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What happened

On 2 April 2017, at about 1730 Eastern Standard Time (EST), a Virgin Australia ATR - Gie Avions De Transport Regional ATR72-212A aircraft, registered VH-FVL, departed Moranbah for Brisbane, Queensland on a scheduled passenger service. There were two flight crew, two cabin crew and 38 passengers on board the aircraft. The captain was the pilot flying (PF) and the first officer was the pilot monitoring (PM).[1] The flight also acted as line training for the first officer.

While in the cruise, air traffic control (ATC) cleared the aircraft for the LAVEG ONE standard arrival route for runway 19 at Brisbane Airport. Weather conditions were clear and at 5,700 ft the crew established visual contact with the runway. ATC then gave them radar vectors to intercept the final approach leg.

At around 2,500 ft on descent, the captain disconnected the autopilot and manually flew the aircraft. ATC instructed the crew to track to a 5 NM (9.3 km) final approach leg for runway 19 and cleared the aircraft to descend to 1,700 ft for a visual approach. At 2,300 ft, the captain directed the first officer to select flap 15 and to set 140 kt on the automatic flight control system. The first officer then confirmed that this had been completed. The landing gear was extended soon after.

While the aircraft was turning onto the final approach leg, the captain directed the first officer to select flap 30, set the airspeed indicator bug to the approach speed (V_{APP}),[2] and start the before landing checklist. The first officer completed a radio call with ATC, moved the flap selection lever (Figure 1), set the approach speed (104 kt) and responded 'V approach set', and then started the checklist.

Figure 1: Location of flap lever on ATR72

Source: Virgin Australia

As the aircraft descended on the final approach leg, the crew noticed that the aircraft was not performing as expected. The captain had to keep adjusting the aircraft attitude and engine torque

1 Pilot Flying (PF) and Pilot Monitoring (PM) are procedurally assigned roles with specifically assigned duties at specific stages of a flight. The PF does most of the flying, except in defined circumstances; such as planning for descent, approach and landing. The PM carries out support duties and monitors the PF's actions and aircraft flight path.

2 Final approach speed (V_{APP}) is the speed on the final approach in landing configuration.

setting to control the speed. Passing about 1,000 ft, the captain recognised that the speed was too high, but thought that this could be corrected by 500 ft and continued the approach. The first officer also noticed the unusually high speed and called out ‘speed’ to alert the captain.

The flight crew had no recollection of completing the before landing checklist or completing the callout at 500 ft to ensure that aircraft was in a stabilised approach.[3] Passing 173 ft, the enhanced ground proximity warning system[4] (EGPWS) activated with the alert, TOO LOW FLAP. The captain immediately conducted a missed approach. During the subsequent climb, the captain called ‘flap 15, check power’ and the first officer responded accordingly.

When the aircraft achieved a positive rate of climb, the captain called ‘positive rate, gear up’. ATC cleared the aircraft to climb and then vectored them for a right base leg to conduct the same approach to runway 19. At this time, the first officer commented to the captain a concern that they may have left the flap at 15. After landing, the captain decided to stand the crew down and not conduct the next two sectors.

Recorded data

The operator extracted the flight data from the aircraft’s quick access recorder. It was recorded that the aircraft commenced the turn onto the final approach at 1,720 ft above the airport and was at 1,729 ft when the flaps lever was moved from 15 to 0 degrees at a calibrated air speed (CAS) of 139 kt.

At 900 ft, the air speed had increased to 148 kt and the aircraft was low on the approach. At 542 ft the aircraft had slowed to 123 kt, which coincided with the thrust lever angle set to idle.

Immediately after the TOO LOW FLAP warning at 173 ft, the thrust lever was moved to the go around position and the flap lever moved from flap 0 to flap 15.

The stall speed for the aircraft at flap 0 was about 106 kt at the estimated approach weight of 18 tonnes. The V_{APP} speed was set at 104 kt, which was below the flap 0 stall speed. The minimum speed recorded on approach was 114 kt at 507 ft.

The stick-shaker[5] activates at 15.9 degrees angle of attack[6] and the maximum angle of attack reached during the approach was 14.6 degrees.

Flap procedures

The operator’s ATR 72-500 standard operating procedures stated that all normal landings are conducted using flap 30. On approach, the pilot flying must call ‘flaps 30, set speed bug V approach’. The pilot monitoring is then required to check the speed, select flap 30, monitor the extension of the flap, and set the speed bug to V_{APP} and call ‘[speed] set’. The pilot flying then calls out the before landing checklist for the pilot monitoring to action. The last item on the before landing checklist is for both crew to check that flap 30 has been set.

The flap lever is in the 12 o’clock position for flap 0, in the 2 o’clock position for flap 15, and in the 5 o’clock position for flap 30. The flap position is also shown on the flap indicator where the needle points at 0, 15, or 30 (Figure 2).

Figure 2: A screen capture from the operator’s flight data showing the flap indicator positioned at 0 degrees while the aircraft was passing 1,000 feet on descent

3 On the glidepath at correct airspeed, correctly configured, all checklists and paperwork complete.

4 An aircraft system that uses aircraft inputs with onboard terrain, obstacle, and airport runway databases to predict potential conflict [illegible]’s flight path and terrain or an obstacle.

5 A tactile warnin[illegible] that [illegible] was near an aerodynamically-stalled condition of flight.

6 The angle betw[illegible] r rel[illegible]nd a reference line of the aeroplane or wing.

Source: Operator, modified by the ATSB

Stabilised approach criteria

The operator's stabilised approach criteria included that all approaches shall be stabilised by 1,000 ft above ground elevation. However, in terms of speed, if the pilot-in-command is confident the speed target will be achieved by no later than 500 ft above field elevation, the approach can continue.

The speed criteria is that the aircraft must be within -5 to +10 kt of the speed target.

If the speed remains outside the stabilised criteria at 500 ft above field elevation, or if at any time before it becomes apparent the stabilised criteria will not be met, then a go around must be initiated.

The V_{APP} set for flaps 30 on the day was 104 knots. At 507 ft, the airspeed was 114 kts, which was within the stabilised approach criteria. However, at 358 ft, the airspeed had increased to 128 kts.

The go around was initiated at 173 ft at an airspeed of 121 kts.

Captain's comments

The captain provided the following comments:

- The captain recalled seeing the first officer's hand reaching out and grasping the flap lever when instructed to set flap 30, but was also busy hand flying the aircraft at the time.
- While the aircraft is climbing on a go around, it is the pilot monitoring's responsibility to call 'positive rate', but there was no call from the first officer so the captain made the call.
- When they recognised that the aircraft was performing unusually, the captain thought it was an issue with the aircraft power settings because the aircraft was descending below the approach path.
- Normally, both the pilot flying and pilot monitoring would check the flap settings when it is called in the checklist by checking the position of the flap lever, then the flap indicator, and say 'set'. However, because the captain was busy controlling the aircraft, they may not have checked.
- The first time the captain became aware that the flap was set to 0 degrees was during a review of the flight data animation produced by the operator.
- The captain completed a fatigue report after the flight, although later reported not feeling overly tired during the flight. The captain had arrived at the airport to sign on at 1140 instead of 1340, due to confusion around the rostered flight time. However, to be safe the captain decided that the crew would not continue onto the next destination.
- There are inherent risks with visual approaches at night, given that they are not using the instrument landing system.[7]

First officer's comments

The first officer provided the following comments:

- The workload of the crew increased during the approach when there was a combination of turning onto the final approach path, conducting a visual approach, managing radio calls with ATC and responding to the unexpected aircraft performance.
- Flap settings are generally confirmed through the completion of the before landing checklist, whereby the flap lever and indicator must be visually checked. However, in this case, this part

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[7] A standard ground aid to landing, comprising two directional radio transmitters: the localiser, which provides direction in the horizontal plane; and the glideslope, for vertical plane direction, usually at an inclination of 3°. Distance measuring equipment or marker beacons along the approach provide distance information.

of the checklist happened during a high workload period, and it was subsequently rushed. This checklist item may have been missed.

- The first officer recalled looking at the flap indicator and seeing movement, but may have wrongly assumed that the flaps were moving to flap 30 in lieu of flap 0.

Previous occurrences

A search of the ATSB's database found the following occurrences where the incorrect flap setting was selected on approach:

- On 28 July 2011, the crew of an Airbus A320 was on approach to Melbourne, Victoria (ATSB investigation AO-2011-089).[8] The approach brief included the requirement for flap 2[9] to be selected. At about 245 ft, the captain realised the landing checklist had not been completed and the crew received an EGPWS warning TOO LOW FLAP. The captain identified the aircraft was not in the landing configuration, including flaps and called for a go-around.
- On 24 July 2013, the crew of an Airbus A320 was on approach to Newman Airport, Western Australia (ATSB investigation AO-2013-149).[10] Shortly after passing 500 ft above ground level, the crew received an EGPWS warning TOO LOW FLAP. Full flap was selected at about 185 ft and the aircraft landed shortly after.
- On 2 April 2017, the crew of a Boeing 737 were on approach to land on runway 19 at Brisbane Airport (ATSB occurrence 201701579). At 1,400 ft the call for flap 30 was made, but flap 25 was selected. The landing checklist was commenced at 1,200 ft but interrupted by the issue of a landing clearance from air traffic control. The checklist was recommenced and completed at 1,000 ft, however, the flap setting was not identified. At 300 ft, the EGPWS warning TOO LOW FLAP activated and the crew conducted a missed approach.

Safety analysis

The approach and landing is known to be a phase of flight with a high workload due to the number of tasks to be completed in addition to monitoring the flight path. During the approach, as the aircraft was turning, the first officer was responding to a radio call and completing a checklist. It is likely that the first officer inadvertently selected the flap lever up from 15 to 0, instead of down to 30, and did not crosscheck the flap indicator before moving on to the other tasks. This inadvertent action led to an increase in the aircraft's airspeed, which the flight crew recognised, but at the time were unable to ascertain why. The incorrect flap setting was not detected and a go around initiated after a ground proximity warning alerted the crew to an incorrect configuration at 173 ft.

Due to the high workload in managing the aircraft's performance on approach, the crew did not detect the aircraft's speed was exceeding the stabilised approach criteria of V_{APP} + 10 kts or that the aircraft was incorrectly configured with flap 0. Although at 507 ft, the airspeed was 114 kts, which was within the stabilised approach criteria with the V_{APP} set at 104 kts, at 358 ft, the airspeed had increased to 128 kts, which was outside the stabilised approach criteria.

Since the incorrect flap setting was not detected by the crew on approach, had they managed to slow the aircraft to the V_{APP} of 104 kts for flap 30, they would have been 2 kts below the stall speed for the actual flap setting (106 kts).

Findings

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

[8] https://www.atsb.gov.au/publications/investigation_reports/2011/aair/ao-2011-089/
[9] Flap 2 is equivalent to 15 degrees position.
[10] https://www.atsb.gov.au/publications/investigation_reports/2013/aair/ao-2013-149/

- During the approach, the first officer moved the flap lever up from flap 15 to flap 0, instead of from flap 15 to flap 30 as intended. This resulted in an unstable approach.
- The crew did not identify the incorrect flap setting until the ground proximity warning system alerted them to an incorrect configuration, likely due to workload.

Safety message

Approach and landing have a higher workload compared to other phases of flight because of the continuous monitoring of aircraft parameters and the external environment to maintain a stable approach. This investigation highlights the potential impact crew workload has on flight operations as it can lead to adding, shedding, or rescheduling actions. Handling approaches to land continues to be a safety priority for the ATSB.

General details

Occurrence details

Date and time:	2 April 2017 – 1930 EST	
Occurrence category:	Incident	
Primary occurrence type:	Incorrect configuration	
Location:	Brisbane Airport	
	Latitude: 27° 23.05' S	Longitude: 153° 07.05' E

Aircraft details

Manufacturer and model:	ATR - Gie Avions De Transport Regional ATR72-212A	
Registration:	VH-FVL	
Operator:	Virgin Australia	
Serial number:	974	
Type of operation:	Air Transport High Capacity - Passenger	
Persons on board:	Crew – 4	Passengers – 38
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Smoke in the cockpit involving Bombardier DHC-8-315, VH-TQH

What happened

On 23 June 2017, at about 1549 Central Standard Time,[1] a QantasLink Bombardier DHC-8-315 aircraft, registered VH-TQH, was being operated on a scheduled passenger service from Port Lincoln to Adelaide, South Australia. There were two flight crew, two cabin crew and 46 passengers on board. The captain was designated as the pilot monitoring and the first officer (FO) was the pilot flying.[2]

When on final approach to runway 23 at Adelaide, at about 300 ft, the captain noticed fumes in the cockpit and mentioned this to the FO, who did not notice the smell. Shortly after, at about 200 ft, both crew detected the fumes, which smelt like electrical/chemical burning. They looked down at the centre console and noticed light grey smoke coming from the switch on the aileron/rudder trim control panel. The captain instructed the FO to focus on the landing and that they would manage the problem when they were on the ground. The captain notified air traffic control of smoke in the cockpit and requested emergency services. The controller considered this a 'PAN PAN'[3] call.

After landing, the aircraft was stopped on the taxiway and the captain called for the *Smoke* checklist from the Quick Reference Handbook to be completed. This involved donning oxygen masks, switching the microphone to mask, and turning the recirculation fans off to prevent the smoke being circulated within the aircraft. The smoke had dissipated from the cockpit, but fumes were still present.

Air traffic control called back to ask if the flight crew could continue taxiing. The FO responded they were using oxygen masks and would be shutting down on the taxiway. The captain delivered a public address to the passengers advising there was an issue and to await further instructions. The captain then made a call to the cabin crew to inform them of the smoke, that they were using oxygen, and were planning to do a precautionary disembarkation. The cabin crew member indicated that passengers seated in rows 4 and 5 could also smell the fumes, but there was no smoke.

The FO retrieved the *On ground non-normal* checklist. The captain completed the checklist and made the 'precautionary disembarkation' public address to the passengers. The FO exited and directed the passengers outside to an area away from the aircraft. The cabin crew cleared the cabin to ensure all the passengers had disembarked and the captain switched off all power before they exited as per the *Precautionary disembarkation* and *Evacuation* checklists.

The captain spoke to the airport fire personnel and provided them a description of the issue and where it occurred. The fire personnel assessed the situation and determined there was no fire risk.

The captain briefed the passengers on the incident, describing what happened and why they disembarked. There were no reported injuries or ill effects from the smoke and fumes, and the aircraft was not damaged.

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1 Central Standard Time (CST): Coordinated Universal Time (UTC) + 9.5 hours.

2 Pilot Flying (PF) and Pilot Monitoring (PM) are procedurally assigned roles with specifically assigned duties at specific stages of a flight. The PF does most of the flying, except in defined circumstances; such as planning for descent, approach and landing. The PM carries out support duties and monitors the PF's actions and aircraft flight path.

3 PAN PAN: an internationally recognised radio call announcing an urgency condition which concerns the safety of an aircraft or its occupants but where the flight crew does not require immediate assistance.

Aileron/rudder trim control panel inspection

Following the incident, engineers removed the aileron/rudder trim control panel for inspection. That inspection identified visible damage underneath the rudder trim switch. Specifically, the rudder trim potentiometer[4] was blackened and burnt (Figure 1). The trim control panel was subsequently replaced.

Figure 1: Burnt potentiometer in the aileron/rudder trim control panel (circled in red)

Source: Operator, modified by the ATSB

Additional comments

The following additional comments were made by the captain and operator:

- When the smoke and fumes were detected, the aircraft was about 1 minute from landing. Consequently, the captain elected to continue the landing, rather than action the appropriate checklist. The captain reported that, if the checklist was commenced during the approach, the aircraft's controls would have been handed between the crew while donning masks. The captain considered this to be dangerous while hand flying the aircraft and when close to landing.
- While the crew were disembarking, the aviation rescue and firefighting personnel attempted to enter the aircraft, but unintentionally blocked the exit. This resulted in a minor delay for crew exiting.
- The aviation rescue and firefighting personnel did not allow the cabin crew to remove the first aid kit from the aircraft, which contradicted the operator's emergency procedures.
- The operator reported that communications throughout the incident were well managed and the crew were commended for their response to the incident.

Airservices Australia comments

Airservices advised that the airport fire personnel were present at the exit only after all the passengers had disembarked and then attempted to enter the aircraft to talk to the crew and assess the internal conditions. The request not to remove the first aid kit was made in consideration that fire personnel carry first aid kits at all time. In addition, it was standard practice

[4] An instrument for measuring electromotive force or difference in potential between two points in a circuit; the measurement is made without drawing electric current.

when securing a site not to remove anything from the aircraft until an internal assessment had been made. Airservices were not aware that it was company policy to remove the first aid kit.

Previous occurrences

A search of the ATSB's database found the following occurrences involving smoke or fumes in DHC-8 aircraft originating from in the cockpit:

- On 29 July 2013, the crew of a Bombardier DHC-8-315 were en route from Sydney to Wagga Wagga, New South Wales (ATSB investigation AO-2013-120) when they noticed a blank area in the centre of the flight management system screen. About 10 minutes later, the screen went completely blank and thick, light-grey smoke was observed coming from the unit. Examination of the unit found that two capacitors failed, resulting in the smoke and failure of the unit.
- On 8 June 2014, the crew of a Bombardier DHC-8-202 were on take-off at Cairns, Queensland (ATSB occurrence 201405530). During the take-off, the FO's electronic displays failed and fumes were detected in the cockpit. The take-off was rejected and the aircraft returned to the bay. An engineering inspection revealed water contamination to the No.2 symbol generator.
- On 10 November 2016, the crew of a Bombardier DHC-8-315 were on approach to Adelaide, South Australia (ATSB investigation AO-2016-151). At about 9,000 ft, the FO noticed the captain's electronic attitude director indicator screen had gone blank and the crew conducted the display failure checklist. After the crew were cleared to descend, they noticed an electrical smell, which was suspected to originate from the failed screen. The crew actioned the *fuselage fire or smoke* checklist and made a 'PAN PAN' call to air traffic control. After landing, a precautionary disembarkation on the taxiway was conducted. An engineering inspection found the fumes were caused by damage to a circuit card assembly due to a blown resistor on the video driver.

Findings

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

- The rudder trim potentiometer burnt in-flight, resulting in fumes and smoke in the cockpit during a critical phase of flight.
- Shortly after landing, the crew conducted a precautionary disembarkation on the taxiway, which reduced the risk of fumes exposure to the aircraft's occupants.

Safety message

SafetyWatch

This incident highlights the effective flight crew management of an in-flight issue during a critical phase of flight. The ATSB has published a research report, An analysis of fumes and smoke events in Australia from 2008 to 2012, which found that, from a flight safety perspective, the majority of fumes/smoke events were minor in consequence and the most common source was aircraft systems issues. The research also identified that fumes and smoke events were generally appropriately managed by flight and cabin crew due to effectiveness of crew training and operational procedures, such as using checklists.

General details

Occurrence details

Date and time:	23 June 2017 – 1549 CST	
Occurrence category:	Incident	
Primary occurrence type:	Smoke	
Location:	Adelaide Airport, South Australia	
	Latitude: 34° 56.70' S	Longitude: 138° 31.83' E

Aircraft details

Manufacturer and model:	Bombardier Inc. DHC-8-315	
Registration:	VH-TQH	
Operator:	Eastern Australia Airlines trading as QantasLink	
Serial number:	597	
Type of operation:	Air transport high capacity – passenger	
Persons on board:	Crew – 4	Passengers – 46
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Piston aircraft

Collision with vehicle during approach involving Piper PA-31 VH-JQS

What happened

On the morning of 29 March 2017, a Piper PA-31-350 aircraft (Figure 1), registered VH-JQS, was on a private visual flight rules flight from Moorabbin, Victoria (Vic.) to Barwon Heads/Geelong aeroplane landing area (Barwon Heads ALA),[1] Vic. The pilot was the only person on board.

Figure 1: The occurrence aircraft, VH-JQS

Source: http://cqplanespotting.blogspot.com.au

At about 1015 Australian Eastern Daylight Time (AEDT), the aircraft was on approach to runway 36 at Barwon Heads ALA. The aircraft was configured with the landing gear extended and full flaps selected.

At a distance of about 0.5 NM (0.9 km) from runway 36, the pilot detected the aircraft becoming slightly low on the desired approach profile. The pilot retracted the flaps by 10° in an attempt to reduce the rate of descent. As the aircraft approached runway 36, the pilot noticed the aircraft was still lower than intended and decided to increase power. The pilot looked down momentarily at the throttle quadrant as they put their hand on the throttle control. As they looked back up, they observed a truck approaching from the left along Barwon Heads Road (Figure 2).

The pilot applied full power to conduct a go-around.[2] As full power was applied, the aircraft passed over Barwon Heads Road and the left main landing gear impacted the truck. The pilot observed the truck continue on Barwon Heads Road without stopping and the pilot continued with the go-around. The pilot elected to leave the landing gear extended in case it had sustained damage.

1 Aeroplane landing area: An area of ground suitable for the conduct of take-off and landing of aeroplanes.

2 Go-around: the procedure for discontinuing an approach to land, is a standard manoeuvre performed when a pilot is not completely satisfied that the requirements for a safe landing have been met. This involves the pilot discontinuing the approach to land and may involve gaining altitude before conducting another approach to land.

Figure 2: Barwon Heads/Geelong aeroplane landing area (ALA).

Source: Google Earth, annotated by ATSB

After completing the go-around, the pilot conducted two low passes over the airfield to determine the extent of any damage. During the first pass, the pilot contacted another pilot on the ground who had recently landed. The pilot on the ground was able to confirm that all three landing gear appeared to be intact. On the second pass, the pilot yawed[3] the aircraft left and right to ensure the landing gear was secure.

The pilot subsequently landed the aircraft without incident. The pilot was uninjured and the aircraft sustained minor damage (Figure 3).

[3] Yawing: the motion of an aircraft about its vertical or normal axis.

Figure 3: Damage to left main landing gear of VH-JQS.

Source: Pilot

Pilot comments

The pilot of VH-JQS provided the following comments:

- They had flown into Barwon Heads regularly over the previous five to six years and were familiar with the airport, including the displaced threshold and the vicinity of the Barwon Heads Road.
- In addition to flying duties, the pilot was also working as the company maintenance controller, and had recently taken on extra administrative duties. They stated that they were distracted during the incident flight by these additional pressures.
- The desired approach profile was about a 3° (5 %) descent profile. The pilot was aiming to land about a quarter of the way into the runway in order to ensure clearance over Barwon Heads Road.
- There were no issues with visibility or cloud cover but there was a gusting wind from the north-west. The aircraft became low on approach due to turbulence and windshear.
- When they realised they were becoming low on the approach the pilot reduced flaps by 10° rather than apply power. This was done to avoid reheating the turbo chargers as they had already cooled.
- The truck was not detected earlier as it had been obscured by a row of trees to the south-west of the airport.

Truck driver comments

The driver of the truck provided the following comments:

- The truck driver felt what they thought was downwash from the aircraft but was unaware that contact had been made. At no time did they see the aircraft. It was only when the truck driver reached their destination that they saw the impact marks and damage to the top of the truck and realised contact had been made.
- The truck was 3.950 m in height.

Airport operator comments

The airport operator provided the following comments:

- In late 2014, Barwon Heads ALA underwent a number of upgrades. These upgrades included sealing of runway 36 and improvements to the runway lighting. As part of these upgrades, the airport operator also proposed lengthening runway 36 to the north so that the displaced threshold could be moved further north. This would have allowed more clearance for aircraft flying over Barwon Heads Road. The operator stated that this aspect of the application was rejected by the local council (see *Local council comment* below) so the application went ahead without this component.
- The Aeronautical Information Package (AIP) En Route Supplement Australia (*ERSA*) states that prior permission is required to land at Barwon Heads ALA. This was done to convey information regarding the airport and runways. This information included the displaced threshold and road to the South of runway 36. The airport information was also available online (*YBRS Runway Information - Barwon Heads Airport*).

Local council comment

The local council commented that in general, the use of land as a transport hub (airport) is prohibited in a farming zone. However, the existing ALA site had operated as an airport for a period of almost 40 years and had existing use rights across the entire lot. These existing use rights, however, did not extend to the land north of the runway. Because of this, the council could not consider the part of the airport operator's application relating to the extension of the runway to the north.

Adjusting decent rate during approach

The *CASA flight instructor manual* states that for an engine assisted approach:

> *The use of power on the approach enables the rate of descent to be adjusted safely over a very wide range.*

Additionally the *Civil Aviation Authority New Zealand circuit training* guidance states that:

> *The approach path is monitored by reference to the correct runway perspective. Throughout the descent the aiming point, commonly the runway numbers or threshold, is monitored and the power adjusted as required to maintain a steady rate of descent to touchdown.*
>
> *Power controls the rate of descent*
>
> *With the aeroplane trimmed to maintain the required attitude (airspeed), if the aiming point moves up the windscreen, the aeroplane is undershooting – increase power. If the aim point moves down the windscreen, the aeroplane is overshooting – decrease power.*

Runway 36 displaced threshold

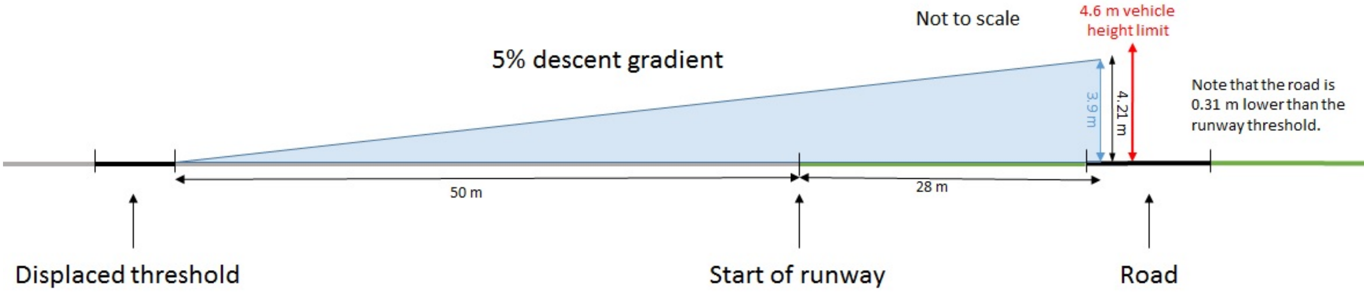
The Civil Aviation Safety Authority (CASA) provides guidance regarding the recommended minimum physical characteristics of landing areas in the *Civil Aviation Advisory Publication (CAAP) 92-1(1): Guidelines for aeroplane landing areas.*

Section 5.5 of that document stated:

> *Both ends of a runway, not intended solely for agricultural operations, should have approach and take-off areas clear of objects above a 5 % slope for day and a 3.3 % slope for night operations.*

Barwon Heads Road is in close proximity to runway 36 (Figure 2). The start of runway 36 was about 25 m from the road, and the displaced threshold was 78 m from the road. Additionally, the elevation of the runway at the threshold was 0.31 m higher than that of the road. Using the 5 per cent approach recommended by CAAP 92-1, a distance of 78 m results in a height of 3.9 m (see Figure 5) over the runway elevation, providing a total road-crossing height of 4.21m. The *VicRoads vehicle height limit* in Victoria for road vehicles was 4.6 m.

Figure 5: Diagram showing a 5 per cent (3 degree) approach profile for Barwon Heads runway 36 and the proximity of Barwon Heads Road. A 5 per cent descent gradient aiming at the threshold results in aircraft passing over Barwon Heads Road at 4.21m which is lower than the VicRoads vehicle height limit of 4.6m.



Source: ATSB

While this incident occurred during daytime, runway 36 at Barwon Heads ALA is available for night use and is equipped with pilot activated lighting. Using the 3.3 per cent slope recommended by CAAP 92-1 for night operations, a distance of 78 m results in a height over Barwon Heads Road of 2.88 m (including the 0.31 m elevation difference). A review of the ATSB's aviation occurrence database showed no similar occurrences on approach to runway 36 at Barwon Heads ALA have been reported to the ATSB.

Safety analysis

At about half a nautical mile from the runway, the aircraft became low on the approach. When the pilot recognised that the aircraft was too low, they elected to reduce the flap setting by 10° rather than add power. As the aircraft got closer to the runway, the aircraft was still lower than the desired approach profile, at which point the pilot elected to add power to gain height. Despite this action, the aircraft remained below the desired approach profile until it made contact with the truck.

The threshold of runway 36 was 78 m from Barwon Heads Road (Figure 2). Using the 5 per cent approach recommended by CAAP 92-1, a distance of 78 m results height of 3.9 m above the runway elevation. Combining this with the 0.31 m elevation difference, results in a clearance of 4.21 m which is less than the 4.6 m road vehicle height permitted in Victoria. Therefore, a normal approach aiming for the threshold of runway 36 at Barwon Heads can intersect with road vehicles on Barwon Heads Road.

Findings

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

- The aircraft descended below the desired approach profile and the corrective action was not effective in sufficiently reducing the rate of descent.
- The displaced threshold on runway 36 at Barwon Heads does not provide the level of clearance recommended by the Civil Aviation Safety Authority Civil Aviation Advisory Publication 92-1.

Safety message

The guidance provided by CAAP 92-1 regarding the recommended minimum physical characteristics of ALAs is not compulsory. Therefore, pilots should not expect the same conditions and protections at an ALA as they would expect at a registered airport. When preparing to operate to ALAs, pilots should gain as much local knowledge about the landing site as possible. This can be achieved by consulting the ERSA, and calling ahead for prior permission and/or airfield information. Aerodrome operators can help facilitate this by distributing relevant information in the ERSA, on their website or by requesting prior permission, as done by Barwon Heads ALA.

This occurrence involved an experienced pilot with over 4,000 hours total flying time and over 1,000 hours as an instructor. Additionally, the pilot had flown into Barwon Heads ALA numerous times previously and was familiar with the displaced threshold and the proximity of the road. Despite this experience, and even with local knowledge, this occurrence resulted in the aircraft impacting a truck while on approach to Barwon Heads ALA. The ATSB's aviation occurrence database shows that experience does not grant immunity from fatal accidents and in 2013 the ATSB published its sixth report of the avoidable accident series *Experience won't always save you.*

General details

Occurrence details

Date and time:	29 March 2017 – 10145 AEDT	
Occurrence category:	Serious incident	
Primary occurrence type:	Controlled flight into terrain	
Location:	Barwon Heads/Geelong (ALA), Victoria	
	Latitude: 38° 15.58' S	Longitude: 144° 25.63' E

Aircraft details

Manufacturer and model:	Piper Aircraft Corp PA-31-350	
Registration:	VH-JQS	
Serial number:	31-7552095	
Type of operation:	Private - Test & Ferry	
Persons on board:	Crew – 1	Passengers - 0
Injuries:	Crew – 0	Passengers - 0
Aircraft damage:	Minor	

Engine failure and fire on ground involving Gippsland Aeronautics GA-8, VH-AJZ

What happened

On 23 March 2017, a Gippsland Aeronautics GA-8 aircraft, registered VH-AJZ, was being used to conduct incendiary bombing aerial work operations[1] in the Prince Regent River area of northern Western Australia (WA). On board were a pilot, a navigator seated in the co-pilot seat and a bombardier in the rear of the aircraft cabin.

While conducting the incendiary bombing operations, the bombardier advised the pilot that he was suffering from motion sickness. The pilot elected to land at Gibb River aircraft landing area (ALA), WA, to take a lunch break and provide the bombardier with time to recover from the motion sickness.

At about 1255 Western Standard Time (WST), the aircraft landed on runway 07 at Gibb River. During the landing roll, the engine failed. The aircraft had sufficient momentum to enable the pilot to turn the aircraft around on the runway and begin to taxi to the parking area at the western end of runway 07. Shortly after turning around, the aircraft came to rest on the runway. The pilot attempted to restart the engine, but the engine did not start. The pilot waited about 10–20 seconds before again attempting to restart the engine.

While attempting the second restart of the engine, the pilot heard a loud noise similar to that of a backfire. The navigator then observed flames and smoke coming from around the front of the engine and immediately notified the pilot. After being notified of the fire, the pilot immediately shut down the engine and switched off the aircraft electrical system.

As the pilot switched off the aircraft electrical system, the navigator located the aircraft fire extinguisher and evacuated from the aircraft through the co-pilot door. After evacuating from the aircraft, the navigator observed fire on the aircraft nose wheel. The navigator had difficulty preparing the fire extinguisher for use and was unable to discharge the fire extinguisher onto the fire.

While the navigator was attempting to extinguish the fire, the pilot exited the aircraft through the pilot door and assisted the bombardier to exit the aircraft. After assisting the bombardier, the pilot moved to the front of the aircraft to assist the navigator with the firefighting. The pilot was able to activate the fire extinguisher and extinguished the fire on the nose wheel. The pilot observed fire continuing to burn within the engine compartment. Due to the heat of the fire, the pilot was unable to access the engine compartment to extinguish this fire. The pilot determined that no more could be done to contain the fire, and therefore, the pilot, navigator and bombardier moved clear of the aircraft to a safe location as the fire continued.

The crew members were not injured. As a result of the fire, the aircraft was destroyed (Figure 1).

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1 Incendiary bombing operations is a method of fire hazard reduction using devices dropped from the aircraft that start fires to conduct controlled burns.

Figure 1: VH-AJZ wreckage

Source: Operator

Pilot comments

The pilot of the aircraft provided the following comments:

- The temperature at Gibb River at the time of the landing was about 33–34 °C.
- There were no abnormal engine indications prior to the engine failing.
- The engine failed in a manner similar to a normal engine shutdown. The pilot had not experienced an engine failure in that manner before.
- The electric fuel pump remained on after landing and throughout the attempted starts. During the attempted starts, the pilot 'cracked' the throttle and advanced the mixture lever while cranking the engine. Between the first and second start attempts, the mixture control was selected to idle cut-off.
- When assisting the bombardier to evacuate, one box of incendiary capsules was removed, however, three or four boxes remained in the aircraft.

Chief pilot comments

The operator's chief pilot provided the following comments:

- Due to the significant fire and heat damage, the cause of the fire could not be determined (Figure 2).
- When taxiing in high ambient temperatures and at low power settings, fuel may vaporise within the mechanical engine fuel pump, and this can lead to the engine failing. When operated in these conditions, the aircraft should be taxied with the electric fuel pump on to prevent fuel vaporisation.

Figure 2: Fire damage to engine

Source: Operator

Engine fire during start emergency procedure

The GA-8 emergency procedures included the 'engine fire during start emergency procedure.' In case of an engine fire during start, the procedural steps to be followed are shown in Figure 3.

Figure 3: GA-8 fire during start on ground emergency procedure extract

During Start On Ground

1. Cranking ....CONTINUE, to get a start which would suck the flames and accumulated fuel through the fuel injector and into the engine.

If engine fails to start:

2. Cranking ....CONTINUE
3. Throttle..FULL OPEN
4. Mixture ....Idle Cut Off
5. Fuel Shutoff Valve ....OFF
6. Ignition ....OFF
7. Master Switches Bus 1 & Bus 2.........................OFF
8. Aircraft ....EVACUATE and extinguish fire using best available means.

Source: Mahindra Aerospace

After the fire was detected, the pilot shut down, rather than continued cranking the engine. After the engine was shut down, the fuel shutoff valve was not selected off.

Safety analysis

The extent of damage to the engine and aircraft prevented the reasons for the engine failure being determined.

The presence of fire on the nose wheel below the engine indicates that the fire was probably fed by a fluid. However, the extent of damage to the engine prevented the reason of the fire being determined.

After identifying the engine fire, the engine was shut down, and cranking was not continued in accordance with the emergency procedure. Cranking the engine may have extinguished the fire before it became unmanageable. After the engine was shut down, the fuel shutoff valve was not closed to provide a barrier between the fuel tanks and the engine. Not completing this step of the engine fire during start emergency procedure increased the likelihood of fire and allowed the fire to intensify.

Findings

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

- The cause of the engine failure and fire could not be determined.
- After the fire was identified, two steps in the emergency procedure were omitted. This included not closing the fuel shutoff valve, which likely resulted in the fire not being extinguished and subsequently intensifying.

Safety Action

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

Aircraft operator

As a result of this occurrence, the aircraft operator has advised the ATSB that they are taking the following safety actions:

Retraining

- The pilot has completed retraining with an emphasis on fire procedures.

Safety message

This investigation highlights the importance of knowing and understanding flight manual normal and emergency procedures. In this accident, steps in the engine fire during start procedures were omitted. When facing a situation as serious as a fire, the published emergency procedures provide the foundation for emergency response management.

General details

Occurrence details

Date and time:	22 April 2017 – 1255 EST	
Occurrence category:	Accident	
Primary occurrence type:	Fire	
Location:	Gibb River ALA, Western Australia	
	Latitude: 16° 25.12’ S	Longitude: 126° 26.77’ E

Aircraft details

Manufacturer and model:	Gippsland Aeronautics Pty Ltd	
Registration:	VH-AJZ	
Serial number:	GA8-05-096	
Type of operation:	Aerial work	
Persons on board:	Crew – 3	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Destroyed	

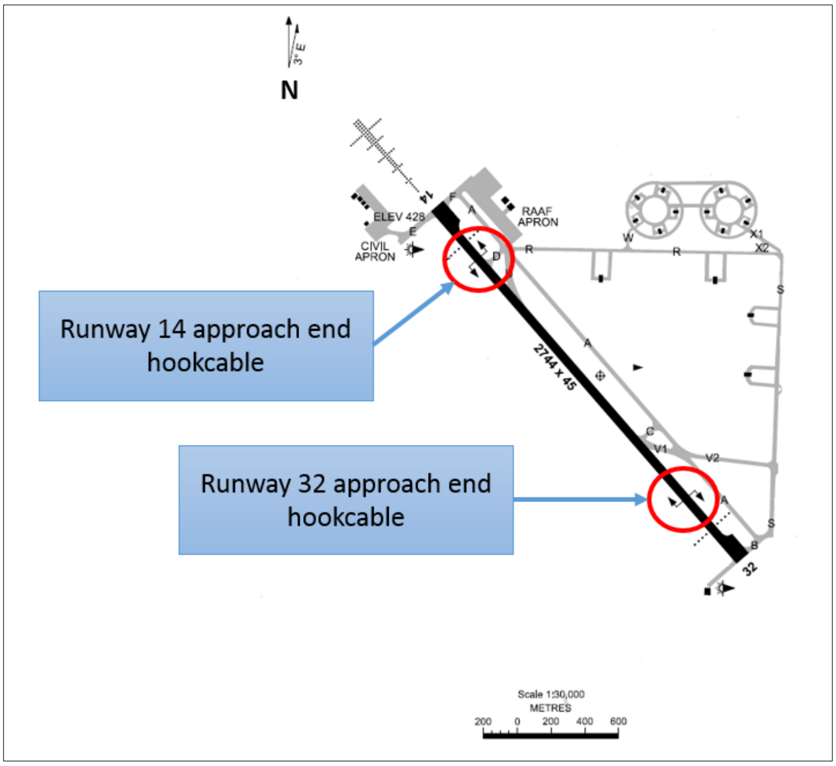
Runway operations with hookcable raised involving Cessna 310, VH-COQ

What happened

On 28 April 2017, at about 0936 Central Standard Time (CST), a Cessna 310R aircraft, registered VH-COQ (COQ), was on approach to land at Tindal Airport, Northern Territory.

Tindal Airport has bi-directional hookcables, used to stop military jets in an emergency, positioned at both ends of the runway (Figure 1). The air traffic control tower had opened for a scheduled military jet departure and was therefore active when COQ made its approach to land. During the tower opening checklist procedure, the tower controller annotated the 'cables' check was completed. About 21 minutes after the tower opened, COQ requested a clearance to land from the base leg position for runway 14. The tower controller scanned the control console, noted that both hookcable pushbutton lights were green, and cleared COQ to land on runway 14.

Figure 1: Tindal airport runway hookcables



Source: Airservices Australia, annotated by ATSB

When COQ was on short final approach to land on runway 14, the pilot noticed the approach end hookcable was raised.[1] They[2] adjusted their aim point beyond the hookcable and landed without incident. The pilot of COQ reported the position of the hookcable to the tower controller, who then rectified the situation.

1 Hookcables are marked by dayglo orange disks.
2 Gender-free plural pronouns: may be used throughout the report to refer to an individual (i.e. they, them and their).

Hookcable status checks

During the air traffic control tower opening procedure, equipment failure resulted in the approach controller working downstairs and the adoption of procedural coordination between the positions of tower controller and approach controller. The tower controller noted that while traffic levels were low at the time of the incident, they were distracted by phone calls and attempts to restore the functioning of the failed equipment. Both the UP and DOWN hookcable positions have green indicator status lights (see *Aircraft arrestor system*).

Aircraft arrestor system

The Tindal Airport aircraft arrestor system (AAS) is used to stop military jets that have a malfunction, which may otherwise result in a runway excursion. The jet will lower a hook at the rear of the aircraft to catch the cable. The AAS includes two cables, one positioned at either end of the runway and displaced from the respective threshold as displayed in Figure 1.

The AAS may be controlled by air traffic control from the air traffic control tower using the cable control console pushbutton selection/indicator lights (Figure 2). There are four pushbutton selection/indicator lights for each hookcable. Two separate green UP and green DOWN pushbuttons are used to select, and then indicate, the desired position for each hookcable.

Figure 2: Tower control console hookcable pushbuttons

Source: Tindal Airport

Enroute Supplement Australia

The Enroute Supplement Australia entry for Tindal Airport includes the following information:

> **Physical characteristics:** Recessed bi-directional hookcables installed. When arrestable aircraft are operating – departure end up, approach end down. In the event of power failure, cables will rise to a height of 10 cm until restored. Recommended that aircraft not approved to trample hookcables confine their operations to between cables outside air traffic control hours.

Enroute Supplement Australia introduction paragraph 22.2 (b) states:

> Pilots should refer to the Pilot Operating Handbook or Flight Manual for specific restrictions for each aircraft. In the absence of any reference to trampling in either the handbook or manual, trampling is not authorised.

Previous incident

On 9 August 2016, an aircraft struck the runway 14 hookcable at Tindal Airport during take-off a few minutes after the air traffic control tower closed. Further information is available from ATSB report *AO-2016-098*.

Safety analysis

The distractions during the opening procedure resulted in the tower controller inadvertently leaving both hookcables in the UP position after they tested the operation of the system. When they received the request to land from COQ, the tower controller subsequently checked the status of the hookcable but they misidentified the two green UP status lights as DOWN indicators, which are also green.

Finding

- When the air traffic tower was opened, the hookcables were inadvertently left in the UP position. When the tower controller subsequently checked the status of the hookcable before clearing COQ to land, they incorrectly identified the green UP light as the green DOWN light and cleared COQ to land.
- The pilot detected the raised cable and adjusted their aim point to ensure they landed past the raised cable.

Safety action

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

Air traffic service provider

As a result of this occurrence, the air traffic service provider has advised the ATSB that they are taking the following safety action:

The possibility of changing the colour of the UP lights will be investigated through an engineering process to better differentiate between the UP and DOWN positions (this will be for all our sites that have arrestor systems). Furthermore, due to the relative low number of civilian aircraft operating at Tindal Airport, Tindal air traffic control will be advising the position of the cable with every landing and take-off clearance given to civilian aircraft. This will help force the controller to verify the position of the cable in addition to the conduct of the instrument scan.

Safety message

This incident highlights the risks of expectation bias. The tower controller observed two green lights on the control console, but did not recognise they were the UP indicators. However, the design of the indicators, where green lights can have two different meanings, removes the usefulness of the colour of the lights in determining whether the hookcable is up or down.

The pilot detected the problem in time to avoid trampling the hookcable during the landing. However, pilots should take note that the hookcables will automatically raise in the event of a power failure.

General details

Occurrence details

Date and time:	28 April 2017 – 0936 CST	
Occurrence category:	Incident	
Primary occurrence type:	Procedural error	
Location:	Tindal Airport, Northern Territory	
	Latitude: 14° 31.27’ S	Longitude: 132° 22.67’ E

Aircraft details

Manufacturer and model:	Cessna Aircraft Company 310R	
Registration:	VH-COQ	
Serial number:	310R1643	
Type of operation:	Charter - passenger	
Persons on board:	Crew – 1	Passengers – 1
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Partial engine failure involving Cessna 210, VH-EGB

What happened

On 12 May 2017, a Cessna 210M aircraft, registered VH-EGB, departed Broome, Western Australia (WA) on a freight charter flight with the intended destination of Fitzroy Crossing, WA.

About one hour into the flight, at about 1027 Western Standard Time (WST), the pilot noticed on the engine data monitor (EDM) that the fuel flow was fluctuating between 40 and 65 litres per hour. The pilot then confirmed that the analogue fuel flow gauge was also fluctuating and enriched the fuel mixture to see if that would stabilise the fuel flow, but the fluctuations continued.

The pilot then completed the fuel vaporisation checklist and switched the selected fuel tank from the right to the left. When the pilot selected the fuel pump on, in accordance with the checklist, the fuel flow initially indicated a rise, then stabilised to normal.

About 20 seconds later, the engine surged and then stopped, but the propeller was still turning. The engine RPM and fuel flow reduced to zero. At that time, the aircraft was 25 to 30 NM beyond Liveringa, so the pilot turned towards that airfield.

The pilot then conducted the engine restart procedure, leaving the left fuel tank selected. The mixture was already fully rich, with the throttle half open. The pilot selected the fuel booster pump on low for three seconds and then increased the throttle to full.

The engine restarted, but was coughing and surging and not producing enough power to maintain level flight at 9,500 ft above mean sea level. The pilot reduced the throttle to lessen the engine surges and set the attitude to maintain an airspeed of 80 kt, which was the best glide speed for that weight. In that configuration, the aircraft was descending at about 600 ft per minute.

The pilot broadcast a Mayday call and then reduced the power to just above idle, where it was running the smoothest. The fuel boost pump was also selected off, which reduced the surging. The aircraft was then descending at about 400 ft per minute. The pilot conducted a straight-in approach to join a five-mile final approach for runway 25 at Liveringa, maintaining additional height (to a normal approach) in case the engine stopped completely, requiring a glide approach and landing.

During the approach, the pilot observed that the cylinder head temperature (CHT) had dropped from above 337º (when they had conducted a trend measurement a few minutes before the engine issues started), to below 200º. The EDM display bar graph of each CHT would normally be at 5 or 6, but were at or below 2, with one cylinder on 0.

The aircraft landed without further incident. After landing, the pilot phoned a maintenance engineer, who advised the pilot to conduct a visual inspection. The pilot observed a fuel outlet valve that had sheared off, but as it was an overflow valve, would not have caused the power loss. The pilot then performed engine run-ups with all indications normal.

Pre-flight

Prior to the flight, the pilot conducted fuel drains, with no water or other contaminants found in the fuel.

Engineering report

The aircraft had just had a 200-hourly maintenance inspection. It was the first flight after the maintenance.

The post-incident inspection found that the fuel fluctuations probably resulted from a full or partial blockage of the fuel vent system.

Rough running and engine stoppage

The operator conducted an investigation into the incident and found the following.

- Although the pilot selected the fuel pump to low, when the throttle is then moved forwards of 19 inches of manifold pressure, an actuator automatically switches the fuel pump to high flow.
- The combination of the fuel mixture in the full rich position and the fuel pump at high flow probably introduced too much fuel into the engine, extinguishing the combustion process. As the aircraft was then at about 9,000 ft, the fuel to air ratio became high enough to result in the engine stopping.
- The pilot's comment that the engine subsequently ran better at lower power setting and the low CHT, suggests that the engine mixture was overly rich.

Cessna service information letter (SIL) SE 79-25, *Fuel flow stabilization*, provided information to aid in the recognition and prevention of excessive fuel vapour accumulation in the fuel system. It stated that 'indications of fuel vapour accumulation are fuel flow gauge fluctuations greater than 5 lbs/hr. This condition with leaner mixtures or with larger fluctuations may result in power surges.'

Findings

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

- The fuel vent system was probably partially or fully blocked, resulting in fuel flow fluctuations.
- The engine probably stopped due to over-rich fuel mixture.

Safety action

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

Aircraft operator

As a result of this occurrence, the aircraft operator has advised the ATSB that they are taking the following safety actions:

Notice to aircrew

The company issued a notice to all flight crew and included Cessna service information letter (SIL) SE 79-25. The SIL included the fuel flow stabilisation procedure, what stated 'Reset the mixture as required'. The notice advised flight crew regarding the 'reset', to first lean the mixture to peak exhaust gas temperature (EGT), then enrich to the company standard operating procedures setting of 75º rich of peak EGT, as 'Placing the mixture to rich will most likely cause engine stoppage at altitude due to an incombustible mixture'.

Maintenance

Closer inspections of fuel tank vent systems are to be carried out during scheduled maintenance.

Daily inspection

Flight crew are to check the fuel vent as part of the daily inspection of aircraft.

Safety message

This incident highlights the importance of good decision making following an engine failure or malfunction. The pilot maintained as much altitude as was safely possible, to increase the glide distance. After turning towards the nearest airfield, the pilot also kept a lookout for suitable forced landing sites.

It further highlights the need for unambiguous actions in emergency procedure checks to prevent an event from escalating.

General details

Occurrence details

Date and time:	12 May 2017 – 1030 WST	
Occurrence category:	Serious incident	
Primary occurrence type:	Engine failure or malfunction	
Location:	near Liveringa, Western Australia	
	Latitude: 18° 03.00' S	Longitude: 124° 10.00' E

Aircraft details

Manufacturer and model:	Cessna Aircraft Company 210	
Registration:	VH-EGB	
Serial number:	21062858	
Type of operation:	Charter- Freight	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

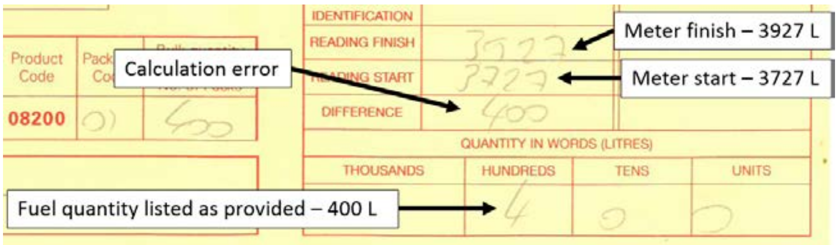
Fuel exhaustion and forced landing involving Beech 58, VH-PBU

What happened

On the morning of 15 June 2017, the pilot of a Beech 58 aircraft, registered VH-PBU, operated by Savannah Aviation, contacted a refueller at Mount Isa Airport, Queensland (Qld) and requested 400 L of fuel be added to the aircraft. The pilot then left the airport and was not present for the refuelling. The refueller attended the aircraft and provided 200 L of fuel. After the refuelling, the refueller completed a fuel delivery receipt (Figure 1). On this delivery receipt the refueller recorded fuel meter readings starting at 3,727 L and finishing at 3,927 L, a difference of 200 L. The refueller recorded the amount provided as 400 L and placed a copy of the delivery receipt through an aircraft window. The refueller then left the aircraft prior to the pilot returning.

After returning to the airport, the pilot of the aircraft collected the fuel delivery receipt and noted 400 L as the quantity listed. However, the pilot did not cross-check the meter readings recorded on the delivery receipt to verify the amount provided. The pilot recorded 400 L of fuel being added in the aircraft fuel log and calculated the total fuel on board to be 570 L. The pilot then cross-checked the fuel added by observing that the fuel gauges had risen since the last flight. The combined fuel capacity of the aircrafts main tanks was 628 L. The pilot then completed two short flights.

Figure 1: Extract of fuel delivery receipt



Source: Queensland Police Service

At the end of the day, the refueller totalled the daily fuel delivery quantities and detected a 200 L discrepancy between the recorded deliveries and the meter readings. The refueller identified that the discrepancy was due to an error in the refuelling of VH-PBU. The refueller immediately went to the aircraft to notify the pilot of the error, however the refueller was not able to locate the pilot. The refueller was then distracted by a phone call and forgot about the refuelling error.

On 19 June, the aircraft was ferried from Mount Isa to Burketown Airport, Qld.

On 20 June, a second pilot conducted a passenger charter flight in the aircraft from Burketown. As this pilot prepared to depart on this flight, a passenger commented on the low fuel level indicated on the aircraft fuel gauges. The pilot reviewed the fuel log which showed 332 L on board. The pilot then cross checked the fuel log calculations against the fuel gauges and was satisfied that the calculations were correct. After the flight, this pilot contacted the pilot who had organised the previous refuelling to confirm that the amount of fuel on board the aircraft was consistent with that in the fuel log. The refuelling pilot confirmed that the amount should be correct. The second pilot conducted three more flights that day. After the second flight, a further 100 L of fuel was added to the aircraft.

On the morning of 26 June 2017, the second pilot prepared to conduct a ferry flight in the aircraft from Burketown to Normanton Airport, Qld. The pilot checked the fuel log which showed 248 L to be on board the aircraft. At about 0815 Eastern Standard Time (EST), the flight departed Burketown, the pilot was the only person on board. The take-off and climb were uneventful.

About 10 NM north of Normanton, the aircraft descended through about 3,500 ft above mean sea level. At this time, the right engine began to surge and the pilot observed fluctuations in fuel flow for the right engine. The pilot selected the right engine low pressure fuel boost pump to on, however, the surging continued. The pilot then used the fuel selector to crossfeed fuel from the left fuel tank to the right engine. After selecting crossfeed from the left main tank, the surging stopped and the right engine resumed normal operation.

About 20 to 30 seconds after selecting crossfeed, both engines began surging. The pilot selected the high pressure fuel boost pumps on for both engines, selected mixture to full rich, advanced the propeller control and advanced the throttles. As the aircraft descended through about 2,000 ft, the engines continued surging. About 20 to 30 seconds later, both engines failed.

After the engines failed, the pilot feathered[1] both propellers. The pilot determined that the aircraft had insufficient energy to glide to Normanton Airport and selected a clear paddock as suitable for a forced landing. The pilot observed a powerline on the southern boundary of the paddock and left the landing gear retracted until they were assured the aircraft would clear the powerline.

After determining that the aircraft would clear the powerline, the pilot lowered the landing gear and landed in the field. During the landing roll the aircraft impacted a number of bushes.

The pilot was not injured during the incident, however, the aircraft sustained substantial damage (Figure 2).

Figure 2: Damage to right wing

Source: Queensland Police Service, annotated by ATSB

Operator refuelling procedure

The operator's operations manual contained the following guidance on recording fuel uplift following refuelling:

> *The crew member supervising refuelling is to note the fuel meter readings before and after fuel delivery and confirm that the correct amount is entered on the fuel record.*

Beech 58 fuel system and management

Accurate fuel determination

Due to the design of the main fuel tanks, unless the tanks were full, it was not possible to determine fuel quantity in each tank by visual inspection or through the use of a dipstick. The

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1 Feathering: the rotation of propeller blades to an edge-on angle to the airflow to minimise aircraft drag following an in-flight engine failure or shutdown.

exact quantity of fuel on board could only be determined when the tanks were filled. Fuel quantity was therefore estimated through the use of a fuel log.

Fuel usage calculations

The operator specified a cruise fuel flow rate of 128 L/hr for the aircraft, a cruise-climb fuel flow rate of 160 L/hr and an allowance of 10 L for engine start and taxi. Company pilots used these figures to calculate the amount of fuel used during flight and deducted this amount from the fuel on board at the start of the flight to calculate current fuel on board. After refuelling, the amount uplifted was added to the fuel log prior to the next flight.

Fuel calibration card

The pilots crossed-checked the fuel log against the aircraft fuel gauges to determine the accuracy of the fuel log calculations. To assist with this check, the aircraft had a fuel calibration card. The data for this card is compiled during maintenance, the aircraft is fuelled with known amounts and these amounts are checked against the aircraft gauge readings in order to calibrate the gauges. The results are recorded on the card. The fuel calibration card is mounted on the instrument panel immediately adjacent to the fuel gauges.

Figure 3: VH-PBU fuel calibration card

FUEL CALIBRATION LITRES

	0	1/4	1/2	3/4	F
LH USEABLE	0	100	165	235	316
RH USEABLE	0	70	155	250	315

AIRCRAFT VH- PBU DATE 29/06/2015

Source: Operator

The Beech 58 also provides external fuel gauges for the main tanks mounted on the wings. The use of these gauges is not specified in the operations manual. Company pilots did not use the external fuel gauges to verify fuel log calculations.

Guidelines for aircraft fuel requirements

The Civil Aviation Safety Authority advisory publication, *CAAP 234-1(1): Guidelines for aircraft fuel requirements*, provides the following guidance for fuel quantity cross-checking:

> *Unless assured that the aircraft tanks are completely full, or a totally reliable and accurately graduated dipstick, sight gauge, drip gauge or tank tab reading can be done, the pilot should endeavour to use the best available fuel quantity cross-check prior to starting. The cross-check should consist of establishing fuel on board by at least two different methods.*

Refuelling pilot comments

The pilot who requested the refuelling on 15 June provided the following comments:

- It would be beneficial to be present when the aircraft is being refuelled. In addition, more diligence should be taken to cross-check the meter readings when reviewing the fuel delivery receipt.
- There were opportunities over the days following the refuelling error for the error to be communicated, however, this did not occur.
- The fuel gauges in the aircraft generally showed an indication of full when the aircraft was loaded with more than three-quarters of tank capacity. After the refuelling on 15 June, the gauges indicated about three-quarters full, therefore the refuelling pilot believed the amount of fuel on board matched the amount calculated in the fuel log.

Forced landing pilot comments

The pilot who was in command of the aircraft at the time of the forced landing provided the following comments:

- The normal method of verifying the accuracy of the fuel log was to cross-check against the fuel gauges. The only other way to accurately determine the fuel on board was to completely fill the main fuel tanks. The operator had no set schedule for filling the main fuel tanks to verify the accuracy of the fuel log. Filling the tanks to full only occurred when required by flight planning requirements.
- Prior to the incident flight, the fuel gauges indicated about a quarter full. The pilot calculated that the flight from Burketown to Normanton would use about 80 L of fuel.
- In normal operations, the right main fuel tank fed fuel to the right engine and the left main fuel tank fed fuel to the left engine.
- The company operated a number of Beech 58 aircraft. The fuel indication calibrations were different in each aircraft. The pilot had not flown PBU regularly, and therefore was not familiar with the fuel gauge readings expected for different fuel loads in this aircraft. The aircraft contained a fuel gauge calibration card (Figure 3) which was only a general guide as to the fuel quantity indication.

Previous occurrence

A review of the ATSB database identified a previous fuel related event involving a Beech 58 aircraft: *Fuel related event involving Beech BE58, VH-ECL, 111 km E of Tindal Aerodrome, NT on 14 August 2013*. The incident is summarised below:

ATSB investigation AO-2013-131

On 14 August 2013, the pilot of a Beech BE58 aircraft, registered VH- ECL, was preparing for a charter flight from Tindal to the Borroloola aeroplane landing area, Northern Territory.

Using the operator’s elected fuel flow rate for the aircraft of 125 L/hr, the pilot calculated that a minimum of 545 L of fuel was required. The pilot elected to carry 570 L. In preparation for the flight, the pilot referenced the fuel log, which indicated that about 267 L of fuel was on board the aircraft. Consequently, the pilot refuelled the aircraft, adding about 153 L into each of the main fuel tanks.

During the cruise, the pilot observed the fuel quantity gauge for the right main fuel tank reading zero, but the fuel flow, and engine temperature and pressure indications were normal. The aircraft landed at Borroloola and the passengers disembarked. The pilot re- checked the fuel calculations and determined that there was sufficient fuel on board for the return trip. The pilot noted that the right fuel quantity gauge was still reading zero and the fuel quantity gauge for the left main tank was indicating about three-quarters full.

On the return flight, when about 50-60 NM from Tindal, the right fuel flow gauge dropped to zero. The pilot shut down the right engine, notified air traffic control and conducted a single-engine landing at Tindal.

This incident highlighted the importance of establishing known fuel status regularly and the need to use multiple sources to determine fuel quantity. This is particularly important for determining accurate fuel flow rate calculations and when the fuel quantity on board can only be accurately determined when the fuel tanks are full.

Safety analysis

On 15 June 2017, the aircraft was refuelled with 200 L of fuel, however, 400 L was recorded as being delivered. The pilot did not detect the discrepancy in the fuel delivery receipt and added 400 L to the aircraft fuel log.

The refuelling procedures did not require a cross-check to verify the amount of fuel provided and the error was not detected by the refueller until the end of the day. While an attempt to communicate this error was made, ultimately it was not communicated to the pilot or the operator.

Over the next 11 days, the aircraft completed a number of flights operated by both pilots without the discrepancy between the calculated and actual fuel on board being detected.

Prior to the flight on 26 June, the fuel log showed the aircraft as having 248 L on board. The pilot verified this value using the aircraft fuel gauges which indicated the tanks were about one quarter full. At this time, the actual fuel on board would have been about 48 L. The fuel calibration card indicated that for a reading of about one quarter full, the actual fuel on board should be 170 L. This indication corresponds more closely to the calculated fuel on board (248 L) than the actual amount of fuel likely to have been on board the aircraft at that time (48 L) and may have reinforced the pilot's assumption that the fuel log calculation was correct.

The aircraft departed Burketown with insufficient fuel to complete the flight to Normanton. As the aircraft descended towards Normanton, the quantity of fuel in the right main tank was exhausted and the right engine began to fail. The pilot was able to keep the engine running momentarily by cross-feeding fuel from the left main tank. Shortly after selecting crossfeed, the quantity of fuel in the left main tank was also exhausted and both engines failed.

Findings

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

- The refueller recorded 400 L on the fuel delivery receipt when only 200 L had been provided. The refuelling procedures did not contain a cross-check to verify the amount of fuel provided and this error was only detected by the refueller at a later stage. The error was not communicated.
- The refuelling pilot did not detect the discrepancy in the fuel delivery receipt and recorded an incorrect amount of 400 L added fuel in the fuel log. Over subsequent flights the discrepancy between the calculated and actual fuel on board was not detected by either pilot.
- The engines failed due to fuel exhaustion.

Safety action

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

Fuel provider

As a result of this occurrence, the fuel provider has advised the ATSB that they are taking the following safety action:

Change to procedure

- The fuel delivery procedure has been amended so that pilots must now review and sign the fuel delivery receipt after receiving fuel.

Safety message

This incident underlines the importance of communication once an error has been discovered. The refuelling error was discovered 11 days prior to the incident flight, however, this was not communicated to the operator or pilots. Knowledge of the error would have enabled the pilots to correct the fuel log and avoid the incident.

Accurate fuel management is critical to the safe operation of an aircraft. The ATSB publication *Avoidable Accidents No. 5 - Starved and exhausted: Fuel management aviation accidents* provides the following key messages:

> *Accurate fuel management starts with knowing exactly how much fuel is being carried at the commencement of a flight. This is easy to know if the aircraft tanks are full, or filled to tabs. If the tanks are not filled to a known setting, then a different approach is needed to determine an accurate quantity of usable fuel.*
>
> *Accurate fuel management also relies on a method of knowing how much fuel is being consumed. Many variables can influence the fuel flow, such as changed power settings, the use of non-standard fuel leaning techniques, or flying at different cruise levels to those planned. If they are not considered and appropriately managed then the pilot's awareness of the remaining usable fuel may be diminished.*
>
> *Keeping fuel supplied to the engines during flight relies on the pilot's knowledge of the aircraft's fuel supply system and being familiar and proficient in its use. Adhering to procedures, maintaining a record of the fuel selections during flight, and ensuring the appropriate tank selections are made before descending towards your destination will lessen the likelihood of fuel starvation at what may be a critical stage of the flight.*

General details

Occurrence details

Date and time:	June 2017 – 0810 EST	
Occurrence category:	Accident	
Primary occurrence type:	Fuel exhaustion	
Location:	6 km N of Normanton Airport, Queensland	
	Latitude: 17° 37.87' S	Longitude: 141° 04.57' E

Aircraft details

Manufacturer and model:	Beech Aircraft Corporation 58	
Registration:	VH-PBU	
Serial number:	TH-407	
Type of operation:	Charter - ferry	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Substantial	

Helicopters

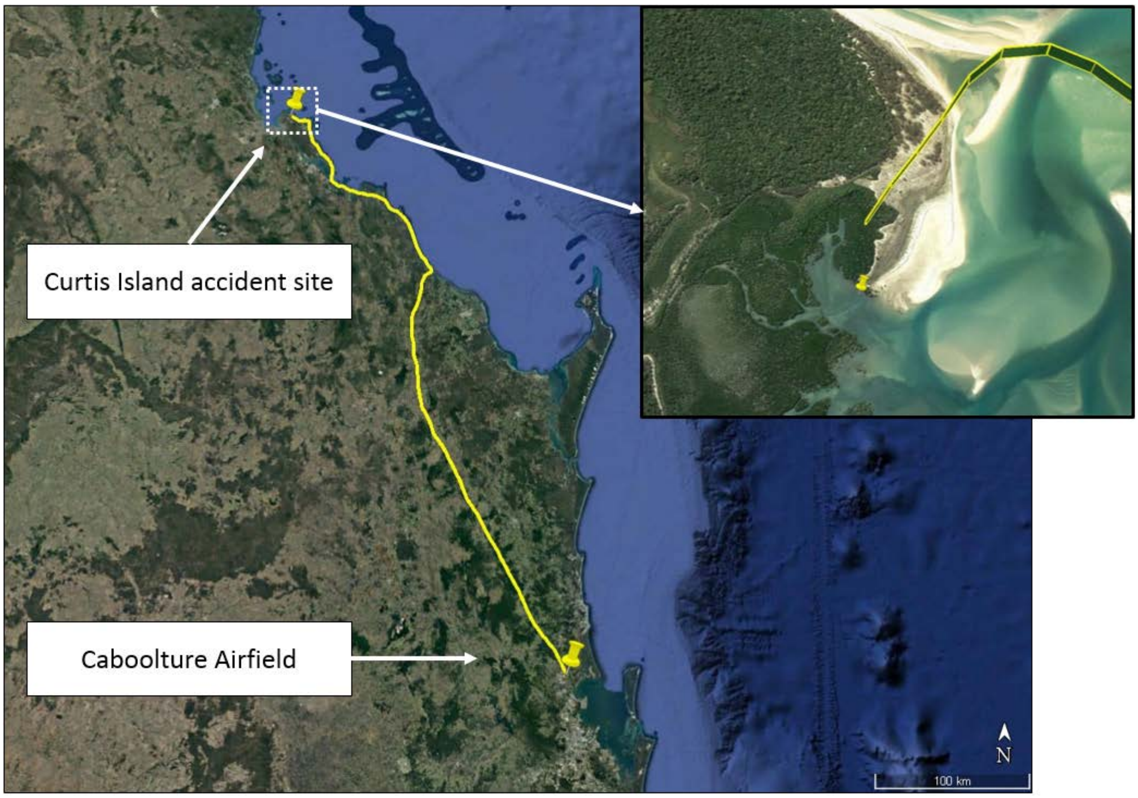
Collision with terrain involving Agusta AB206, VH-DPU

What happened

On 17 March 2017, an Agusta AB206A helicopter, registered VH-DPU, departed Caboolture Airfield, for Curtis Island, Queensland, on a private flight. On board the helicopter were the pilot and one passenger.

Prior to departure, the helicopter had been refuelled to full at Caboolture Airfield. The helicopter was flown for about 2.5 hours north, initially inland, then coastal to the north of Curtis Island where the pilot planned to land for a fishing trip (Figure 1). At 1142 Eastern Standard Time (EST), the pilot sent a text message from their[1] mobile phone to a friend monitoring their search and rescue time, which indicated they had arrived at their planned fishing spot.[2] At 1144, the helicopter was recorded on an OzRunways application, running on a mobile device, at the north-east coast of Curtis Island heading 209°.

Figure 1: VH-DPU track and accident site (drop pin)



Source: OzRunways track on Google earth, annotated by ATSB

The pilot reported that they tracked along the coast at about 500 ft and then turned the helicopter to the left from the coast to identify their planned landing site. The pilot was uncertain of the number of turns conducted near the landing site, but believed that it was during the second turn at about 50 ft and 40–60 kt that they suddenly felt there was ‘no power’. The pilot reported that the helicopter made one uncontrolled turn through about 360° during the descent, and at some stage

1 Gender-free plural pronouns: may be used throughout the report to refer to an individual (i.e. they, them and their).
2 The pilot was aware that there was no mobile phone coverage at ground level.

they lowered the collective with the assumption the engine had failed.[3] The main rotor blades appeared to be flapping[4] violently to the point the pilot thought the blades were going to separate from the helicopter before impact with the water. The pilot and passenger reported that they did not see any caution lights or hear any audio alarms before or during the accident sequence.

The helicopter initially impacted upright in the water before the airframe separated from the helicopter skids, turned through 180° and rolled onto its left side (Figure 2). This placed the passenger, in the left seat, under water. As soon as movement ceased, the pilot tried to pull the passenger's head above the water, but the passenger was initially trapped in their harness. The passenger subsequently struggled free from their harness without unfastening it. The pilot and passenger exited the helicopter, at which stage the pilot reported to the passenger that they felt paralysed below the waist.

Figure 2: VH-DPU accident site at low tide

Source: Queensland Police Service

The pilot and passenger decided to attempt to retrieve the emergency position indicating radio beacon (EPIRB),[5] which was located in a bracket mount on the passenger side of the helicopter, which was under water. On their third unsuccessful attempt to retrieve the EPIRB, the pilot became temporarily entangled with the helicopter controls and headset under water and no further attempts were made. The passenger then assisted the pilot, who was unable to move their legs, to above the high tide mark along with the provisions they could retrieve from the helicopter, which included a first aid kit.

On 18 March 2017 (the next day), a member of the public sighted debris north of Curtis Island, which they reported to the police. The recovery of the debris revealed the name of the accident passenger's daughter. When the police contacted the passenger's family, the family told the police the helicopter was overdue. The Australian Maritime Safety Authority then coordinated the search, which included use of OzRunways data. Although the pilot could see the search and rescue services within their vicinity at times during the search period, they could not signal them. At about 0300 on 19 March 2017, the rescue helicopter located the wreckage and survivors, who were

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[3] 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.

[4] Main rotor blade flap: the movement of a rotor blade in the vertical sense relative to the plane of rotation.

[5] The helicopter was not fitted with an emergency locator transmitter.

transferred to Rockhampton Hospital. The pilot and passenger were seriously injured and the helicopter was substantially damaged.

Fuel on board

The helicopter was originally manufactured with a standard 288 L fuel tank and was subsequently modified with a fuel range extender device, which increased the fuel tank capacity to 344 L. The standard fuel refill port is not located at the top of the fuel tank. The range extender is an L-joint device fitted to the refill port, which raises the height of the refill port to increase the capacity of the fuel tank. It was reported that the helicopter was refuelled to full fuel (344 L) with the addition of 212 L on the morning of the accident by the pilot's maintenance provider. The pilot did not visually inspect the fuel quantity, but noted the fuel gauge indicated full when power was applied to the helicopter.

The manufacturer calculated the helicopter would consume about 100 L per hour of fuel. If the helicopter had full fuel at departure, the manufacturer estimated that after 2.5 hours of flight there should have been about 94 L of fuel on board. This is greater than the quantity of fuel which would activate the low fuel level caution light, which is about 76 L. The pilot reported that the fuel gauge indicated about 25 gallons (95 L) when they conducted their pre-landing checks and the low fuel caution light did not illuminate during the flight. The passenger reported a strong smell of aviation fuel in the water immediately following the accident.

Examination of the wreckage

The aviation loss surveyor appointed by the insurer recovered the helicopter wreckage from Curtis Island to Rockhampton for an initial examination. They found the fuel tank ruptured and fuel present in the fuel filter, which is located in the fuel line between the fuel tank and the engine. They followed the fuel line to the engine fuel control unit and found fuel present on both the inlet and outlet side of the unit. They inspected the engine inlet and outlet, and did not find any obvious damage. They noted one of the rotor blades had very little damage, which indicated to them that there was little rotational energy in the rotor blades at the time of impact.

The surveyor subsequently conducted further detailed inspections of components and parts. They found the drives for the fuel pump, fuel control unit and governor were intact. The engine and transmission chip detectors and filters for the fluid systems (fuel, oil and hydraulic) revealed no evidence of a mechanical failure.

ATSB review of photographic evidence

The Queensland Police Service provided a considerable number of photographs of the wreckage to the ATSB. On review of the photographs, the ATSB could not identify any obvious mechanical fault with the helicopter that was not attributable to accident impact damage. The overhead circuit breaker panel had several tripped circuit breakers, including the warning lights, audio panel and instrument lights circuit breakers. However, it is possible for circuit breakers to trip as a result of impact forces.

Testing the warning and caution lights, and checking the overhead circuit breakers, are items in the flight manual checklists for before and after engine start. The pilot reported that these checks were performed before departure from Caboolture. They made radio transmissions during the flight and communicated with the passenger using headsets, which indicates that the audio circuit breaker was in prior to the accident. The ATSB noted that the condition of the main and tail rotor blades indicated there was little rotational energy in the blades at the time of impact (Figure 3).

Figure 3: VH-DPU main and tail rotor blades

Source: Queensland Police Service

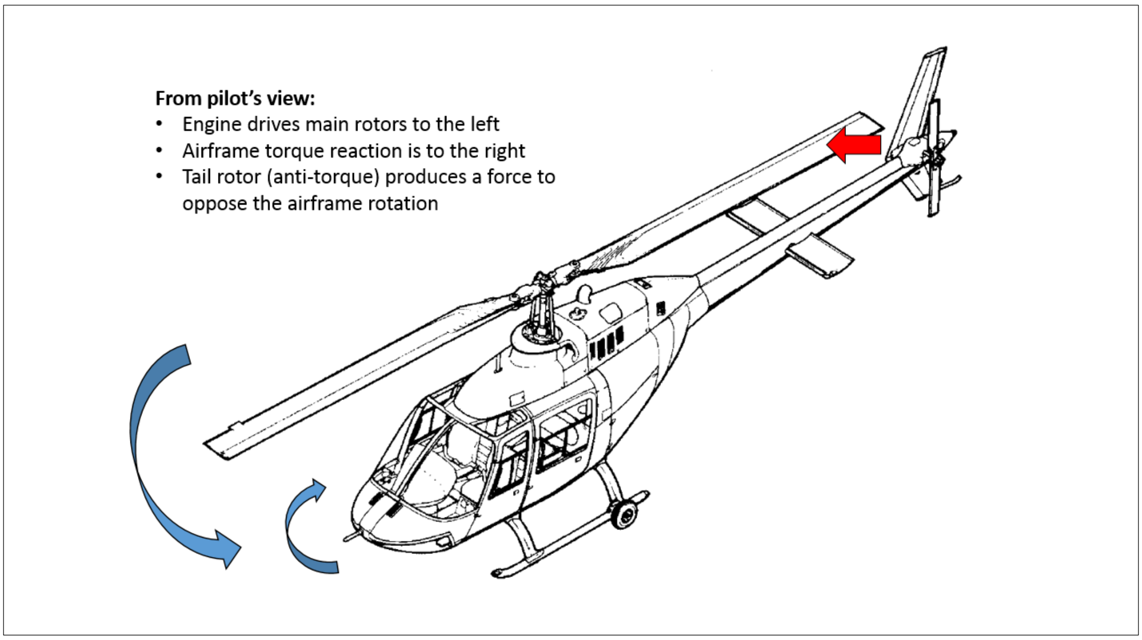
Engine out warning

The helicopter was fitted with an 'engine out' warning light and audio alarm (horn). The warning activates at 55 (+/- 3) per cent engine gas generator speed. Activation of the warning light is checked when the battery is switched on in the engine pre-start check. The pilot reported that this was checked serviceable before the accident flight in accordance with the checklist. The pilot and passenger reported that they did not observe any warning lights or hear any alarms during the accident sequence. The ATSB inspected the 'engine out' light bulb and found no evidence of stretching or ductile failure. Substantial impact force is required to damage a light bulb filament and a hot filament will sustain damage at a lower force than a cold filament. The absence of damage to the filament, by itself, is inconclusive.

Torque effect

The AB206A helicopter engine drives the main rotors to the left, when viewed from the pilot's seat. This subjects the airframe to a turning moment to the right (Figure 4). The tail rotor provides the anti-torque force to prevent the engine power from turning the airframe to the right. It is mechanically connected to the main rotor system through the main rotor gearbox and operates at a speed, which is much higher, but proportional to the main rotors. A reduction in rotor speed will reduce the anti-torque force provided by the tail rotor and can lead to loss of tail rotor effectiveness and consequently loss of directional control.

Figure 4: General effect of engine torque



Source: Bell Helicopter, annotated by ATSB (Agusta AB206A rotors turn in the same direction)

Rotor stalls

During a powered descent, or a descent following an engine failure, the helicopter experiences a rate of descent airflow in opposition to the rotor induced airflow.[6] This can increase the rotor blade's angle of attack[7] to the point that the root of the blades may stall.[8] Decaying rotor speed is the initial indication. If the pilot does not respond to the early symptoms by lowering the collective, then the stalled region spreads outward towards the rotor tips. A complete rotor stall will lead to a loss of directional control, severe blade flapping and possible blade failure from high blade coning angles.[9]

Further information on rotor stall and how to recover from low rotor speed is available from the United States Federal Aviation Administration *Helicopter flying handbook*, chapter 11: Helicopter emergencies and hazards.

Pilot reaction to low rotor speed

If a high collective setting is in use, then the rotor blades will have a high pitch setting with associated high rotor drag. In the absence of power, or with insufficient power, the high drag will reduce the speed of the rotors.

In 1999, the Flight Safety Foundation published the results of a United Kingdom Civil Aviation Authority (UK CAA) *Simulator-based study of helicopter pilots' reaction times*.[10]

6 Induced airflow is airflow drawn in and accelerated by the rotor disc.

7 The angle of attack is the angular difference between the chord of the blade (straight line between the blade's leading edge and trailing edge) and the relative airflow.

8 Aerodynamic stall: occurs when airflow separates from the rotor blade's upper surface and becomes turbulent. A stall occurs at high angles of attack, typically 16˚ to 18˚, and results in reduced lift and increased drag.

9 Coning of main rotor blades: the upwards movement of the main rotor blades while they are rotating. This is usually in response to an increase in aerodynamic force as a result of a control input from the pilot. It is more pronounced at high weights and/or low main rotor speed.

10 FSF Helicopter Safety (1999): Simulator-based study of emergencies yields insights into pilots' reaction times. Vol. 25 No. 2.

The research was conducted in response to three recommendations from fatal helicopter accidents in the UK in 1981, 1986 and 1992. The accidents were associated with low rotor speed at impact.

The UK CAA found that 'pilots immediately detected failures involving variables within their focus of attention, but required more time to detect alerting cues outside their focus of attention.' It also found that 'auditory cues were probably the most significant alerting stimuli in each type of helicopter, and some differences in detection times correlated with the degree to which auditory cues were 'attention getting'.'

Low rotor speed warning

The AB206A helicopter flight manual emergency procedures section included the following details within the caution system:

> Caution/warning light: ROTOR LOW RPM (audio & light) (if installed)
>
> Fault and remedy: Rotor RPM is below normal. Reduce collective pitch and check that throttle is full open.

The 206A was manufactured by Agusta,[11] in Europe, and by Bell Helicopter in North America and Canada. The accident helicopter was an Agusta AB206A, manufactured for the Austrian Army in 1969 and registered in Australia on 7 April 2011. The pilot was unsure if the helicopter was fitted with a low rotor speed warning system, but the former owner reported that it was not fitted. The manufacturer reported that at the time of the delivery of the helicopter from production, the low rotor speed warning system was not fitted to the AB206A helicopters. Bell Helicopter have published approved data to retrofit a low rotor speed warning system to some serial numbers of their 206A helicopters (service instruction 206-74), but there is currently no approved data to retrofit a low rotor speed warning system to the Agusta AB206A.

Certification specifications

The accident helicopter was operating under the Civil Aviation Safety Authority type acceptance certificate for the AB206A, which referenced the European Aviation Safety Agency (EASA) issued type certificate data sheet for the certification specifications (CS). VH-DPU was manufactured in 1969 in Italy to the United States (US) Civil Aeronautics Board[12] standard Civil Air Regulations Part 6 (CAR 6) Rotorcraft airworthiness: normal category, dated 20 December 1956.

Current EASA (*CS*-27) and US Federal Aviation Administration (*27.33*) certification specifications for 'Main rotor speed and pitch limits' include the following:

> For each single engine helicopter…there must be a main rotor low speed warning.

In accordance with CS 27.33 (e) (1) and (3):

> The warning must be furnished to the pilot in all flight conditions…when the speed of a main rotor approaches a value that can jeopardise safe flight, and, a visual device that requires the attention of the crew within the cockpit is not acceptable by itself.

The CAR 6 standard did not require the installation of a low rotor speed warning system, only instrument markings to indicate the limits beyond which operation is dangerous. Nevertheless, from the AB206B model, the low rotor speed warning system was factory installed as standard.

Previous accidents

Low rotor speed

The ATSB investigation of a forced landing involving a Robinson R44 helicopter (*AO-2016-172*) on 17 December 2016 indicated that the pilot was alerted to a low rotor speed condition by the associated warning horn. The pilot noted the rotor speed had reduced to 85 per cent at the time

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[11] Agusta are now Leonardo Helicopters

[12] Precursor to the US Federal Aviation Administration

the warning directed their attention to the rotor speed. They were conscious of a potential rotor stall condition if they allowed the rotor speed to reduce below 80 per cent while they positioned the helicopter for an autorotation to a safe landing site.

Active noise reduction headsets

The pilot of VH-DPU was wearing an active noise reduction (also known as noise cancelling) headset and was not alerted to any unusual noises before they experienced what they described as 'no power.' Several pilots involved in previous accidents have commented that the use of these headsets may have impeded their ability to hear aircraft warning devices or the early signs of an impending mechanical failure.

For further information see the following ATSB reports:

AO-2012-096 Ditching involving Robinson R44, VH-CYH

AO-2016-134 Wheels up landing involving Cessna 210, VH-UPN

AO-2017-041 Forced landing involving Robinson R44, VH-MQE

Emergency locator transmitters

In 2013, the ATSB published a report on the effectiveness of emergency locator transmitters (ELTs) in aviation accidents (*AR-2012-128*). ELTs are radio beacons carried on aircraft so that in the event of an accident in a remote location the wreckage and survivors can be located quickly by search and rescue services. This increases the chances of survival for the occupants. The report included personal locator beacons (PLBs) and EPIRBs.

Airframe mounted ELTs are designed to automatically activate during a crash, by a g-force activated switch or, less commonly, by a water-activated switch. The report identified safety concerns regarding the operation of ELTs and found that they functioned as intended in about 40–60 per cent of accidents in which their activation was expected. The report indicated that carrying a PLB (or EPIRB) in place of, or as well as, an airframe mounted ELT will most likely only be beneficial to safety if it is carried on the person, rather than being fitted or stowed elsewhere in the aircraft.

Safety analysis

Accident sequence

The potential wind effect on the helicopter just prior to the accident sequence was not analysed due to the pilot's uncertainty[13] in the number of turns prior to and during the accident sequence and their report of light wind conditions leading up to the accident. The pilot reported that during the approach to land, there was suddenly 'no power' and that they experienced a sudden engine failure. However, the ATSB notes that the symptoms reported by the pilot were similar to the symptoms of a rotor stall.

If a helicopter is in an incipient rotor stall and the pilot either maintains or increases collective, the rotor stall will deepen. In this situation, the helicopter will not respond in the normal and expected manner, instead, rotor speed will decay and the rate of descent will increase. This response by the helicopter could be perceived by the pilot as a loss of power.

During the accident sequence, the airframe separated from the helicopter skids and turned 180°, which indicates that there was a turning moment (torque) on the airframe at touchdown. This is consistent with the pilot's report that the helicopter rotated during the accident sequence. In the event of an engine failure, there will be no turning moment from the engine applied to the airframe. Any turning moment from the tail rotor is easily corrected and becomes negligible at low rotor

[13] The pilot was seriously injured in the accident, which resulted in a 6 week delay before the ATSB were able to interview them.

speed. However, in a rotor stall the engine continues to apply torque to the airframe, which results in an uncommanded turn at low rotor speed.

The separation of the airframe from the landing skids, and final relative position of the airframe and landing skids, was consistent with low forward speed and engine torque combined with low rotor speed at impact. Therefore, the accident was probably the result of a rotor stall, but it was not determined how the helicopter entered the rotor stall. From the evidence available, fuel starvation or fuel exhaustion were considered unlikely.

Caution system

The pilot checked the circuit breakers and tested the caution and warning lights before take-off. Therefore, the circuit breakers, which were found out post-accident, probably tripped as a result of the impact forces. The results of the analysis of the 'engine out' light bulb were inconclusive, but did not contradict the findings of the aviation loss surveyor, who found no evidence of pre-impact mechanical fault. Of note, the pilot was using an active noise reduction headset. Active noise reduction headsets could impair a pilot's ability to hear a warning horn, such as the 'engine out' warning,[14] which is not transmitted through the intercom system, or any subtle pitch changes in rotor speed or engine speed. However, the ATSB did not perform any tests to evaluate this effect.

Low rotor speed warning

Previous research has found that auditory cues can reduce pilot detection time of a problem in an emergency. The current European and United States airworthiness standards for this category of helicopter require a main rotor low speed warning system, but this was not required for the accident helicopter, which was manufactured to 1956 standards. The pilot did not identify a low rotor speed condition before they experienced 'no power' and the helicopter was not fitted with a low rotor speed warning system.

The condition of the rotor blades post-impact indicated there was little rotational energy in the blades at the time of impact. The helicopter could lose rotor speed due to either an engine failure or rotor stall condition. In each case, other than an engine failure close to the ground,[15] the pilot should lower the collective to maintain or recover rotor speed.

It is probable that the helicopter had entered an incipient rotor stall while the pilot's attention was focused on positioning the helicopter for their intended landing site. In the absence of a low rotor speed warning this was initially undetected until the pilot suddenly experienced 'no power', at which stage there was insufficient height to recover. Therefore, the absence of a low rotor speed warning system increased the risk of a loss of control.

Emergency position indicating radio beacon

The helicopter was carrying an emergency position indicating radio beacon (EPIRB), which must be manually activated. However, the pilot was unable to locate and retrieve the beacon from the wreckage in order to activate it after the accident. The pilot reported their arrival at their intended landing spot before the accident occurred, which, in combination with their inability to retrieve and activate the beacon, resulted in a considerable delay after the accident before search and rescue was activated.

The pilot and passenger were found by search and rescue services about 39 hours after the accident. Therefore, the absence of an automatically activated emergency locator transmitter (ELT) and the inability of the occupants to retrieve their EPIRB increased the risks associated with their post-accident survival.

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[14] The 'engine out' warning horn is transmitted through a cabin speaker.

[15] Close to the ground there is no time to enter autorotation and the pilot is only required to raise the collective, as required, to minimise the rate of descent at touchdown.

Findings

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

- It is probable the helicopter experienced a main rotor stall from a low height and low forward speed.
- The helicopter was not fitted with a low rotor speed warning system. A low rotor speed warning system was not a certification requirement for the helicopter at the time of manufacture and there is currently no approved data for the modification. The absence of a low rotor speed warning system increased the risk of the pilot losing control of the helicopter.
- The helicopter was carrying an emergency position indicating radio beacon which was inaccessible after the accident. This resulted in a considerable delay to the search and rescue.
- The pilot reported a sudden loss of power. However, examination of the wreckage by the aviation loss surveyor found no evidence of pre-impact mechanical fault. Fuel starvation or fuel exhaustion were considered unlikely.

Safety message

The pilot reported that it was beneficial to have a first aid kit on board the helicopter, which they retrieved and used following the accident. However, they considered it necessary to carry the emergency position indicating radio beacon on the person, rather than fitted to the helicopter. They further noted that a high quality strobe light would have assisted them to signal their location once search and rescue services were in the vicinity.

The use of active noise reduction (noise cancelling) headsets has become prevalent in aviation. It is, however, important to always consider their compatibility with the aircraft warning systems. The Civil Aviation Safety Authority have published an airworthiness article (previously an airworthiness advisory circular) *AAC 1-43 Noise isolating headsets*, which highlights the potential benefits and risks associated with the use of these headsets.

General details

Occurrence details

Date and time:	17 March 2017 – 1144 EST	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	45 km NNW Gladstone Airport, Queensland	
	Latitude: 23° 29.27’ S	Longitude: 151° 04.33’ E

Aircraft details

Manufacturer and model:	Agusta, S.p.A, Costruzioni Aeronautiche AB 206A	
Registration:	VH-DPU	
Serial number:	8130	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – 1
Injuries:	Crew – 1 (serious)	Passengers – 1 (serious)
Aircraft damage:	Substantial	

Collision with terrain involving Robinson R44, VH-MNU

What happened

On 17 May 2017, the pilot of a Robinson Helicopter R44 II, registered VH-MNU, was conducting aerial work at Moreton Island, Queensland with one passenger on board.

The pilot completed one flight without incident and, after refuelling, departed for a second local flight at about 1005 Eastern Standard Time (EST). At the start of the flight, the wind was from the east-north-east at about 5–6 kt, but increased to about 10 kt.

At about 1130, the helicopter was approximately 50 ft above ground level and tracking in a south-westerly direction at an airspeed of about 10 kt (and groundspeed of about 20 kt), when the pilot commenced a right turn.

The pilot felt a loss of tail rotor effectiveness (LTE) as the helicopter continued to yaw to the right and reported that they were unable to arrest the yaw with left pedal input. The pilot applied forward cyclic to try to increase the helicopter's forward speed, and some right cyclic to try to follow the turn. The pilot hoped the tail rotor effectiveness would return as the helicopter turned back into wind, but as it rotated through about 110 degrees, the rate of yaw started to increase. The pilot then raised the collective in an attempt to increase the helicopter's height above trees, which further increased the yaw rate due to the increase in torque.

The helicopter completed about two full rotations and reached about 80 ft above the ground, when the low rotor RPM warning horn sounded. The pilot immediately lowered the collective and the helicopter descended. The pilot stated that they were going down, and the passenger braced for the impact.

As the helicopter neared treetop height, the pilot deployed the emergency floats. As the floats contacted the trees, the pilot raised the collective to cushion the impact. The pilot and passenger sustained minor injuries and the helicopter was substantially damaged (Figure 1).

Figure 1: Accident site showing damage to VH-MNU

Source: Pilot

Use of emergency floats

The pilot commented that the company pilots had previously discussed the use of the floats in case of having to conduct a forced landing over a treed area. The pilot assessed that the floats would increase the surface area, therefore slowing the helicopter's descent.

Helmet

The pilot was wearing a helmet at the time of the accident. Although the helmet's visor caused the pilot's nose to bleed, the helmet sustained impact and scratch damage that probably prevented the pilot sustaining more serious injuries.

Performance

The helicopter departed for the flight about 36 kg below the maximum take-off weight and had been operating for about 30 minutes using about 30 L of fuel at the time of the accident, and was therefore more than 60 kg below the maximum take-off weight at the time of the accident.

Operator report

The helicopter operator conducted an investigation into the accident and provided the ATSB with a copy of their investigation report. The operator's findings included the following.

- The pilot wrote down their risk considerations prior to the flight and included LTE, but did not include the recovery technique. When the helicopter encountered the initial weathervane LTE, the correct recovery procedure of full left pedal, forward cyclic was not observed.
- Although the pilot had the required training for low-level operations, they had not received specific training for the task.
- The pilot's scan during low-level operation may have been affected by focusing on the map, depicting drop locations.

Loss of tail rotor effectiveness

The United States Federal Aviation Administration (FAA) Helicopter flying handbook

The FAA Helicopter flying handbook chapter 11: Helicopter emergencies and hazards stated that loss of tail rotor effectiveness (LTE) is an uncommanded rapid yaw towards the advancing blade and is an aerodynamic condition caused by a control margin deficiency in the tail rotor. Tail rotor thrust is affected by numerous factors, including relative wind, forward airspeed, power setting and main rotor blade airflow interfering with airflow entering the tail rotor. Several wind directions relative to the nose of the helicopter are conducive to LTE, including the following:

- 120–240º, in which the helicopter attempts to weathervane its nose into the relative wind. The Handbook states 'If the pilot allows a right yaw rate to develop and the tail of the helicopter moves into this region, the yaw rate can accelerate rapidly.
- 285–315°, which can lead to turbulent airflow from the main rotor disc interfering with the tail rotor.
- 210–330°, which can lead to the development of unsteady airflow through the tail rotor.

The FAA handbook warns that a combination of factors in a particular situation can lead to more anti-torque required from the tail rotor than it can generate. In addition, low speed flight activities are a high risk activity for LTE. The FAA handbook advises pilots (among other things) to avoid tailwinds below an airspeed of 30 kt. In addition, it provides the following recovery technique for a sudden unanticipated yaw:

- apply full left pedal while simultaneously moving cyclic control forward to increase speed
- if altitude permits, reduce power
- as recovery is effected, adjust controls for normal forward flight.

Robinson Helicopter Company safety notice SN-42: Unanticipated yaw

The Robinson Helicopter Company advised that to avoid unanticipated yaw, pilots should be aware of conditions that may require large or rapid pedal inputs. They recommend practising slow, steady-rate hovering pedal turns to maintain proficiency in controlling yaw.

Low rotor RPM recovery

The Robinson Helicopter Company R44 II Pilot's operating handbook stated 'To restore RPM, immediately roll throttle on, lower collective and, in forward flight, apply aft cyclic.'

Findings

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

- The combination of low airspeed and turning right with a tailwind contributed to a loss of tail rotor effectiveness. The pilot's response was ineffective at recovering control of the helicopter, particularly given the operation at low height above the trees.

Safety action

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

Helicopter operator

As a result of this occurrence, the helicopter operator has advised the ATSB that they are taking the following safety actions:

- Company pilots are to be briefed and trained on task specific operations.
- A presentation on LTE has been given to all company helicopter pilots.
- The operations manual has been amended to highlight and add more detail to specific task training and pilot limitations.
- Training items have been updated to incorporate scenario/task training flights.
- Company pilots were required to re-read the operations manual, with a focus on the planning section (Part D).
- Company pilots will complete cockpit resource management (CRM) training.

Safety message

LTE

The FAA handbook states: 'In order to avoid the onset of LTE in this downwind condition, it is imperative to maintain positive control of the yaw rate and devote full attention to flying the helicopter'.

Effectiveness of helmets in helicopter operations

The United States Army referenced two United States Army Aeromedical Research Laboratory studies of helmet effectiveness in USAARL report 93-2. The first study from the period 1957–1960 found that fatal head injuries were 2.4 times more common among unhelmeted occupants of potentially survivable helicopter accidents than among occupants wearing the army's APH-5 helmet. The second study from the period 1972–1988 found that the risk of fatal head injury was

6.3 times greater in unhelmeted occupants of potentially survivable helicopter accidents than among occupants wearing the army's SPH-4[1] helmet.

In a separate study (report 98-18) the Army Aeromedical Research Laboratory reviewed 459 accidents in the period 1990–1996 where helmet visor use was verified. They found that visor use was attributed to preventing facial injury in 102 accidents (22.2 per cent) and reducing injury in 13 accidents (2.8 per cent).

This accident highlights the effectiveness of wearing a helmet to prevent a more serious injury. ATSB report AO-2014-058 provides an account of a serious head injury to an R22 pilot who was not wearing a helmet. In a later ATSB report, AO-2015-134, the operator commented that the pilot of an R22 accident would have suffered more serious head injuries if they were not wearing a helmet.

General details

Occurrence details

Date and time:	17 May 2017 – 1130 EST	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	near Bulwer/Moreton Island (HLS), Queensland	
	Latitude: 27° 04.00' S	Longitude: 153° 22.00' E

Helicopter details

Manufacturer and model:	Robinson Helicopter Company R44 II	
Registration:	VH-MNU	
Serial number:	11964	
Type of operation:	Aerial work	
Persons on board:	Crew – 1	Passengers – 1
Injuries:	Crew – 1 Minor	Passengers – 1 Minor
Aircraft damage:	Substantial	

1 SPH-4 was the newer model helmet in use at the time period of the second study.

Forced landing involving Robinson Helicopter R44, VH-MQE

What happened

At about 1500 Eastern Standard Time (EST) on 6 April 2017, a Robinson Helicopter R44 II, registered VH-MQE (MQE), departed from Melanie Camp landing area, Queensland. The pilot and three passengers were on board the scenic charter flight.

After about half an hour into the scenic flight, the pilot commenced a large orbit around a lake that was located about 15 km NE of Melanie Camp. They turned downwind at about 550 ft above ground level (AGL), with an airspeed of about 65 knots and the main rotor RPM was about 101 per cent. About 15 seconds later, the main rotor low RPM horn sounded through the pilot's headset. The pilot observed the main rotor low RPM warning light illuminate and a rapid decrease in main rotor speed. The pilot advanced the engine throttle and lowered the collective[1] but found that this made little difference with no increase in main rotor speed even though full engine power was applied. Shortly afterwards, the pilot initiated an autorotation[2] and prepared to land on a beach.

As the helicopter approached the landing spot, the pilot arrested the helicopter's rate of descent and the skids contacted the sand in a run-on landing.[3] After touchdown, the helicopter continued to travel forward about 3 m before the left skid dug into soft sand, which resulted in a dynamic roll over.[4] The helicopter came to rest on the left side (Figure 1). The pilot unfastened their seat belt and noted that the engine was not operating. They turned the fuel selector to off, moved the engine throttle to idle cut off, and turned off the engine magneto switches and the electrical master switch. The pilot and three passengers exited the helicopter through the right forward and aft exits.

About 40 minutes later, a company helicopter that had also been flying in the area located them. There were no injuries and the helicopter was substantially damaged (Figure 1).

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

2 Autorotation is a condition of descending flight where, following engine failure or deliberate disengagement, the rotor blades are driven solely by aerodynamic forces resulting from rate of descent airflow through the rotor. The rate of descent is determined mainly by airspeed.

3 A run-on landing refers to where the helicopter still has forward speed.

4 Dynamic rollover is when the helicopter starts to pivot laterally around its skid or wheel.

Figure 1: VH-MQE accident site

Source: Pilot

Pilot comment

The pilot provided the following comments:

- They had flown in this area previously. On the day of the accident, they had flown MQE to Coen Airport to pick up the passengers and flown back to Melanie Camp landing area without any issues.
- They were using a noise-cancelling headset (active noise reduction), which cancelled out any ambient noise. The pilot noted that if they did not have this type of headset they may have been able to hear if there were any unusual engine noises.
- At an altitude of about 550 ft they felt that there was insufficient height to position the helicopter into wind for landing. From that height, it was not possible to estimate the slope or the nature of the landing surface. After the landing, the pilot determined that the sand was very soft with a slight downslope towards the direction of the landing.
- At about 10 minutes prior to the main rotor low RPM warning, the clutch light had illuminated. The light extinguished in about 4 seconds, which was within the normal operating limits for the clutch light. The pilot indicated that there had been no other issues with the clutch mechanism during the day.
- The helicopter had sufficient fuel for the flight and was within the weight and balance limits.
- They had not experienced such a dramatic decrease in main rotor RPM before, despite conducting practice autorotations.

Operator comment

The operator reported that subsequent to the accident, the helicopter sustained substantial damage due to ocean tides (Figure 2) before it was recovered.

Figure 2: Subsequent damage due to the ocean tides

Source: Operator

Previous accident

Another ATSB investigation (AO-2012-096 - Ditching involving Robinson R44, 83 km N of Horn Island Airport, Queensland) documented the accident pilot using a noise-cancelling headset on the flight. The accident pilot believed that the headset may have dampened any abnormal engine sounds. Consequently, they only became aware of the engine problems when the engine governor failed.

Safety analysis

Due to the nature of the subsequent damage to the helicopter after the accident the integrity of the helicopter systems prior to the accident were not determined. Consequently, the reason for the loss of main rotor speed was not determined.

The pilot indicated that if a noise-cancelling headset was not used then they would have been able to hear the ambient noises and detect any changes in the 'normal' sounds of the helicopter.

Findings

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

- At about 550 ft, after the main rotor low RPM warning system activated, the pilot initiated an autorotation and the helicopter rolled onto the left side after landing. The reason for the main rotor low RPM warning was not determined.
- The pilot was using a noise-cancelling headset that may have masked any abnormal sounds from the helicopter prior to the low rotor RPM warning.

Safety message

The noise-cancelling headset worn by the pilot may have masked changes in the 'normal' sounds of the helicopter. The Civil Aviation Safety Authority (CASA) Airworthiness Article 1-43 Noise

Isolating Headsets highlights that noise attenuating and noise-cancelling headsets can in some circumstances reduce the effectiveness of aural cues, such as abnormal noises, which might give some warning of unusual operations.

General details

Occurrence details

Date and time:	6 April 2017 – 1530 EST	
Occurrence category:	Accident	
Primary occurrence type:	Forced landing	
Location:	27 km N Silver Plains (ALA), Queensland	
	Latitude: 13° 44.00' S	Longitude: 143° 32.40' E

Aircraft details

Manufacturer and model:	Robinson Helicopter Co R44 II	
Registration:	VH-MQE	
Serial number:	13338	
Type of operation:	Charter - Passenger	
Persons on board:	Crew – 1	Passengers – 3
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Substantial	

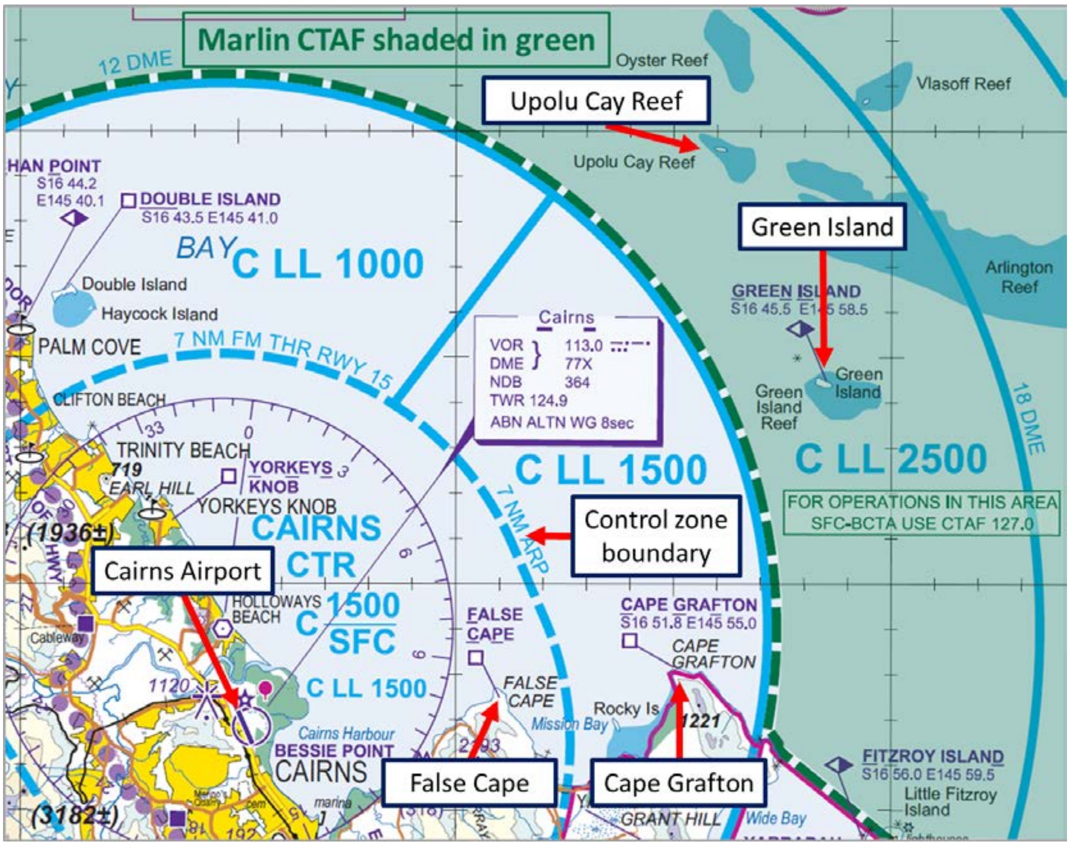
Separation issue

Proximity event involving Bell 407, VH-VHU and Piper PA-31, VH FDQ

What happened

On 5 February 2017, at about 1639 Eastern Standard Time (EST), a Bell 407 helicopter, registered VH-VHU (VHU), departed from Cairns Airport, Queensland, on a local scenic charter flight (visual flight rules), tracking towards Green Island (Figure 1). On board were the pilot and six passengers.

Figure 1: Extract of Cairns visual terminal chart showing the Marlin CTAF shaded in green, Green Island and Cape Grafton



Source: Airservices Australia – annotated by ATSB

At that time, a Piper PA-31-350 aircraft, registered VH-FDQ (FDQ), was also conducting a scenic charter flight in the area. At about 1640, the pilot of FDQ contacted the Cairns approach controller and requested clearance to enter the Cairns controlled airspace. The pilot advised that they were at 10 NM and at 1,000 ft and requested to return via either east of Cape Grafton or False Cape.[1] The controller acknowledged FDQ and confirmed that the pilot intended to remain outside controlled airspace and track to Cape Grafton. The pilot confirmed that they would complete an orbit at Green Island and then track to Cape Grafton at 1,000 ft (Figure 1). At about 1641, the approach controller suggested if available that the pilot of FDQ climb to 1,500 ft, as there were multiple helicopters in the area on climb to 1,000 ft (the same altitude as FDQ). Although outside

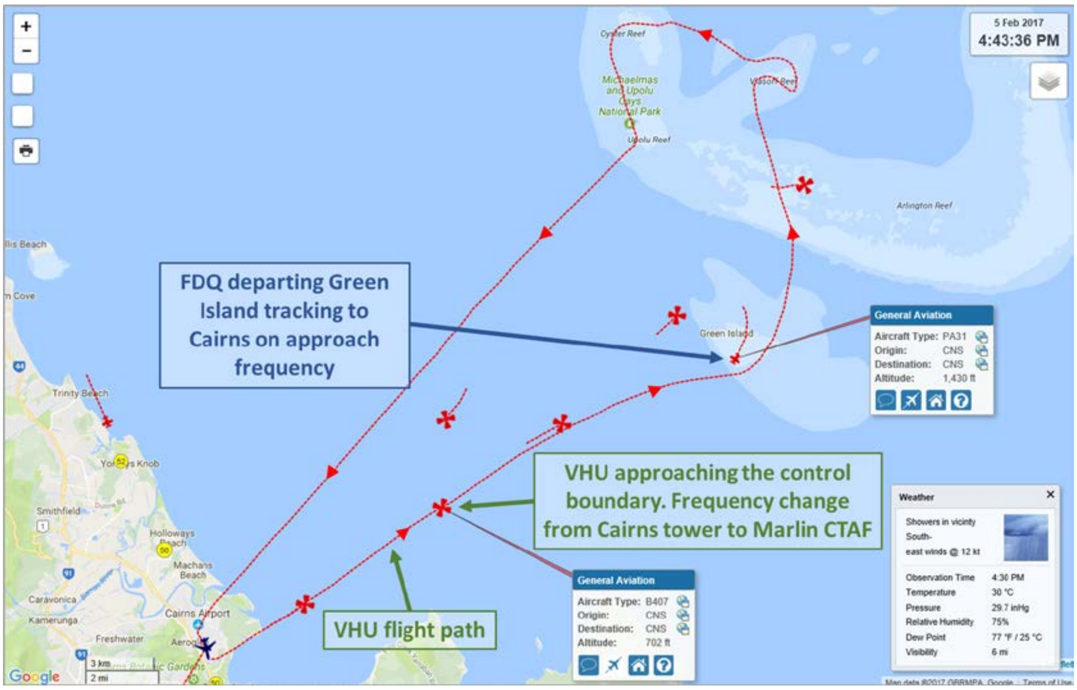
[1] When FDQ departed, there were two Cessna 208 aircraft (C208) that had just completed a scenic flight to Green Island and were holding at False Cape waiting to be sequenced for a landing at Cairns Airport. Due to the localised weather to the north of the airport prevented the C208 tracking via Upolu Cay to Cairns Airport.

controlled airspace, the controller provided traffic as a helicopter (not VHU) was already at 1,000 ft and about 2 NM W of FDQ. The pilot of FDQ responded that they would climb to 1,500 ft.

At about 1643, the tower controller notified VHU that they were approaching the control boundary and that control services were terminated. The pilot of VHU changed their radio from Cairns Tower to the Marlin common traffic advisory frequency (CTAF),[2] and broadcast that they were at the zone boundary and would track direct to Green Island climbing from 500 ft to 1,000 ft. The pilot did not receive a response and commenced the climb.

About 30 seconds later, the approach controller cleared the pilot of FDQ (then orbiting at Green Island) to track to Cairns via a left base circuit leg for runway 15 at 1,500 ft (Figure 2).

Figure 2: Location of VHU when changed to the Marlin CTAF and approximate location of FDQ when commenced tracking direct to Cairns



Source: Airservices Web Trak, modified by the ATSB

As VHU approached 900 ft on climb, the pilot indicated that their attention was inside the cockpit to ensure they did not climb above 1,000 ft and to set up the helicopter in the cruise. When the pilot subsequently scanned outside, they sighted an aircraft rapidly approaching[3] in the opposite direction (FDQ). The pilot of VHU conducted a rapid descent to increase the separation with FDQ and estimated that the vertical separation between the two aircraft was between 100 to 150 ft.[4] Radar data indicated that the minimum separation between the two aircraft was 400 ft vertically and 500 m horizontally.

Both aircraft subsequently landed without further incident.

Communications

At the time of the incident, the pilot of VHU had Marlin CTAF selected and was flying in an area where the Cairns Approach frequency should be monitored. At the same time, FDQ was on Cairns Approach frequency and flying in an area where the Marlin CTAF should be monitored.

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[2] CTAF – Common Traffic Advisory Frequency. The frequencies allocated, are those on which pilots can arrange mutual separation at non-controlled aerodromes.

[3] The pilot of VHU estimated that their airspeed was about 100 kt and the closing speed between the two aircraft was about 200 to 240 kt.

[4] The incident occurred outside of controlled airspace.

The pilot of VHU commented that they were not aware of the pilot of FDQ's intentions and did not expect to see an aircraft approaching rapidly in the opposite direction.

The pilot of VHU also commented that although the helicopter was fitted with two radios, they only selected and monitored one frequency at a time, to ensure that communications were not over-transmitted in a very busy airspace. For this flight, the frequency after leaving the Cairns control zone boundary and before the Marlin CTAF boundary was the Cairns Approach frequency.

The operator of FDQ indicated that they also have two radios and maintain an active listening watch on two frequencies.

The operator of VHU commented that immediately outside the Cairns control zone boundary pilots may not be monitoring a common frequency and therefore may not be aware of traffic advisory calls. As such, the operator of VHU believes there can be an elevated risk of a collision, particularly during times of high traffic.

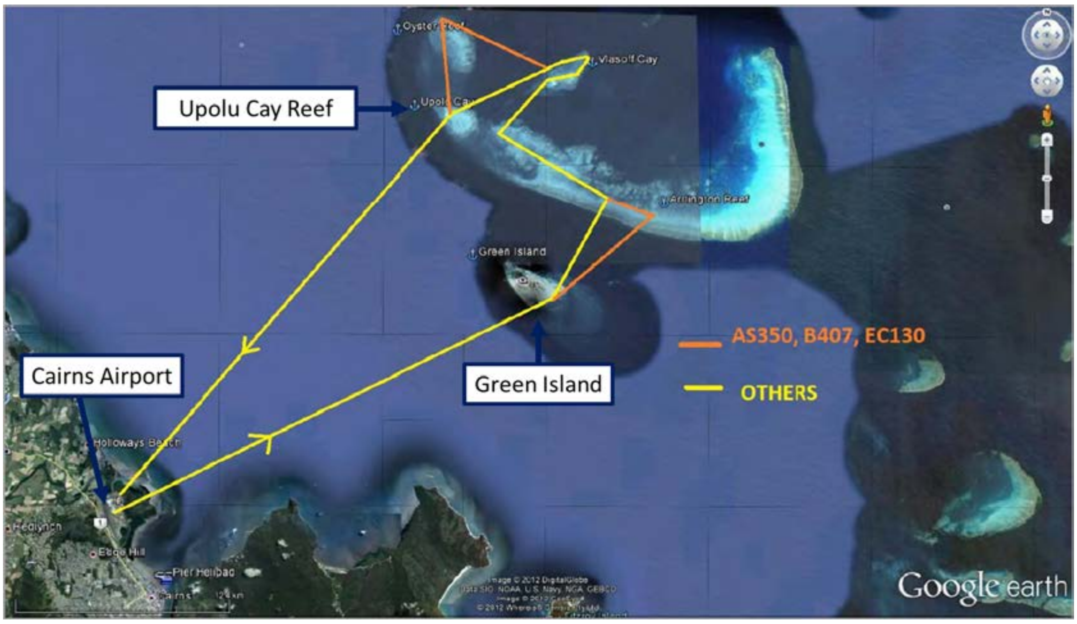
Scenic flight routes

The operator of VHU commented that this incident occurred at one of the busiest times of the year for scenic flights by helicopters and fixed wing aircraft from Cairns to the Great Barrier Reef. The pilot of VHU reported that it would not be uncommon at this time of year to have eight to ten aircraft in the area conducting scenic flights at any one time. To ensure separation they usually fly a set route at a similar altitude and adjust their airspeed so that they follow each other.

At the time of this incident, the Civil Aviation Safety Authority (CASA) was liaising with Airservices and local charter operators to review procedures for possible flight corridors and altitudes to help maintain aircraft separation.

In the interim, on 10 January 2017, the operator of VHU sent an email to the chief pilots of other scenic flight operators with a suggested route for scenic flights (Figure 3). They reported that all helicopter operators agreed to fly in a counter clockwise direction and that this had decreased the incidence of near collisions between helicopters.

Figure 3: Suggested route for scenic flights



Source: Helicopter operator– annotated by ATSB

Similar incidents

A search of the ATSB database identified one other occurrence in the 2 months before this incident that involved a near collision in the Marlin CTAF. A Cessna 172 was tracking in the Marlin

CTAF from Upolu Cay Reef (Figure 1) to False Cape at 1,000 ft. The pilot of an Airbus Helicopters AS350 (AS350) had entered the Marlin CTAF tracking outbound, and broadcast on the Marlin CTAF their intention to track to Green Island and did not receive any response. The AS350 was on climb, passing about 750 ft, when the pilot reported that they had to take evasive action to avoid a collision with the Cessna 172.

In a submission to a draft of this report, CASA provided information about two other relevant near miss incidents, which had not been reported to the ATSB.

Findings

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

- VHU and FDQ were on reciprocal tracks, near the control zone boundary, and the pilots were communicating on different radio frequencies at the time of the separation issue. Neither pilot was aware of the other aircraft prior to the incident.
- There are no published routes and procedures for scenic flights in the Cairns/Great Barrier Reef area. FDQ was operating contra to the inbound direction used by the helicopter operator, but in accordance with their air traffic control clearance, and still outside controlled airspace at the time of the incident.

Safety action

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

Civil Aviation Safety Authority

As a result of this occurrence, the Civil Aviation Safety Authority has advised the ATSB that they are taking the following safety actions:

CASA are engaged with Airservices and the local operators to find a workable safety outcome to the aircraft separation issues.

Safety message

This incident highlights the importance of effective risk analysis by operators. An effective risk analysis of the scenic routes would probably have highlighted the potential for opposite-direction traffic. This may have led to risk management strategies such as implementation of vertical separation planning.

A search for other traffic is eight times more effective when a radio is used in combination with a visual lookout than when no radio is used. In areas outside controlled airspace, it is the pilot’s responsibility to maintain separation with other aircraft. For this, it is important that pilots use both alerted and un-alerted see-and-avoid principles.

The ATSB report *Limitations of the See-and-Avoid Principle* outlines the major factors that limit the effectiveness of un-alerted see-and-avoid.

The ATSB SafetyWatch highlights the broad safety concerns that come out of our investigation findings and from the occurrence data reported to us by industry. One of the safety concerns is under reporting of occurrences.

ATSB research has found that accidents and incidents are not always reported to the ATSB when they should be. It is possible that other occurrences related to this incident have not been reported to the ATSB.

While we use a notification to determine whether to investigate an occurrence, looked at as a whole, notifications also provides a bigger picture of aviation safety trends and patterns.

General details

Occurrence details

Date and time:	5 February 2017 – 1645 EST	
Occurrence category:	Incident	
Primary occurrence type:	Aircraft separation issue	
Location:	near Cairns Airport, Queensland	
	Latitude: 16° 48.73' S	Longitude: 145° 53.50' E

Aircraft details – VH-VHU

Manufacturer and model:	Bell Helicopter Company 407	
Registration:	VH-VHU	
Serial number:	53524	
Type of operation:	Charter - Passenger	
Persons on board:	Crew – 1	Passengers – 6
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Aircraft details – VH-FDQ

Manufacturer and model:	Piper Aircraft Corporation PA-31	
Registration:	VH-FDQ	
Serial number:	31-7652150	
Type of operation:	Charter - Passenger	
Persons on board:	Crew – 1	Passengers – Unknown
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Nil	

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (ATSB) is an independent Commonwealth Government statutory agency. The Bureau is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

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

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

Purpose of safety investigations

The object of a safety investigation is to identify and reduce safety-related risk. ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated. The terms the ATSB uses to refer to key safety and risk concepts are set out in the next section: Terminology Used in this Report.

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

About this Bulletin

The ATSB receives around 16,000 notifications of Aviation occurrences each year, 8,000 of which are accidents, serious incidents and incidents. It also receives a lesser number of similar occurrences in the Rail and Marine transport sectors. It is from the information provided in these notifications that the ATSB makes a decision on whether or not to investigate. While some further information is sought in some cases to assist in making those decisions, resource constraints dictate that a significant amount of professional judgement is needed to be exercised.

There are times when more detailed information about the circumstances of the occurrence allows the ATSB to make a more informed decision both about whether to investigate at all and, if so, what necessary resources are required (investigation level). In addition, further publically available information on accidents and serious incidents increases safety awareness in the industry and enables improved research activities and analysis of safety trends, leading to more targeted safety education.

The Short Investigation Team gathers additional factual information on aviation accidents and serious incidents (with the exception of 'high risk operations), and similar Rail and Marine occurrences, where the initial decision has been not to commence a 'full' (level 1 to 4) investigation.

The primary objective of the team is to undertake limited-scope, fact gathering investigations, which result in a short summary report. The summary report is a compilation of the information the ATSB has gathered, sourced from individuals or organisations involved in the occurrences, on the circumstances surrounding the occurrence and what safety action may have been taken or identified as a result of the occurrence.

These reports are released publically. In the aviation transport context, the reports are released periodically in a Bulletin format.

Conducting these Short investigations has a number of benefits:

- Publication of the circumstances surrounding a larger number of occurrences enables greater industry awareness of potential safety issues and possible safety action.
- The additional information gathered results in a richer source of information for research and statistical analysis purposes that can be used both by ATSB research staff as well as other stakeholders, including the portfolio agencies and research institutions.
- Reviewing the additional information serves as a screening process to allow decisions to be made about whether a full investigation is warranted. This addresses the issue of 'not knowing what we don't know' and ensures that the ATSB does not miss opportunities to identify safety issues and facilitate safety action.
- In cases where the initial decision was to conduct a full investigation, but which, after the preliminary evidence collection and review phase, later suggested that further resources are not warranted, the investigation may be finalised with a short factual report.
- It assists Australia to more fully comply with its obligations under ICAO Annex 13 to investigate all aviation accidents and serious incidents.
- Publicises ***Safety Messages*** aimed at improving awareness of issues and good safety practices to both the transport industries and the travelling public.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Short Investigations
Aviation Short Investigations Bulletin Issue 62
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