Australian Government

Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT

Occurrence Investigation Report AO-2008-043

Final

Collision with terrain
10 km east of Cairns Aerodrome, Qld
Robinson Helicopter Company
R44 Clipper II, VH-RYW

18 June 2008

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Collision with terrain - 10 km east of Cairns Aerodrome, Qld - 18 June 2008 – VH-RYW, Robinson Helicopter Company R44 Clipper II

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Figure 1: Airservices Australia
Figure 2: Google Earth
Figure 3: Robinson Helicopter Company R44 II Pilot's Operating Handbook
Figures 4 and 5: Queensland Police Service
Figures 6, 7 and 8: US Department of Transportation Federal Aviation Administration

Abstract

At 1026 Eastern Standard Time on 18 June 2008, a Robinson Helicopter Company R44 Clipper II helicopter, registered VH-RYW, departed Cairns Airport, Qld, to film a residential development site that was located in the vicinity of False Cape, about 10 km east of the airport. On board the helicopter were the pilot and three passengers.

The occupants of the helicopter reported that while conducting the second period of filming, there was a sudden and violent movement of the nose of the helicopter to the right, which continued into a rapid rotation of the helicopter. The pilot's reported attempt to reduce the rate of right yaw was unsuccessful, and he entered autorotation and attempted to reach a clear area. The helicopter subsequently collided with trees before impacting the ground, seriously injuring the pilot and front seat passenger.

This accident highlighted the risk of loss of tail rotor effectiveness associated with the conduct of aerial filming/photography and other similar flights involving high power, low forward airspeed and the action of adverse airflow on a helicopter.

The investigation also identified that the lack of the nomination of a search and rescue or scheduled reporting time for the flight, decreased the likelihood of a timely response in the case of an emergency.

In response to this accident, the helicopter manufacturer advised that it was considering a revision to the aerial survey and photography flights safety notice that was contained in the R44 Pilot's Operating Handbook. That revision would, if adopted, include a discussion of the risk of unanticipated right yaw associated with the conduct of those flights.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory Agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

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

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

Purpose of safety investigations

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

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

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

When safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation, the person, organisation or agency must provide a written response within 90 days. That response must indicate whether the person, organisation or agency accepts the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

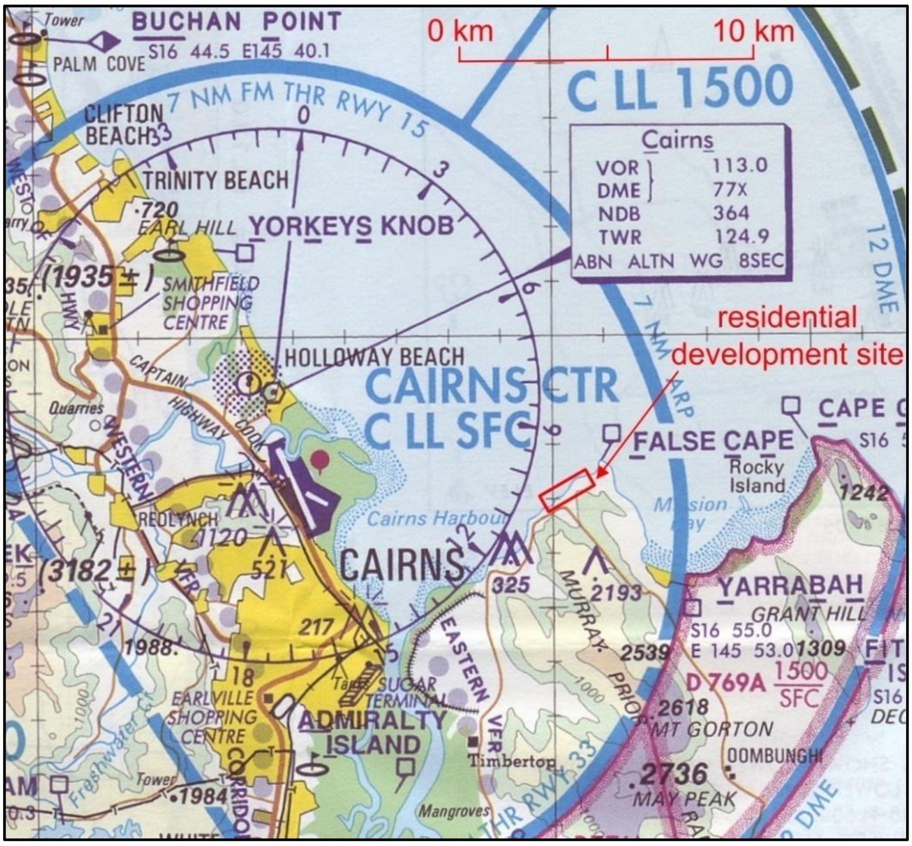
About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au

FACTUAL INFORMATION

History of the flight

At 1026 Eastern Standard Time[1] on 18 June 2008, a Robinson Helicopter Company R44 Clipper II (R44) helicopter, registered VH-RYW, departed Cairns Airport, Qld, to film a residential development site that was located in the vicinity of False Cape, about 10 km east of the airport (Figure 1). On board the helicopter were the pilot and three passengers. The task of the passenger seated in the front left seat was to obtain video imagery of the site, while the occupant of the left rear seat obtained still imagery of the site. The third passenger was not involved in the aerial filming operation.

Figure 1: Area map



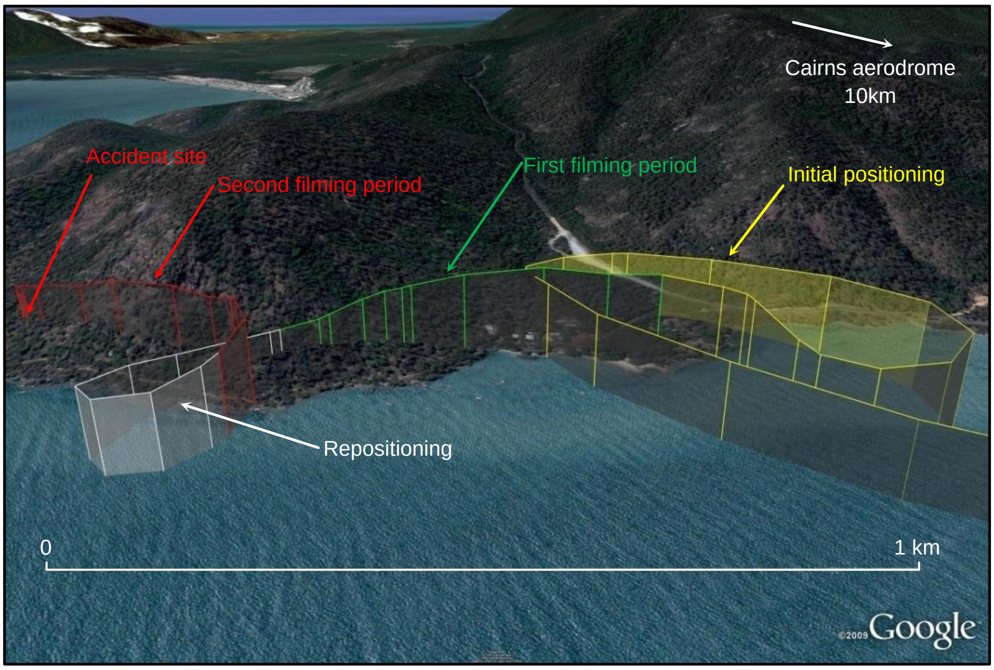
At 1031, the pilot advised air traffic services (ATS) that the helicopter had arrived at the development site. In response to queries by ATS, the pilot also advised that he expected the task to take no longer than 1 hour, and that he would be operating not above 500 ft above mean sea level (AMSL). No specific scheduled reporting

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

time (SKED) or search and rescue time (SARTIME)[2] was established for the conduct of the photography activity, and there was no further radio communication between the pilot and ATS. The pilot reported that he did not establish a SKED or SARTIME as '...we were operating inside controlled airspace so we [were] basically just direct with tower'. ATS later reported that while no specific SKED or SARTIME had been coordinated with the pilot, the aerodrome controller (ADC) was using a console timer set to 30 minutes as a prompt to check the normal operation of the helicopter. The ADC had planned to contact the pilot at 1100.

In response to a request by one of the passengers, the pilot initially positioned the helicopter to the south-west of the development site, in order to commence the filming in a north-easterly direction, along the development site (Figure 2).

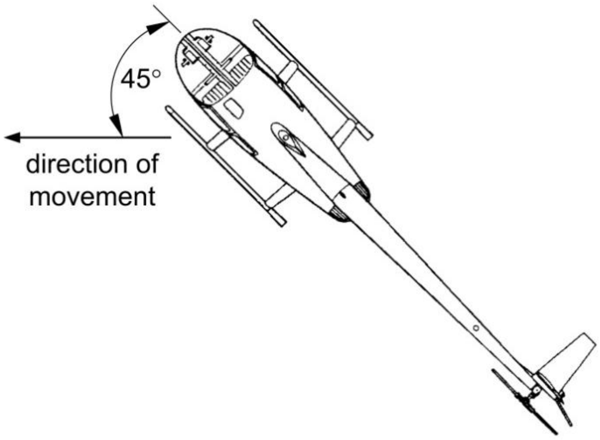
Figure 2: GPS flight profile looking south-east



The helicopter's left front and rear doors had been removed to facilitate the flight, and the passengers described the first filming as being conducted with the helicopter moving sideways to the left, with the nose of the helicopter pointing towards the rising terrain. The pilot recalled that during the filming, the indicated airspeed of the helicopter was about 10 to 15 kts, and that the nose of the helicopter was offset about 45° right of the direction of movement (Figure 3). The pilot's recollection was consistent with the in-flight video footage that was examined following the accident. The altitude of the first filming run commenced at about 500 ft and descended to about 300 ft. Due to the local variation in the terrain, those altitudes corresponded to heights above the ground of between about 150 and 500 ft.

[2] A SKED or SARTIME was a nominated time by which a pilot intended to contact ATS to confirm the normal operation of his or her aircraft. Failure to report by a nominated time resulted in the initiation of search and rescue action by ATS.

Figure 3: Approximate movement of the helicopter during filming



The passengers reported that, during the first period of filming, the helicopter began 'wobbling', 'rocking' and 'swerving', and that the pilot informed them that he needed to reposition the helicopter. The pilot advised the investigation that the helicopter was repositioned to facilitate the filming, and not due to any concern with the performance of the helicopter.

Following the repositioning of the helicopter, a second period of filming commenced at 1034 (Figure 2). During that filming, the pilot manoeuvred the helicopter in a similar orientation and airspeed to that of the first period of filming. The altitude during the second period of filming commenced at about 500 ft and reduced to about 370 ft. Those altitudes corresponded to heights above the ground of between about 200 and 470 ft.

The passengers stated that, during the second period of filming, the movement of the helicopter appeared to be affected in the same manner as experienced during the first period of filming. The passengers described that almost immediately after that movement, there was a sudden, violent movement of the nose of the helicopter to the right, which developed into a rapid rotation of the helicopter in that direction.

The pilot reported that in response to the unanticipated right yaw[3], he initially lowered the collective lever[4] and pushed the cyclic stick[5] forward in an attempt to increase airspeed. The amount of cyclic and collective applied by the pilot was limited by the proximity of the terrain. There was no reported tail rotor pedal input[6] as part of the initial recovery action by the pilot, in an effort to oppose the yaw. The pilot reported that, despite the application of forward cyclic, the rapid yaw prevented the airspeed from increasing. The pilot recalled that at some point, he raised the collective slightly and observed an increase in the helicopter's rate of rotation. He also reported applying alternate left and right tail rotor pedal with no apparent effect on the rate of yaw. When it appeared that the right yaw could not be

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3 Rotation of the helicopter about its vertical axis.

4 Lowering the collective lever reduces the main rotor thrust (effectively lift) produced by the main rotor blades.

5 Pushing forward on the cyclic tilts the main rotor disk forward and lowers the nose of the helicopter.

6 Directional and anti-torque control of a 'conventional' helicopter is primarily achieved via the tail rotor pedals, which vary the thrust of the tail rotor.

stopped, the pilot lowered the collective fully and attempted to reach a nearby clear area. The helicopter descended rapidly to tree-top height and the pilot, recognising that collision with the trees was imminent, raised the collective to reduce the rate of descent.

The pilot subsequently reported that he could not clearly recall what inputs were applied to the tail rotor pedals. He believed that initially he would have instinctively opposed the yaw by the application of left pedal, and that he would have applied right pedal as required when the collective was fully lowered.

The rear-seat passengers recalled hearing an audio warning[7] activate at some point after the helicopter commenced rotating to the right. Neither of the front-seat occupants recalled hearing any warnings during the accident sequence.

The helicopter collided with trees and came to rest on its right side and the helicopter's pop-out floats activated during the impact sequence (Figure 4). The two rear-seat passengers received minor injuries and were able to extricate themselves from the helicopter. They then assisted the pilot and front-seat passenger, both of whom were seriously injured, to exit the helicopter.

Figure 4: Accident site and wreckage

The emergency services were notified of the accident via mobile telephone by one of two witnesses to the accident who were on the ground in support of the filming task. The pilot also notified the operator of the accident via mobile telephone, who in turn notified ATS at 1039. The pilot reported that the nature of the emergency and the proximity of the helicopter to terrain did not enable him time to notify ATS of the emergency.

Air Traffic Services attempted unsuccessfully to contact the pilot at 1041. The helicopter had ceased showing on radar at 1036.

7 The only audio warning in the R44 was associated with low main rotor RPM.

Personnel information

The pilot held a Commercial Pilot (Helicopter) Licence that was issued on 15 March 2005, and was endorsed on the R44. The pilot also held a Class 1 medical certificate without restriction. The pilot had completed low-level flying training that, in conjunction with the required procedures and approvals that were held by the operator, permitted the filming activity to be conducted below 500 ft above ground level (AGL).

Prior to the accident flight, the pilot had accrued 312.1 hours flight time, of which 188.7 hours were in R44 helicopters. The majority of those R44 flying hours was accrued in the accident aircraft. The pilot conducted the filming activity in accordance with the flight and duty requirements detailed in Part 48 of the Civil Aviation Orders. The pilot's most recent flight review was conducted on 27 March 2007 and a company check flight was conducted on 5 June 2008.

Aircraft information

The R44 is a four-seat, single main and tail rotor helicopter that is powered by a fuel-injected, six-cylinder piston engine, and equipped with skid-type landing gear. The accident aircraft was also fitted with pop-out floats.

The helicopter, serial number 11163, was manufactured in the US in 2006. At the time of the accident, the helicopter had been operated for a total of 700.9 hours.

Recent maintenance

Maintenance records indicated that the helicopter last underwent a routine 100-hourly maintenance inspection on 2 June 2008, at 670.3 hours in service. A new maintenance release for the helicopter was issued at that time.

The pilot reported that the helicopter had been operating normally prior to the unanticipated right yaw.

Aircraft weight and performance

Weight and balance calculations indicated that the helicopter was being operated at about 1,094 kg (below the maximum allowable gross weight of 1,134 kg) and within the centre of gravity limits at the time of the accident. The helicopter manufacturer's performance data indicated that, at the time of the accident, the helicopter was capable of hovering out of ground effect[8] in zero wind conditions.

[8] Helicopters require less power to hover close to the ground due to a cushioning effect created by the main rotor downwash striking the ground. Under those conditions, the helicopter is operating 'in ground effect'. The US Federal Aviation Administration's *Rotorcraft Flying Handbook* stated that flight in ground effect usually occurs at less than one rotor diameter above the surface (33 ft (10 m) for an R44 helicopter). Operations above that height are defined as being conducted 'out of ground effect'.

Meteorological information

The Bureau of Meteorology (BoM) reported weather conditions in the vicinity of False Cape at the time of the accident as light showers of rain with scattered broken[9] cloud with a base of 2,500 ft and a south-easterly wind at about 20 kts. With respect to the possibility of turbulence in the operating area, the BoM analysis stated:

> Given that the winds over the terrain were not particularly strong (10 to 20 knots), widespread severe turbulence would not be anticipated. However, it is possible that mountain waves[10] may have occurred, including breaking waves, and also downslope winds in the vicinity of the high terrain. It is also reasonable to expect that the likelihood of encountering these phenomena would have been significantly greater at low altitude and close to terrain.

Neither of the two witnesses on the ground who were supporting the flight and were in the vicinity of the accident site, recalled any significant wind at the time of the accident. One of the witnesses described their position as being 'sheltered', and reported being unsure if they would have noticed any wind. The witnesses did not recall the helicopter appearing to be affected by wind.

The in-flight video imagery taken immediately prior to the right yaw, and examined by the investigation, indicated random movement of the camera and wind noise. The camera zoom function was in use at that time, which may have accounted for the observed random movement. The video footage did not indicate the presence of wind on either the trees or water. Several instances of wind noise were present on the recording. Wind noise could be expected as a result of the helicopter's left lateral movement with the doors removed, and the camera's location in the left of the helicopter.

The pilot described the conditions in the operating area as being 'pretty calm', and stated that he did not notice any turbulence.

Wreckage information[11]

The accident occurred over sloping, timbered terrain adjacent to a road associated with the development site. The elevation of the accident site was about 180 ft. The helicopter initially contacted a number of trees while rotating to the right, before impacting the ground in a nose-low attitude and coming to rest on its right side with the engine still running. The tail rotor and associated gearbox were located a short distance away from the main wreckage (Figure 5).

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

[10] An undulating flow of wind on the downwind, or lee, side of a mountain ridge that is caused by wind blowing strongly over the ridge.

[11] The ATSB did not attend the accident site immediately following the accident notification. However, the investigation team subsequently attended the site to verify information that had been provided to the team.

Figure 5: Detached tail rotor and gearbox

The tail rotor blades and gearbox, and sections of the tail boom, tail rotor driveshaft and tail rotor pitch change rod were forwarded to the Australian Transport Safety Bureau (ATSB) for technical examination.

Examination of components recovered from the R44

The damage to the tail rotor assembly was determined to have been associated with the contact with trees and the subsequent ground impact. No pre-existing mechanical damage or pre-impact defects to any of the components examined were identified that could have contributed to the accident.

As a result of the initial data gathering and analysis by the investigation, and after the helicopter had been removed from the accident site by the aircraft insurer, the need was identified for the examination of the tail rotor flight control system. Those components were recovered from the helicopter wreckage by the operator, and forwarded to the ATSB facilities in Canberra for technical examination.

There was disruption of the tail rotor flight control system as a result of the impact sequence, and associated with the removal and transport of the wreckage to the ATSB's facilities. As a result, the pre-impact continuity of that system could not be conclusively established. However, an examination of the available tail rotor flight control system components identified that there was no pre-existing damage to, or defect in those components that would have affected the operation of the tail rotor flight controls.

Organisational and management information

Operating procedures

The company Operations Manual detailed procedures for the conduct of aerial photography.

The chief pilot reported that at some time prior to the filming task, he advised the pilot that the operation was to be conducted no lower than 500 ft. The chief pilot stated that this minimum operating altitude limited exposure to the hazards associated with low-level operation and, as such, no additional guidance was required. The chief pilot advised that the need to maintain 20 to 30 kts, in order to ensure directional control, was emphasised generally to all pilots conducting aerial photography; although not specifically prior to the accident flight.

The pilot reported discussing the conduct of the filming task in general terms with the passengers prior to departure. No specific operating altitude or airspeed was included in that discussion.

The Operations Manual procedure detailing the conduct of media flights[12] included a requirement that, in the 12 months prior to the conduct of a media flight, the pilot shall have undertaken a flight conducted by a Check and Training pilot. Those check flights focussed on the hazards of low-level flight, including 'the symptoms of and recovery from loss of tail rotor effect.' There was no requirement for such a check flight prior to the conduct of the accident flight, as it did not constitute a media flight.

Pilot competencies regarding loss of tail rotor effectiveness

The Civil Aviation Safety Authority (CASA) publication, *Day (VFR) Syllabus Helicopters*,[13] detailed the sequences and standards that must be met by applicants for helicopter licences. In particular, the syllabus required that applicants were able to correctly describe the conditions leading to, and the procedure to be followed to recover from, loss of tail rotor effectiveness (LTE). Both the pilot and chief pilot confirmed that a discussion of LTE had been included as part of the pilot's flight training.[14]

The pilot advised that he did not believe the movement of the helicopter during the conduct of the filming task would have increased the risk of LTE, except possibly in conjunction with a wind gust. With regard to the appropriate recovery action from LTE, the pilot stated that the collective should be lowered and forward cyclic applied to increase airspeed. Additionally, the pilot recounted that the throttle could be increased and, if possible, the helicopter turned into wind. There was no consideration of the application of full left pedal as required as part of any initial recovery action (see Loss of tail rotor effectiveness discussion on page 9 of this report). The pilot stated that recovery options were limited at low altitude, due to the increased rate of descent that would result from lowering the collective and applying forward cyclic.

12 Media flights were defined as photographic flights conducted for the purposes of electronic or non-electronic news gathering.

13 Issue 2.0-Effective 1 June 2004 of the syllabus was valid at the time the pilot was undergoing flight training.

14 The chief pilot had been the pilot's flight instructor for significant periods of his training for the issue of his Private and Commercial Pilot (Helicopter) Licences.

Additional information

Loss of tail rotor effectiveness

In 1995, the US Federal Aviation Administration (FAA) produced an advisory circular (AC)[15] on the aerodynamic phenomena, 'loss of tail rotor effectiveness' (LTE) (also referred to as 'unanticipated right yaw'[16]). The circular stated that:

> LTE is a critical, low-speed aerodynamic flight characteristic which can result in an uncommanded rapid right yaw rate which does not subside of its own accord and, if not corrected, can result in loss of aircraft control.
>
> LTE is not related to a maintenance malfunction and may occur in varying degrees in *all* single main rotor helicopters at airspeeds less than 30 knots.
>
> Any maneuver which requires the pilot to operate in a high-power, low-airspeed environment with a left crosswind or tailwind creates an environment where unanticipated right yaw may occur.

The results of flight and wind tunnel testing identified three relative wind azimuths that either singularly, or in combination, can increase the risk of LTE by allowing the development of accelerating right yaw rates:

- wind from the left front of the helicopter at between 285° to 315° relative to the nose of the helicopter
- tailwind from 120° to 240° relative to the nose of the helicopter
- left crosswind between 210° and 330° relative to the nose of the helicopter.

It was also established that exposure to those relative winds did not result in aerodynamic stall of the tail rotor.

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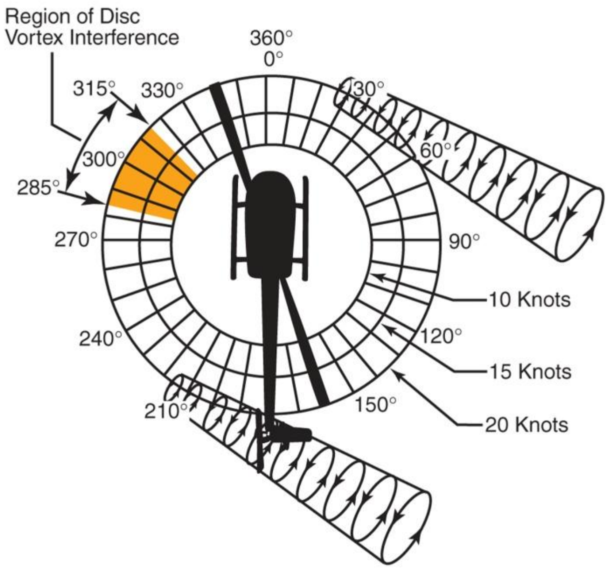
15 Federal Aviation Administration (1995) *Unanticipated Right Yaw in Helicopters* (Advisory Circular 90-95), available at: http://rgl.faa.gov/Regulatory_and_Guidance_Library%5CrgAdvisoryCircular.nsf/list/AC%2090-95/$FILE/ac90-95.pdf

16 On US-manufactured helicopters, the main rotor rotates counter clockwise as viewed from above. A loss of tail rotor effectiveness in these helicopters will result in the nose of the helicopter rotating to the right. On some European and Russian-manufactured helicopters, the main rotor rotates in the opposite direction resulting in the nose rotating to the left if tail rotor effectiveness is lost. The FAA Advisory Circular discussion of LTE focussed on US-manufactured helicopters.

Wind from the left front of the helicopter at between 285° to 315° relative to the nose of the helicopter

A wind from the left front of the helicopter at between 285° and 315° caused vortices generated by the main rotor to affect the airflow over the tail rotor (Figure 6). The result was a variation in the thrust produced by the tail rotor, and associated deviations in yaw.

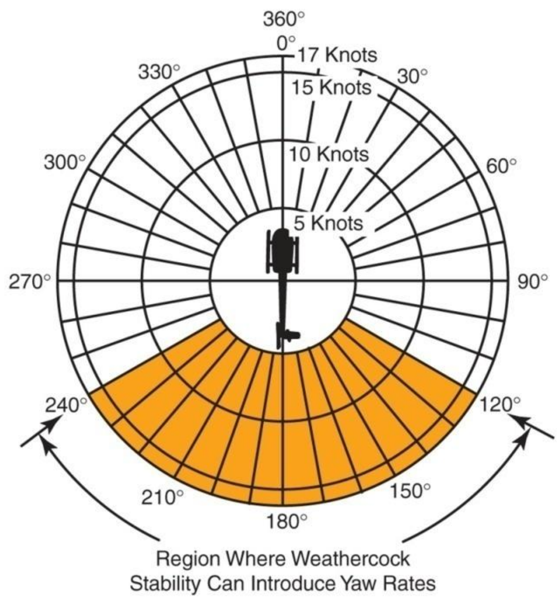
Figure 6: Main rotor vortex interference



Tailwind from 120° to 240° relative to the nose of the helicopter

Relative tailwinds from 120° to 240° can accelerate existing yaw rates by the relative wind acting on the vertical fin and fuselage (Figure 7). In this case, the relative wind acts to weathercock the nose of the helicopter into the relative wind.

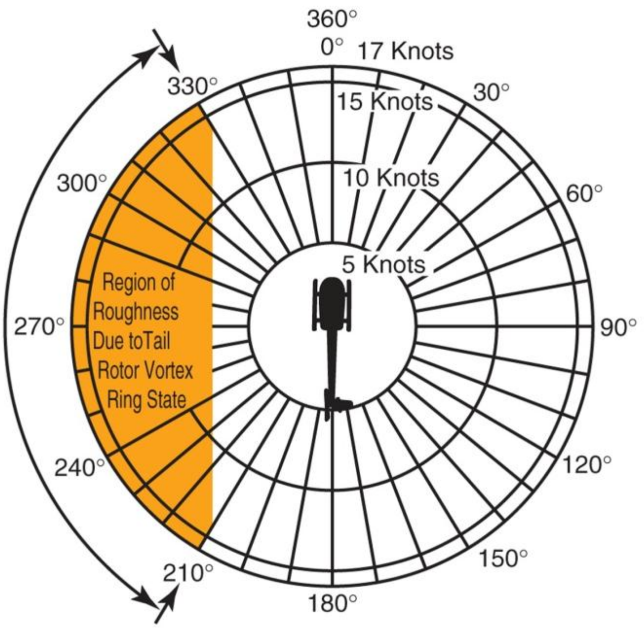
Figure 7: Weathercock stability



Left crosswind between 210° and 330° relative to the nose of the helicopter

A left crosswind from between 210° and 330° can result in tail rotor vortex ring state[17] (Figure 8). A variation in tail rotor thrust results, with associated deviations in yaw.

Figure 8: Tail rotor vortex ring state



The FAA AC also advised that, irrespective of the relative wind affecting a helicopter, operation below effective translation lift (ETL)[18] can also increase the risk of LTE, due to the higher power demand and corresponding anti-torque requirements. If the additional power required exceeds that available, those requirements can lead to a reduction in main and tail rotor RPM, and a corresponding loss of tail rotor thrust.

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17 In a conventional, US-manufactured helicopter, tail rotor vortex ring state occurs when the induced airflow towards the left of the helicopter as a result of the rotation of the tail rotor is intermittently approximated by the effect of the left crosswind. The resulting variations in the airflow through the tail rotor affect the thrust produced by the tail rotor.

18 Any component of airflow over the main rotor acts to reduce the effect of the main rotor downwash, making the rotor more efficient and resulting in less power required to maintain altitude. This beneficial effect is known as effective translational lift (ETL), and is most noticeable at forward airspeeds of about 10 to 20 kts.

Factors affecting the severity of the onset of LTE

The FAA AC stated that the severity of the onset of LTE was affected by the following factors:

> a. Gross Weight and Density Altitude. An increase in either of these factors will decrease the power margin between the maximum power available and the power required to hover. The pilot should conduct low-level, low-airspeed maneuvers with minimum weight.
>
> b. Low Indicated Airspeed. At airspeeds below translational lift, the tail rotor is required to produce nearly 100 percent of the directional control. If the required amount of tail rotor thrust is not available for any reason, the aircraft will yaw to the right.

Recommended recovery techniques

On encountering LTE, the FAA AC advised the following recovery action:

> Apply full left pedal. Simultaneously, move cyclic forward to increase speed. If altitude permits, reduce power[19].
>
> As recovery is effected, adjust controls for normal forward flight.
>
> If the rotation cannot be stopped and ground contact is imminent, an autorotation may be the best course of action. The pilot should maintain full left pedal until rotation stops, then adjust to maintain heading.

In regard to the application of collective during the recovery, the AC further stated:

> Collective pitch reduction will aid in arresting the yaw rate but may cause an increase in the rate of descent. Any large, rapid increase in collective to prevent ground or obstacle contact may further increase the yaw rate and decrease rotor rpm.
>
> The amount of collective reduction should be based on height above obstructions or surface, gross weight of the aircraft, and the existing atmospheric conditions

Industry understanding of the LTE risk

The chief pilots of a number of helicopter operators were contacted as part of the investigation in order to gain a general indication of the understanding by industry of the LTE risk, including of the conditions that increased that risk, and the appropriate recovery technique.

The results of the survey (Appendix A) indicated that most operators understood the inherent LTE risk during operations that involved:

- the use of high power, with the corresponding high anti-torque requirements due to factors including:
    - high operating weight
    - high density altitude
    - low airspeed.

19 In the R44, power can be reduced by lowering the collective or by reducing throttle.

- reduced yaw stability, as a result of operating at low forward airspeed.

The majority of operators specifically listed aerial photography/filming as an activity that elevated the risk of LTE.

Most operators were consistent in their planned use of collective and cyclic during the recovery from LTE. Of note, the intended application of tail rotor pedal during recovery varied between a number of the operators surveyed.

Risks associated with photographic flights

The R44 Pilot's Operating Handbook contained a number of Safety Notices (SN) associated with various aspects of helicopter operations. SN-34 detailed the risks associated with the conduct of aerial survey and photography flights, including that:

> Often, to please the photographer, an inexperienced pilot will slow the helicopter to less than 30 KIAS and then attempt to maneuver for the best picture angle. While maneuvering, the pilot may lose track of airspeed and wind conditions. The helicopter can rapidly lose translational lift and begin to settle.
>
> Photo flights should only be conducted by well trained, experienced pilots who: ...Are willing to say no to the photographer and only fly the aircraft at speeds, altitudes, and wind angles that are safe and allow good escape routes.

Consistent with FAA AC 90-95, SN-34 also cautioned against any loss of tail rotor RPM as a result of slowing below ETL and its effect on the rate of any rotation of the helicopter.

Previous LTE-related occurrences in Australia

Loss of tail rotor effectiveness has been identified as a contributing factor in a number of previous helicopter accidents and incidents in Australia (for example, see ATSB occurrences 200003293, 200600738 and 200606570).[20]

In particular, investigation 200600738 identified that an R44 experienced LTE during the conduct of a filming task whilst operating at about 2,000 ft AGL and at low airspeed.

Search and rescue alerting

Section 2-20-110 of the Manual of Air Traffic Services (MATS) stated that, in addition to preventing collisions and ensuring the safe and efficient flow of air traffic, an objective of ATS was to:

> ...notify appropriate organisations regarding aircraft in need of search and rescue [SAR] aid, and assist such organisations as required.

20 Available at www.atsb.gov.au

In order to achieve the ATS objectives in the vicinity of an aerodrome, MATS 12-50-240 stated that the primary function of Aerodrome Controllers was to:

> Maintain a visual observation of operations on and in the vicinity of the aerodrome.

The visibility of an aircraft can be expected to be adversely affected by the distance from an observer, particularly during low-level operations with wooded terrain as a backdrop. In addition, in the event of an emergency, operation at low level can minimise the time available for a pilot to transmit a distress call.

Although specifically related to crossing Bass Strait, in regard to the timely provision of assistance in the event of an emergency, the En Route Supplement Australia (ERSA) stated that:[21]

> Air Traffic Services will respond immediately to any emergency call, but in the event of radio failure or other situation that prevents use of radio, the use of SKED reporting over water will ensure that SAR action is taken following a missed SKED report. A SKED report ensures quicker response[22] than a nominated SARTIME for which SAR action would be taken at the expiration of that time, or if incidental information was received indicating an aircraft was in difficulty.

Typically, SKED reporting uses 30-minute intervals[23] but nothing prevents a pilot/controller establishing a reporting period of less than 30 minutes depending, on the nature of the operation. The aerial filming operation could similarly have utilised SKED reporting to provide for enhanced search and rescue alerting.

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[21] See paragraph 1.3.1 of Special Procedure, SP1- Bass Strait Crossings.

[22] ATS will initiate communication checks immediately following the expiry of a SARTIME. Search and Rescue procedures will commence 15 minutes after the expiry of a SARTIME if the checks fail to reveal news of the aircraft. See MATS 4-15-410.

[23] See Aeronautical Information Publication ENR 1.1 Air Route Specifications, paragraph 20.8.

ANALYSIS

Technical examination of the helicopter tail rotor drive and flight control systems did not reveal any pre-existing condition or fault that could have contributed to the accident. In that case, the investigation considered the operational factors with either the potential to have contributed to the development of the accident, or to affect future operations. The following analysis examines those factors.

Loss of tail rotor effectiveness

The reported lack of any audio warning prior to the accelerating right yaw meant that it was unlikely that low rotor RPM was a factor in the development of the loss of tail rotor effectiveness (LTE).

The low forward airspeed and lateral movement of the helicopter during the filming task exposed the helicopter to two of the risk factors that were detailed in US Federal Aviation Administration Advisory Circular (FAA AC) 90-95 as increasing the risk of LTE. That combination of factors probably resulted in the disruption of the airflow through the tail rotor due to vortex interference from the main rotor, and/or as a result of tail rotor vortex ring state. Combined with possible localised wind effects, that resulted in an accelerating right yaw that continued into LTE.

Consistent with the caution in the FAA AC, the high gross weight of the helicopter, due in part to the unnecessary carriage of one of the passengers, probably increased the severity of the onset of the LTE and added to the difficulty experienced by the pilot in recovering control of the helicopter.

The conduct of the filming below the minimum height stipulated by the chief pilot, suggested that the pilot was probably adversely influenced by his perception of the requirements for the task; in particular, the preference for filming closer to the site. That was consistent with the R44 Pilot’s Operating Handbook Safety Notice SN-34, which cautioned against focussing on pleasing the photographer, to the detriment of flying the helicopter as planned.

In terms of the application by the pilot of collective and cyclic in order to recover the helicopter, the low operating altitude and nature of the terrain in front of the helicopter, restricted the available recovery options following the LTE. Those restrictions, and the initial action by the pilot to not oppose the initial yaw with full left pedal as required in such circumstances, reduced the likelihood of a successful recovery.

Although in a particularly stressful situation, the reported momentary application by the pilot of increased collective and right pedal at some stage during the recovery would have acted to increase the rate of right yaw. The pilot’s decision to fully lower the collective, and enter autorotation when it became apparent that the yaw rate could not be reduced, was consistent with the advice presented in the FAA AC.

Although the pilot had discussed the phenomena of LTE during flight training, the task on the accident flight was undertaken at high gross weight and low airspeed, and in a manner that contributed to the development of a number of the normally-accepted LTE risk factors. That suggested a lack of awareness by the pilot of the LTE risk during the conduct of filming and/or photographic flights. The incomplete initial recovery action could be attributed to task overload during the emergency or, more probably, to a lack of recent consideration of, or exposure to the recovery from LTE by the pilot.

The chief pilot's belief that there were no specific risks associated with the filming task, including of LTE, as the flight was not planned to be conducted at low level, was not consistent with the FAA AC, or with the evidence from past LTE occurrences. A discussion with the pilot of the LTE risk as it applies to the conduct of filming flights, similar to that provided for a media flight, would have provided a timely reminder of the risk of, and appropriate recovery from, LTE and would probably have influenced the conduct of the flight.

Emergency response

Since no search and rescue time, or scheduled reporting time (SKED) was established by the pilot or air traffic services (ATS) for the filming task, an emergency response relied on either a distress call from the pilot, or the observation of the emergency by ATS.

The low-level nature of the flight, together with the significance of the emergency, prevented the pilot from transmitting a distress call. In that case, the detection of the emergency relied on ATS being able to continuously monitor the flight. The distance of the operation from Cairns tower, and the heavily-wooded backdrop to the operation, which increased the difficulty of observing the helicopter, suggested that the establishment of a SKED would have assured a more timely response to the emergency by ATS.

In this instance, there was no delay in the emergency response as a result of the notification by the witnesses to emergency services. In other circumstances, the nomination of a SKED would have ensured the prompt detection of the emergency, and the timely provision of emergency assistance.

FINDINGS

From the evidence available, the following findings are made with respect to the collision with terrain that occurred in the vicinity of False Cape, Qld on 18 June 2008 and involved Robinson Helicopter Company R44 Clipper II, registration VH-RYW. They should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The sideways movement of the helicopter during the filming, combined with the low airspeed, exposed the helicopter to adverse wind azimuths and increased the risk of the loss of tail rotor effectiveness (LTE).
- The helicopter encountered LTE.
- The helicopter’s high gross weight increased the severity of the onset of the LTE.
- The pilot’s initial recovery actions were incomplete.
- Operation of the helicopter at low altitude and towards rising terrain restricted the available recovery options for the pilot.
- The operation of the helicopter at low altitude and airspeed, and at high gross weight was probably adversely influenced by the pilot’s perception of the requirements of the filming task.
- The conduct of the flight suggested a lack of awareness by the pilot of the LTE risk during filming flights and of the appropriate LTE recovery actions.
- The lack of any discussion between the pilot and chief pilot of the risk of LTE during the filming task increased the risk of the exposure of the helicopter to the conditions for LTE, and of an inappropriate response by the pilot.

Other safety factors

- The lack of the nomination of a scheduled reporting time for the flight meant that a timely response in the case of an emergency could not be assured.

SAFETY ACTION

Any safety issues identified during the conduct of an investigation are listed in the Findings and Safety Actions sections of the report. However, whereas an investigation may not identify any particular safety issues, relevant organisation(s) may proactively initiate safety action in order to further reduce their safety risk.

All of the relevant organisations identified during this investigation were given a draft report and invited to provide submissions. Although no safety issues were identified during this investigation, the following proactive safety action was submitted by those organisations.

Helicopter manufacturer

Risk of unanticipated right yaw during aerial survey and/or photography flights

Action taken by the helicopter manufacturer

In response to this accident, the helicopter manufacturer advised that it was considering a revision to the aerial survey and photography safety notice (Safety Notice 34) that was contained in the R44 Pilot's Operating Handbook. That revision would, if adopted, include a discussion of the risk of unanticipated right yaw associated with the conduct of those flights.

APPENDIX A: LOSS OF TAIL ROTOR EFFECTIVENESS SURVEY RESULTS

Operator	Activities and conditions that increase the risk of the loss of tail rotor effectiveness (LTE)	Recommended recovery technique
1	Activities conducted at high power (for example, out of ground effect (OGE) hovering at high gross weights) with high anti-torque requirement. Airspeed less than 12 to 15 kts. The tail rotor efficiency is reduced by localised airflow, though not necessarily stalled.	Apply forward cyclic to increase airspeed while maintaining full left pedal. If altitude permits, lower the collective.
2	Activities conducted at high power (for example, external load operation, aerial shooting, power line survey, aerial photography) with high anti-torque requirement. Airspeed less than 10 to 15 kts (high power requirement and reduced yaw stability). Gusty conditions can also induce yaw rates.	Apply forward cyclic to increase airspeed. Initial application of full left pedal to oppose the yaw. Subsequent pedal position would depend on wind conditions. If altitude permits, lower the collective.
3	Activities such as aerial fire fighting, external load operations, and photography have an increased risk of LTE. Relative wind from one or more of three specific directions: rearwards, airflow interference from the main rotor, wind from the left producing a tail rotor vortex ring state. Low airspeed (below about 20 kts) and relatively high power also increase the risk of LTE.	Apply forward cyclic to increase airspeed. Initial application of full left pedal to oppose the yaw. If no effect then pedals should be positioned to about neutral. If altitude permits, lower the collective to reduce the anti-torque requirement. Low altitude operation reduces the likelihood of successfully recovery due to reduced escape routes.
4	Any task that requires high power (for example, OGE hover, heavy external load operation, aerial photography/filming has an increased risk of LTE, particularly if an appreciation of the wind is not maintained. Adverse wind azimuths can affect the thrust produced by the tail rotor. In the case of the	If altitude permits, reduce the throttle and lower the collective to reduce the anti-torque requirements. Forward cyclic applied to increase the airspeed and tail rotor pedals positioned to about the neutral position.

Operator	Activities and conditions that increase the risk of the loss of tail rotor effectiveness (LTE)	Recommended recovery technique
	R44, restriction of the throttle by tensing on the collective[24] can result in reduced tail rotor RPM/thrust due to reduced power available. The increased power requirement and reduced yaw stability due to low airspeed and task distraction (that reduces attention on flying the helicopter, wind direction, and so on) can increase the risk of LTE.	
5	Heavy external load operation and aerial filming task have a higher risk of LTE due to the high operating weight, potential for out-of-wind operation and focussed attention on the task leading to reduced attention on flying the helicopter (including wind direction). Adverse wind directions, high power requirements and low airspeed all increase the risk of LTE.	Simultaneously reduce the power (lower collective) and apply forward cyclic to increase airspeed. Yaw should be opposed by pedal input. If the yaw continues the pedal position should be held (not necessarily full opposing pedal). Primary recovery is via collective and cyclic inputs.
6	Any activity that requires operation at low airspeed, particularly at low level (such as weed survey operations). The wind direction is the primary consideration combined with hovering operation at low airspeed and high operating weights.	Simultaneously reduce power (lower collective) and apply forward cyclic to increase airspeed. Yaw should be opposed by full opposite pedal input until recovery is affected. Low altitude operation increases the risk of adverse consequences associated with LTE due to the risk of collision with the ground during recovery actions.
7	Filming work carries the highest risk of LTE due to exposure to adverse winds during out-of-balance, low airspeed operation. The wind direction is the primary consideration combined with operation below 20 to 25 kts. The helicopter	Based on experience of an LTE event, the most effective recovery was to close the throttle and enter autorotation. Application of forward cyclic to increase airspeed was not feasible due to the constant fluctuating fore/aft cyclic inputs

[24] The R44 throttle is located on the collective and the governor maintains engine RPM by detecting changes in the RPM and applying corrective throttle inputs via a friction clutch. The governor is easily overridden by the pilot.

Operator	Activities and conditions that increase the risk of the loss of tail rotor effectiveness (LTE)	Recommended recovery technique
	does not have to be heavy to be affected by LTE. Operations at high density altitude reduce the efficiency of the tail rotor and can lead to an increased risk of LTE.	required to maintain the helicopter level as the helicopter yawed through 360° whilst still moving in the original direction. Application of full left pedal, neutral pedal and right pedal did not have any noticeable effect on the yaw rate.

APPENDIX B: SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included:

- the pilot and passengers of VH-RYW
- the witnesses to the accident
- the Queensland Police Service
- the Bureau of Meteorology
- Airservices Australia (Airservices).

References

US Federal Aviation Administration (1995) *Unanticipated Right Yaw in Helicopters* (Advisory Circular 90-95).

Robinson Helicopter Company R44 II Pilot's Operating Handbook.

R.W. Prouty (2004). *Helicopter Aerodynamics*. Mojave CA: Helobooks, a Division of Mojave Books LLC.

Submissions

Under Part 4, Division 2 (Investigation Reports), 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. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the pilot and passengers of the helicopter, the operator, the organisation responsible for maintenance of the helicopter, the Civil Aviation Safety Authority (CASA), Airservices, the helicopter manufacturer and the US National Transportation Safety Board.

Submissions were received from one of the helicopter's passengers, CASA, Airservices and the helicopter manufacturer. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Collision with terrain, 10 km east of Cairns Aerodrome, Qld
Robinson Helicopter Company R44 Clipper II, VH-RYW
18 June 2008