining right pedal. In some instances, the pilot re-centered the pedal before entering again a right pedal input. This cannot help and only delays recovery from the yaw. If the yaw deceleration is not enough, more right pedal must be added, reaching the pedal end-stop if necessary.

The most probable reason for accidents following unanticipated yaw events is a late and too limited pedal input. The pedal curve shows that this cannot stop the yaw in the short term. During an unanticipated yaw event, the tail rotor remains fully effective and provides the best chance to recover. Yaw rate and wind conditions reduce its thrust if it is at a constant pitch. There must be counterbalance by a huge pitch increase. The only warning the pilot may get of potential loss of control is the onset of unanticipated yaw.

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The apparent lack of efficiency of a limited pedal input can lead to misinterpretation of an unanticipated yaw as a full loss of tail rotor thrust (for example, as would be the case after rupture of the tail rotor drive). The symptom (unexpected intense left yaw) is similar and the short term response to a small and late pedal input is almost zero for both. Only full right pedal input will make the required difference and enable the pilot to identify whether he is experiencing unanticipated yaw or full loss of tail rotor thrust (due to malfunction) and, as a result, enable him to take the most appropriate action. If full right pedal has no effect on the yaw, it is clear that there has been a definite full loss of thrust, necessitating an immediate landing. If, however, full right pedal decelerates the yaw, it becomes clear that the issue is unanticipated yaw in character, which necessitates staying well clear of the ground and obstacles until a full recovery has been achieved.

Unanticipated yaw when performance limited

In pure hover, about 10% of the total power is spent on the tail rotor. Applying full right pedal can more than triple the tail rotor power consumption. When the helicopter is power-limited (engine or MGB torque limit), it is possible that full pedal cannot be reached while staying inside the helicopter's performance limitations. If the power is available, applying full right pedal means an over-torque resulting in only maintenance actions rather than loss of control and possible accident. If a hard power limitation exists (MGB torque limit or engine limit monitored by the engine FADEC), the additional power required on the tail rotor can be unavailable. This will result in RPM droop, which further increases the need for anti-torque while impairing the tail rotor thrust capability.

Most unanticipated yaw accidents do not occur in performance-limited conditions and, therefore, allow using full right pedal to secure a straightforward recovery. Be aware, however, that when performance is limited, prevention of unanticipated yaw occurrence becomes even more important (3 first points in the next paragraph).

What to do?

- Take particular care when wind comes from the right side or forward-right quadrant. Do not fly unnecessarily in those conditions.

- Prefer, as much as possible, yaw maneuvers to the right, especially in performance-limited conditions. It is easier to monitor the torque demand at the start of the maneuver than when responding to an abrupt unanticipated yaw.

- To make a yaw maneuver, apply a low angular rate of turn and closely monitor it. Yaw acceleration will be more obvious than during an aggressive maneuver.

- If unanticipated yaw occurs, react immediately and with large amplitude opposite pedal input. Be ready to use full pedal, if necessary. Do not limit yourself to what you feel sufficient, your feeling can be wrong. Never bring the pedal back to neutral before the yaw is stopped.

Appendix C – Unanticipated yaw occurrences

Introduction

There have been a significant number of accidents resulting from unanticipated yaw, or loss of tail rotor effectiveness (LTE), in helicopters at low height and low airspeed. For example, the United States National Transportation Safety Board (NTSB) stated in its 2017 safety alert that, during the 10-year period from 2004 to 2014, it investigated 55 accidents involving LTE. The safety alert provided details of three of these accidents, including one that occurred during a go-around.

Unanticipated yaw accidents have occurred involving many helicopter types. A wide range of factors can be involved in the development of an accident involving unanticipated yaw, and there was insufficient data available to reliably compare the rate of unanticipated yaw accidents on different helicopter types.

The ATSB reviewed its database, the NTSB database and other sources to identify unanticipated yaw accidents with published investigation reports involving helicopters with a Fenestron and main rotor blades that rotated clockwise in the period from 2008–2019. Accidents were only included if they occurred at low airspeed (during landing, take-off or manouvering) and no technical problems with the helicopter were known to be associated with the loss of control.

The following sections include details from 16 accidents that were identified. A common feature of several of these accidents was that the pilot had a low level of experience on the helicopter type (with six having 15 hours or less and another two having about 24 hours on type). Of these eight pilots, one had more than 1,000 hours total helicopter experience, two had more than 500 hours total experience and two had more than 300 hours total experience. Other features common to multiple accidents included the helicopter being in an intentional left turn prior to the rapid yaw, and the helicopter climbing prior to the rapid yaw (or the pilot lifting the collective during the rapid yaw).

Accident involving EC120B at Enniskillen, Ireland, on 25 June 2019

The EC120B helicopter rolled on to its side during take-off, resulting in substantial damage to the helicopter and no injuries.

The UK Air Accidents Investigation Board (AAIB) report stated:

> The helicopter was parked on the apron adjacent to the fuel installation where it had just been refuelled to full tanks. … the pilot performed the pre-takeoff checks and raised the collective pitch lever. He led with right yaw pedal but, as the helicopter became light on the skids, it started to yaw to the left. Due to the close proximity of the fuel storage tanks, he applied left cyclic control to move the helicopter to the left away from them, but the helicopter continued to yaw to the left. After yawing through 360°, the helicopter lost height with the left skid contacting the apron. The helicopter rolled about the left skid and the main rotor contacted the ground and debris was scattered over a wide area. The helicopter continued to yaw through another 90° about the tail before rolling onto its right side…
>
> Over the preceding weekend the pilot had been flying a Robinson R44 helicopter on which the main rotor blades turn anticlockwise when viewed from above. The EC120 main rotor blades turn in the opposite direction ie clockwise when viewed from above. The pilot was aware of this difference and the way it affects the use of the yaw pedals: raising the collective pitch lever in the Robinson requires increasing amount of left pedal to counter the rotor torque, but in the EC120 increasing amounts of right pedal are required. The pilot believed that during the initial phase of applying collective lever, he had used insufficient right yaw pedal, allowing the helicopter to yaw left, and the application of additional right pedal did not then reduce the yaw rate.

The pilot had 395 hours total flight time, including 13 flight hours on the EC120B.

Accident involving Cabri G2 at Pierrevert, France, on 31 January 2019

The Cabri G2 helicopter collided with terrain and rolled, resulting in injuries to the two occupants and the helicopter was destroyed.

The French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) report stated:

> The pilot, accompanied by a passenger … [was] bound for a helipad located on a golf course in Pierrevert (Alpes-de-Haute-Provence). After passing south of his destination, he flew east before heading towards the helipad. He did not overfly the helipad but made a wide right turn to land facing the northwest. On final, at a height of about 30 m, the helicopter suddenly began yawing to the left. The helicopter rotated several times losing height, then hit the ground and rolled over…
>
> The examinations of the flight controls, the main rotor, the Fenestron and the governor did not identify any failures that contributed to the accident…
>
> Over the period 2008-2018, the BEA has identified 12 occurrences involving GUIMBAL Cabri G2 helicopters and uncontrolled departures in yaw. Of these, at least three occurrences mentioned insufficient right pedal input by the pilot and at least two events indicated inappropriate reactions by the pilot, who pulled on the collective lever.
>
> The risk of experiencing an uncontrolled departure in yaw is similar with a conventional tail rotor or a Fenestron. However, with a Fenestron, the response curve is different and the amount of pedal deflection is greater…
>
> The meteorological conditions estimated by Météo-France at the accident site were as follows: mean wind of 3 knots from 060°, gusts from the north-east less than 10 knots near the ground.
>
> While approaching from the west, it is likely that the pilot saw the helipad and headed southward so that he could fly back towards the helipad in a west facing direction. Having already landed on this helipad, it is probable that he wanted to directly assess the factors required to make a decision about landing (air safety, ground safety, power, wind, approach path, etc.) while making a 360° turn, and then line up for final. This practice restricted his ability to evaluate the strength and direction of the wind and his choice of existing approach paths. On final, he did not modify his flight path to avoid flying over tall trees even though the environment allowed him to do so. At this point, he was flying at a low airspeed, out-of-ground effect, with a crosswind from the right with a tailwind component. These conditions were conducive to an uncontrolled departure in yaw.

The pilot had 244 total flight hours and 15 hours on the Cabri G2. His other experience was on R22 and R44 helicopters.

Accident involving EC130 at Mansfield, Australia, on 19 January 2019

The helicopter rolled on its side during take-off, resulting in substantial damage to the helicopter and minor injuries to the pilot. The ATSB report stated:

> On the morning of 19 January 2019, a Eurocopter EC130 helicopter, registered VH-YHS, conducted a private flight from Moorabbin Airport to an authorised landing area (ALA) near Mansfield, Victoria with the pilot and two passengers on board. A return flight to Moorabbin was planned for later that afternoon.
>
> At about 1500… the pilot and passengers boarded the helicopter at the ALA for the return flight. The pilot prepared for take-off and lifted off the helicopter more rapidly than he normally did. As the helicopter became airborne, it began to rotate counter-clockwise (yaw to the left). The pilot tried to control the yaw but the helicopter quickly turned through 360° and, unable to control it, he made a decision to land the helicopter.
>
> The left skid of the descending helicopter subsequently contacted the ground, resulting in a rolling movement that led to the main rotor blades striking the ground…
>
> The investigation did not identify any airworthiness issues with the helicopter and it was considered that the loss of control was not attributable to a mechanical issue. It was also determined that the prevailing light winds did not contribute to the loss of control.
>
> The pilot reported that he did not lift the helicopter into a balanced hover, and tried controlling its yaw mainly with the cyclic control instead of through the full application of opposing right, tail rotor pedal. Management of unanticipated yaw in helicopters with shrouded tail rotors (Fenestron) is the subject of the manufacturer's guidance and learnings from similar accidents.

The pilot had 315 total flight hours, including 227 hours on the EC130.

Accident involving EC130 at Mullen, United States, on 3 August 2018

The EC130 helicopter collided with terrain while manouvering, resulting in a serious injury to a passenger and substantial damage to the helicopter.

The NTSB report stated:

> The private pilot reported that he was approaching a golf course to survey a potential landing area when, during a left turn, the helicopter experienced a loss of tail rotor effectiveness. He stated that he added right pedal and eventually full right pedal to counter the rotation without success. The helicopter impacted the ground, which resulted in substantial damage to the main rotor and fuselage. Parametric data recovered from an onboard recorder showed that the left turn tightened in radius and that both the groundspeed and airspeed decreased during the turn. The left yaw rate increased rapidly as the helicopter entered the downwind portion of the turn. The cockpit image recorder captured the pilot applying a slight right pedal input during the onset of the left yaw, followed by his improper left pedal input that remained until ground impact. There was no evidence of mechanical malfunctions or failures with the helicopter that would have precluded normal operation. The left yaw would likely have been arrested had the pilot applied adequate and correct antitorque pedal when the yaw first started…
>
> The pilot's inadequate and incorrect antitorque pedal application during a tight, decelerating turn downwind, which resulted in a loss of yaw control.

The pilot had 212.5 hours total flight time, including 193.8 hours on the EC130, and 80.2 hours total time as pilot in command.

Accident involving EC120B at Länna, Sweden, on 11 July 2018

The EC120B collided with terrain during take-off, resulting in substantial damage.

The Swedish Accident Investigation Authority published an English summary, which stated:

> The flight started from a site for helicopter operations at Länna south of Stockholm. The helicopter had previously been moved out from a nearby hangar and was placed on a so-called helicopter dolly. A wheel loader that had been used during the move was parked less than seven metres in front of the helicopter.
>
> The pilot had planned to make the take-off with a distinct liftoff to get off from the dolly and to reduce the risk of sliding off it. The pilot has stated, that just before the take-off, he felt some uncertainty about the characteristics of the helicopter type. He has further stated that he raised the collective lever while he pressed on the left control pedal.
>
> During the take-off, the helicopter immediately began to move forward, and at the same time started to turn rapidly to the left. According to the pilot, the helicopter rotated to the left around its yaw axis one and a half turn and then the tail section collided with the parked wheel loader. The pilot lowered the collective lever and after rotating an additional 360 degrees, the helicopter struck the ground and finally stopped near a hangar…
>
> The pilot had limited experience of the helicopter type and had only 2 hours of flight time during the last 90 days. He had his previous main experience from another helicopter type where the direction of rotation of the main rotor cause a torque, which at take-off, needs to be compensated with pedal pressure on the left control pedal, in contrary to the current type where the torque needs to be compensated by means of the right control pedal.
>
> The site had limited obstacle clearance and the fact that the helicopter was placed on a helicopter dolly meant that the take-off had a relatively high degree of difficulty. Nothing in the investigation indicates that a technical issue with the helicopter could have contributed to the accident. The accident was caused by the pilot’s compensation with the control pedals during the take-off was done in such way that the helicopter's yaw to the left came to be increased instead of being counteracted. This resulted in loss of control of the helicopter.
>
> The pilot’s limited experience of the helicopter type and his low flight trim [time] contributed to the accident. The limited obstacle clearance, which was caused by a wheel loader being parked near the helicopter, contributed to the extent of the damage.

The pilot had 567 total flight hours and 7 hours on the EC120B. Most of his other experience was on Bell 206 helicopters.

Accident involving EC120B at Skogn airport, Norway on 25 May 2018

The EC120B helicopter rolled over during landing, resulting in substantial damage.

The Accident Investigation Board Norway (AIBN) published an English summary, which stated:

> The helicopter came out of control in connection with landing. It rotated uncontrolled before it ended up on the side, after the left skid had first hit the ground.
>
> There were two people on board. The commander was uninjured while the passenger suffered minor cuts. The helicopter was substantially damaged. Examinations of the helicopter have not revealed technical findings that can explain the loss of control.
>
> The Accident Investigation Board Norway finds it probable that the phenomenon of Loss of Tail rotor effectiveness (LTE) may have occurred after the commander failed to correct the helicopter using the right pedal. The AIBN believes that the commander's low experience level contributed to the situation, which was not interrupted in time.

Additional information from the full report (in Norwegian) included:

- The pilot had 143 total flight hours and 8 flight hours on the EC120B (3 hours in command). The pilot's other experience was on the R44.
- The pilot reported applying full right pedal input to oppose the left yaw and then lifted the collective, which required additional power and increased the yaw to the left.

Accident involving Cabri G2 at Waikawa Beach, New Zealand, on 24 August 2017

The Cabri G2 collided with terrain, resulting in substantial damage and injuries to the two occupants.

The New Zealand Civil Aviation Authority (CAA) report stated:

> On the day of the accident the instructor was conducting two training flights to demonstrate the effects of controls. The accident occurred while conducting the second flight…
>
> The pilots evaluated the conditions and landing area, conducting two overhead circuits upon arrival. The instructor took control of the aircraft to execute the approach to a hover…
>
> As the helicopter neared the airspeed at which translational lift would be lost, the instructor briefed the student that the right pedal should be applied early to keep the nose aligned with the landing direction and that they must anticipate a left yaw during the transition to a hover.
>
> Prior to establishing a hover, the helicopter developed a rapid left yaw rate. The instructor pilot was unable to arrest the yaw rate and regain control of the helicopter, and the aircraft struck the ground…
>
> As the yaw rate developed, the instructor pilot likely increased collective pitch to abort the approach and initiate a climb. The increase in main rotor pitch created a higher demand for anti-torque thrust, resulting in an increased left yaw rate. As the instructor pilot attempted to stabilise the helicopter the cyclic inputs caused the aircraft to accelerate to the left-rear in relation to the intended approach track.
>
> The instructor pilot did not make the appropriate control inputs to effectively prevent or arrest the left yaw rate as the aircraft transitioned from cruise to hovering flight, resulting in a loss of control and impact with terrain…
>
> The characteristics of Fenestron-equipped aircraft are significantly different from that of a conventional tail rotor. The thrust created by the Fenestron is adequate, and the amount of pedal input required by the pilot is much larger and must be applied more rapidly than what is required for a conventional anti-torque system…
>
> The accident occurred on a VMC approach to a clear, unimproved landing area in favourable conditions.

The instructor pilot had 623 total flight hours and 23.6 hours on the Cabri G2.

Accident involving EC120B at Courchevel, France on 1 July 2016

The EC120B helicopter collided with terrain, and the helicopter was destroyed.

The French BEA published an English summary, which stated:

> During final approach, at a height of 10 m, the pilot lost control of the helicopter in yaw. The helicopter struck the ground and turned over onto its right side.

Additional information from the full report (in French) included:

- The pilot had 170 total flight hours, including 160 hours on the EC120B.
- No problems were identified with the helicopter.
- The chosen approach path resulted in the helicopter operating without ground effect, with slow airspeed and with a tailwind component.
- When the helicopter yawed to the left, the pilot tried to counteract the movement. While the helicopter was already at the power limit, the pilot requested more power by full right pedal. The pilot also increased application of the collective, which required power.

Accident involving Cabri G2 at Beaumont, United States, on 3 January 2016

The Cabri G2 helicopter collided with terrain during a hover taxi, resulting in substantial damage to the helicopter but no injuries to either of the occupants.

The NTSB report stated:

> According to the private pilot, after completing a local area flight, he was hover-taxiing the helicopter to the ramp on about a 065-degree heading. Once the helicopter was clear of the taxiway, the helicopter encountered a small wind gust, which the pilot classified as a "tailwind." He corrected the helicopter's subsequent left rotation by applying about one-quarter of right tail rotor pedal and noted that the airspeed was about 20 knots and the altitude was about 10 ft.
>
> About 1 second later, the helicopter encountered another more significant wind gust. The pilot noted that he applied full right tail rotor pedal but that the helicopter continued to rotate left and that he then "nudged" the cyclic to the right to "follow the left spin out" and regain control. The pilot was able to stop the forward momentum of the helicopter; however, the left skid contacted the ground, and the helicopter rolled left and impacted terrain.
>
> The pilot reported that there were no preimpact mechanical failures or malfunctions with the airframe or engine that would have precluded normal operation and that he considered this a loss of tail rotor effectiveness event. The pilot reported that the wind at the airport at the time of the accident was from 220 degrees at 14 knots gusting to 24 knots. It is likely that the pilot did not maintain a nose-into-the-wind position and that, when the helicopter began to settle with power, it lost tail rotor effectiveness.
>
> The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot's inadequate compensation for wind during a hover-taxi and his failure to maintain helicopter control due to a loss of tail rotor effectiveness.

The pilot had 62 hours total flight time and 24 hours total time as pilot in command. This experience included 24 hours total time on the Cabri G2, including 17 hours as pilot in command.

Accident involving EC130 at Megève Airport, France on October 2015

The EC130 helicopter collided with the ground during take-off, and the collision destroyed the helicopter and resulted in four serious injuries and two minor injuries.

The BEA investigation report stated:

> During the morning, the pilot made several “Mont Blanc” sightseeing flights with the same helicopter from Megève altiport. During take-off for the fourth flight and as for the previous flights, he stabilized the helicopter in hover in the ground effect and then began to rotate it to the left around its yaw axis in order to face the climb-out path.
>
> During this manoeuvre, the pilot lost the yaw control of the aircraft, which turned several times on itself before crashing below a slope adjacent to the take-off area…

> The effect of the travel of the rudder pedals on the yaw control is different depending on whether the helicopters are fitted with a conventional tail rotor or a fenestron. The shrouded tail rotor of the EC130 is of the fenestron type.
>
> When hovering, full travel on the right rudder pedal has more effect on helicopters equipped with a fenestron than on those equipped with a conventional tail rotor.
>
> To counteract a fast left yaw rotation with a fenestron, it is necessary to apply a sharp input to the right rudder pedal and maintain the movement until the rotation stops…
>
> The pilot stated that there was no wind on the Megève altiport at the time of the accident. This was confirmed by the position of the windsock on a photograph taken at the time of take-off…
>
> After stabilizing the helicopter in hover in the ground effect, the pilot was unable to stop or slow down the left rotation he had initiated to orient the aircraft towards its climb-out path.
>
> The investigation did not bring to light any technical element that might explain it.

The pilot had 300 flight hours in helicopters, including 9.5 hours on the EC130, 74 hours on the AS350 (which also has a clockwise-rotating main rotor and a conventional tail rotor), and the remainder on R22 and R44 helicopters. The pilot had renewed his AS350/EC130 type rating on an AS350 helicopter the previous day.

Based on video evidence, the investigation noted that on previous take-offs the pilot rotated the helicopter 120° in the hover before increasing forward speed, whereas the accident flight the left turn continued beyond 120°, rapidly turning a further 240° in the next 3 seconds (at about 80° per second). As part of the investigation, a flight in a helicopter of the same type in similar conditions was undertaken, and it was found that pushing the right pedal to 70 per cent of its travel stopped a yaw rate of 100° per second to the left in 3 seconds.

Accident involving EC130 at Dubai, The United Arab Emirates, on 22 January 2014

The EC130 helicopter collided with terrain during take-off, resulting in significant damage to the helicopter and serious injuries to the two occupants.

The UAE Air Accident Investigation Sector report stated:

> On 22 January 2014, an Airbus Helicopters EC-130B4 Aircraft, registration A6-DYR, operated by Helidubai impacted the heliport during departure to Dubai International Airport (OMDB) from the Atlantis Palm hotel heliport.
>
> The Aircraft had operated six passenger tourist flights over Dubai prior to the positioning flight from the Atlantic Palm heliport to the Dubai Air Wing fixed operating base (FOB) at OMDB. The final flight of each day was a positioning flight from the heliport to the Operator’s FOB at OMDB.
>
> The departure was normally a coastal departure along the Palm, inbound to OMDB. The flight required lifting to a hover position, a pedal turn to a northerly heading, and a standard climbing departure from the heliport…
>
> On lift-off, the Pilot simultaneously pulled power into the climb while applying continuous left pedal, turning the Aircraft counter clockwise (to the left). This turn continued past the optimal northerly heading for departure, with the Aircraft turning rapidly counter clockwise.
>
> The turn rate accelerated, increasing to approximately 180° per second at a height of approximately 22 meters (72 feet) above the heliport.
>
> The Aircraft then descended rapidly, pitching forward, while continuing in a counter clockwise turn prior until impact with the heliport. The Aircraft impacted the heliport vertically, with a level attitude, minimal forward speed, with approximately 5° nose down attitude and a rapid rate of descent (ROD), until impact.

The pilot had 2,425 hours total flight time, including 276.5 hours on the helicopter type.

Accident involving EC120B at Ballina, Australia, on 8 December 2013

The EC120B helicopter rolled on to its side during landing, resulting in substantial damage to the helicopter.

The ATSB report stated:

> On 8 December 2013, … [an EC120B] helicopter, registered VH-VMT, departed from a property 16 km north of the Ballina/Byron Gateway Airport, New South Wales for a local flight. On board the helicopter were the pilot and two passengers.
>
> At about 1555, the helicopter returned to the property from the north, overflew and approached to land on a heading of about 340º. The pilot reported that the wind was from the north, at about 20 kt.
>
> When about 3 ft above ground level, the pilot reported that he entered the hover with an airspeed of less than 10 kt and with full engine power selected. Immediately after, the helicopter began to yaw to the left. The pilot applied right anti-torque pedal to counteract the yaw and reduced the engine power to idle. The helicopter continued to yaw left and the pilot applied full right anti-torque pedal, but was unable to arrest the rotation. The helicopter rotated left about 90° before the left skid lowered and contacted the ground. It continued to rotate and rolled onto its right side. The helicopter was substantially damaged and the pilot and passengers were able to evacuate uninjured…

The pilot had 550 total flight hours, including 280 hours on the EC120B. The pilot reported that they had recently been operating an AS350 helicopter, which required less anti-torque pedal input than the EC120B.

Accident involving Cabri G2 at Kemble, United Kingdom, on 26 October 2011

The Cabri G2 helicopter landed heavily, resulting in substantial damage to the helicopter and no injuries.

The UK Air Accidents Investigation Board (AAIB) report stated:

> The helicopter was approaching to land at Cotswold Airport (Kemble) after a short flight to the north of the airfield. The pilot rejoined the circuit left-hand downwind for Runway 26; the wind was from 200° at 17 kt. He turned finals to the south of the runway and, as he passed the airfield boundary, turned the helicopter into wind. However, during the final stages as he levelled off at about 5 feet, the helicopter started to yaw gently to the left. The pilot continued applying right yaw pedal but, as it reached about 45-60° to the wind direction, the yaw rate increased dramatically and he pulled the collective to clear the ground. As anticipated, this increased the yaw rate and the helicopter turned through about three to six complete revolutions, during which time he checked that he was applying the correct pedal input. The engine then stopped…
>
> The pilot stated that he believed that “slow application of right yaw pedal” was the cause of the accident… It is understood that no pre-impact mechanical anomalies were found after inspection.

The pilot had 1,850 hours total flight time, including 6 hours on the Cabri G2.

Accident involving EC120B at Redhill, United Kingdom, Ireland, on 4 June 2011

The EC120B helicopter rolled on to its side during take-off, resulting in substantial damage to the helicopter and no injuries.

The UK Air Accidents Investigation Board (AAIB) report stated:

> The helicopter was hover taxiing towards its allocated landing pad beside a hangar. The wind at the time was described as north-easterly at 9 kt, gusting to 21 kt. The pilot stated that as he approached the landing pad he applied left yaw pedal to turn left. The helicopter responded but continued to turn beyond the desired heading. The pilot applied right pedal in an attempt to stop the turn, but the helicopter continued to rotate at an increasing rate until control was lost. The right skid contacted the ground, causing the helicopter to roll onto its right side and the main rotors to strike the ground.

> The pilot believed the initial left turn had allowed the helicopter's tail to be pushed by the wind, rotating it further and more rapidly than intended. He applied insufficient right yaw pedal to compensate, allowing the rate of turn to accelerate sufficiently for control to be lost.

The pilot had 126 hours total flight time, including 41 flight hours on the EC120B.

Accident involving EC130 at Deer Isle, United States, on 1 August 2009

The EC130 helicopter was substantially damaged during a forced landing.

The NTSB report stated:

> The helicopter departed a private yacht and was flying along an island shoreline at approximately 400 feet above mean sea level when the pilot entered an out-of-ground effect hover and initiated a left-pedal turn. The helicopter started turning faster than commanded, and the pilot was unable to regain control. The helicopter subsequently lost altitude and impacted the water. Prior to impacting the water, the pilot deployed the emergency skidmounted floats to prevent sinking. According to the pilot, "the accident was totally pilot error with no mechanical malfunction." Examination of the wreckage confirmed no evidence of any mechanical malfunction or failure…
>
> The National Transportation Safety Board determines the probable cause(s) of this accident to be:
>
> The pilot's loss of directional control during an out-of-ground-effect hover.

The pilot had 680 total flight hours in rotorcraft, and 55 hours on the EC130.

Accident involving Aerospatiale/Westland SA 341G Gazelle at Rudding Park, United Kingdom, on 26 January 2008

The SA 341G Gazelle helicopter collided with terrain, fatally injuring the two occupants.

The UK Air Accidents Investigation Board (AAIB) report stated:

> The pilot, who was experienced in fixed-wing aircraft but newly-qualified in helicopters, was undertaking a helicopter flight with a passenger, in gusty wind conditions. He was seen flying slowly, at a low level, near a chalet he owned in the grounds of an hotel when the aircraft was seen to spin around, before pitching up and falling to the ground, fatally injuring the two occupants…
>
> It is considered likely that, at the time of the accident, the pilot was trying to observe his chalet in the grounds of the hotel. In doing so, however, he had placed the helicopter in a precarious position with a strong blustery wind adversely affecting the controllability of the aircraft whilst flying at a low forward airspeed…
>
> In the absence of any significant technical defect, it is considered that the pilot lost control of the helicopter in yaw due to the strength, direction and gusty nature of the wind acting on the aircraft whilst flying at low forward airspeed. It is likely that in the attempt to recover the situation the pilot also lost control in pitch, causing the helicopter to pitch up severely before falling into the trees and impacting the ground.
>
> Because of the lack of detailed recorded flight data and the fact the pilot died in the accident, it has not been possible to define causal factors beyond the pilot's loss of control of the helicopter. However, it is considered that the main contributing factors to this accident were the pilot's lack of experience and probable inadequacies in his training…
>
> Loss of tail rotor effectiveness currently forms part of the PPL(H) training syllabus; this is difficult to demonstrate in the air and thus relies upon theoretical briefing in the classroom. Some helicopter types, including the Gazelle, are considered particularly vulnerable to this phenomenon and this theoretical knowledge should, reasonably, be tested in the ground school theory exam…

The AAIB stated also included the following statements:

> The Gazelle has a fenestron, or 'fantail', which is a shrouded fan, enclosed inside the vertical tail fin. Eurocopter's Service Letter 1673-67-04, issued in February 2005, describes how, when transitioning from cruise to hover flight, a larger yaw pedal control input is required for a fenestron-tailed helicopter compared to a conventional tail rotor. Also noted in this Service Letter is that, if the wind is coming from the left or from behind, it will increase the rotation speed of the helicopter and hence more right rudder pedal is required to counteract this effect…

> The AAIB has investigated seven previous occurrences to civil Gazelle helicopters involving loss of yaw control, the last being on 8 May 2005 (EW/C2005/05/01). A recurring factor is a lack of pilot experience.
>
> The Gazelle tail fin is considerably larger than most non-fenestron-equipped helicopters, making the execution of a spot turn a challenge due to the weathercock effect in windy conditions…

The pilot had 853 hours total flight time, of which 56 hours were in helicopters, including 46 hours on the helicopter type (most conducted with an instructor on board).

Glossary

AAIB	Air Accidents Investigation Board
AC	Advisory Circular
ALA	Aeroplane landing area
AMC	Acceptable means of compliance
AMM	Aircraft maintenance manual
AOC	Air Operator's Certificate
APU	Auxiliary power unit
ATSB	Australian Transport Safety Bureau
BEA	French Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile
CAAP	Civil Aviation Advisory Publication
CAO	Civil Aviation Order
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
CWP	Caution warning panel
EASA	European Aviation Safety Agency
EST	Eastern Standard Time
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FLI	First limit indicator
HIGE	Hover in ground effect
HLS	Helicopter landing site
HOGE	Hover out of ground effect
HUET	Helicopter underwater escape training
IBF	Inlet barrier filter
ICUS	In command under supervision
JAR	Joint Aviation Regulation
LAME	Licenced aircraft maintenance engineer
LTE	Loss of tail rotor effectiveness
MAUW	Maximum all-up weight
MOS	Manual of Standards
MTOW	Maximum take-off weight
NPRM	Notice of proposed rule making
NTSB	National Transportation Safety Board
OEB	Operational Evaluation Board

QPS	Queensland Police Service
RFM	Rotorcraft flight manual
RFMS	Rotorcraft flight manual supplement
ROV	Remotely-operated underwater vehicle
SAR	Search and rescue
SARTIME	Search and rescue time
SMS	Safety management system
UTC	Coordinated Universal Time
VEMD	Vehicle engine multifunction display
VFR	Visual flight rules
WAS	Whitsunday Air Services

Australian Transport Safety Bureau

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. It is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

The ATSB's purpose is to improve the safety of, and public confidence in, aviation, rail and marine transport through:

- 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, as well as participating in overseas investigations involving Australian-registered aircraft and ships. It prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

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

Purpose of safety investigations

The objective of a safety investigation is to enhance transport safety. This is done through:

- identifying safety issues and facilitating safety action to address those issues
- providing information about occurrences and their associated safety factors to facilitate learning within the transport industry.

It is not a function of the ATSB to apportion blame or provide a means for determining 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. The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.

Terminology

An explanation of terminology used in ATSB investigation reports is available on the ATSB website. This includes terms such as occurrence, contributing factor, other factor that increased risk, and safety issue.