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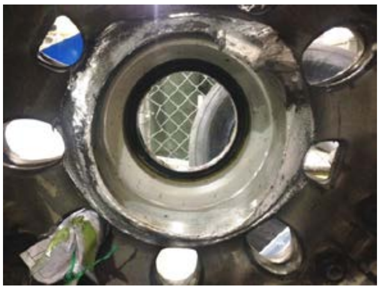
Inboard wheel half remnant



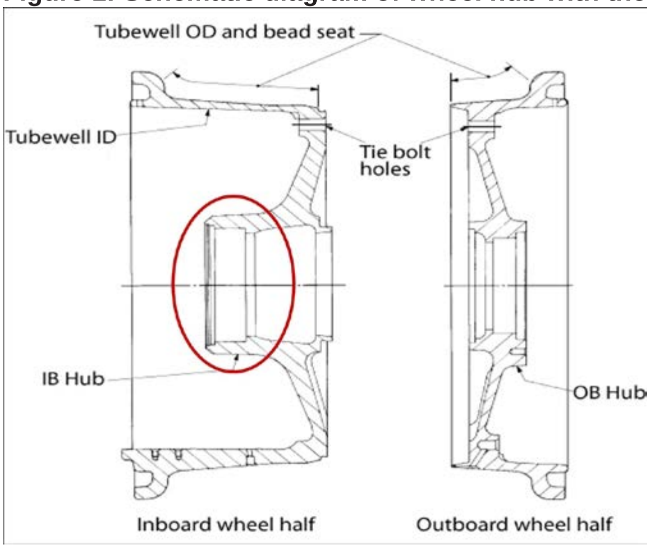
Source: Aircraft operator

On 10 June 2014, a Boeing 737 aircraft, registered ZK-ZQB and operated by Jetconnect Limited landed at Sydney Airport, New South Wales. During taxiing, the crew felt a slight shuddering from around the main landing gear; they also observed that they required a higher-than-normal thrust to taxi the aircraft. At the crew's request, personnel in the Air Traffic Control tower and a passing aircraft observed ZK-ZQB, but did not see anything abnormal. The crew then requested that Rescue and Fire Fighting Services conduct a close-up inspection. They advised the crew that pieces of metal had fallen onto the runway and that the right, outer main wheel was leaning over. After parking the aircraft, an examination by Licenced Aircraft Maintenance Engineers confirmed that the inboard wheel half-hub had fractured into several pieces and that the wheel bearings were intact (Inset figure).

Wheel hub failure

The wheel hub consisted of an inboard and outboard section (Figure 1).The inboard wheel half on ZK-ZQB was part number 2612462 and serial number B3902.

Figure 1: Schematic diagram of wheel hub with the failure location circled



Source: Honeywell

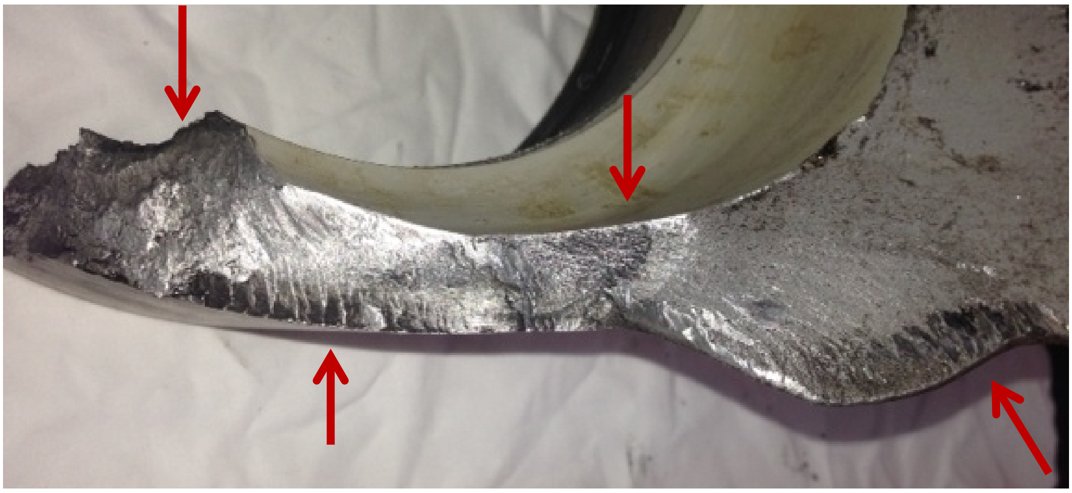
After removal of the bearing cup, the aircraft operator inspected the bore and reported that there was no sign of bearing cup rotation. A visual inspection of the fracture surfaces was then performed by the operator's maintenance organisation that indicated the origin of the failure to most likely be in the area of the bearing bore radius (Figures 2a and b). However, that area had been damaged, following the final fracture. From the point of origin, a series of cracks grew both axially (Figure 2b) and circumferentially around the inboard hub (Figure 3). In the axial direction, chevrons on the fracture surface radiated from the radius area. Circumferential crack growth occurred partly by joining a series of smaller, tertiary cracks on the hub's outer diameter. The surfaces of that circumferential crack showed the joining process as a series of ratchet marks. This earlier part of that fracture surface was burnished as the two faces of the crack had rubbed together over a period of time, obliterating some detail. The crack then became a singular front with beach marks, an indicator of fatigue cracking. The area of ultimate failure changed from fatigue to the more rapid, overload mode.

The wheel manufacturer also examined the failure. They concluded it was likely that the fatigue crack initiated in the stress-concentrated, transition region between the bearing bore wall and the circumferential radius. Ultrasonic testing of this area detected possible small fatigue cracks or origins.

Figures 2a and b: Fractured hub from the inboard wheel half and chevrons leading from the damaged, radius-area origin; the arrow shows the direction of crack growth from that area

Source: Aircraft operator

Figure 3: Secondary, circumferential crack showing, from left to right, the damaged origin area, ratchet marks/burnishing, beach marks and ultimate failure by overload



Source: Aircraft operator

Related manufacturer's and operator's service information

Due to previous failures of the wheel hub, service bulletins and requirements for inspection were issued by the aircraft and wheel manufacturers. These included a Boeing Service Letter,[1] which indicated that there was a known failure mode of the wheel hub, which was related to a loose or spinning bearing cup in the hub bore. As noted earlier, inspection of the bore, post-cup removal, found no indication of bearing cup rotation. The Boeing Fleet Team Digest[2] noted that failures could also occur from fatigue initiating in the bearing bore radius area (as was the case in ZK-ZQB); however, those failures had primarily occurred in the redesigned wheel hubs that superseded the 2612462 part number i.e. from PN 2615480.

In 2010, Boeing also issued a Special Attention Service Bulletin[3] covering 737 wheel failures. That bulletin recommended ultrasonic inspection, in accordance with the wheel manufacturer's service bulletin[4], of relevant part and serial numbers, whenever a wheel was removed from the aircraft. For part number 2612462, the wheel manufacturer recommended non-destructive testing (NDT) at each overhaul interval. In ZQB's case, this averaged approximately 180 landing cycles per interval. That inspection required[5] visual examination of each component, measurement of specific parts/areas and ultrasonic inspection of the hub outer diameter of both wheel halves to detect bearing-bore cracks at every tyre change and wheel overhaul. However, if the bearing cup had been removed, other NDT methods (eddy current, ultrasound or fluorescent penetrant inspection (FPI)) were to be used to inspect the bearing bore's internal diameter and corner radius. The component maintenance manual also noted that visual inspection of the wheel halves was to investigate for damage to paint or corrosion-protection coatings, as stress concentrators in corrosion could also initiate fatigue cracking.

In summary, note that for PN 2615480, serial number (SN) B15418 and prior and SN H0483 and prior wheel halves, mandatory annual NDT inspection was required. For PN 2612462 and PN 2615480, SN B15418 and above and SN H0483 and above wheel halves, compliance with the NDT recommendation was optional.

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1 Boeing Service Letter 737-SL32-*162*

2 Boeing Fleet Team Digest *737-NG-FTD-32-08008*

3 Boeing *Special Attention Service Bulletin 737-32-1444* issued April 08, 2010

4 Honeywell *Service Bulletin 2612311-32-003* issued 5 Feb 2010

5 As per the Honeywell *Component Maintenance Manual (CMM) ATA 32-40-14*

Maintenance

Examination of the maintenance records, from the 15 months before the inboard wheel-half failure, found that the wheel manufacturer's recommended inspections had been performed whenever the wheel had been removed from the aircraft. Although the March 2013 major service specified non-removal of the bearing cup and, consequently, ultrasonic inspection, all services since then used eddy current inspection. The wheel manufacturer's service bulletin specified that such a test could only be done if the bearing cup and sleeve assembly had been removed. No discrepancies were reported for the visual, ultrasonic, eddy current and FPI methods used as part of these inspections. The most recent record that included landing cycle data (February 2014), noted that 84 cycles had occurred in the two months since the last service (December 2013) and that the total time since new (TSN)/ time since overhaul (TSO) hours were 22901/1803 respectively. In March 2013, a major service was carried out and the tie bolt hole radii were shot peened. This shot peening was restricted to this area and did not include the bearing bore radius.[6]

Safety action

The ATSB was advised by the aircraft operator that they are upgrading their fleet with carbon brakes from a different manufacturer. As a result, all current main wheel assemblies will be replaced with wheels from that manufacturer; hence, those wheels will have a different part number. The modification program of fitment with new wheels and brakes commenced in February 2015 and will be completed by the end of May 2015.

General details

Occurrence details

Date and time:	10 June 2014 – 08:30 EST
Occurrence category:	Incident
Primary occurrence type:	Landing gear indication
Location:	Sydney Aerodrome, N.S.W. Latitude: 33° 56.507' S Longitude:151° 10.635' E

Aircraft details

Manufacturer and model:	Boeing 737- 838	
Registration:	ZK-ZQB	
Operator:	Jetconnect	
Serial number:	34201/3006	
Type of operation:	Air Transport High Capacity - Passenger	
Persons on board:	Crew – 7	Passengers – 155
Injuries:	Crew – 0	Passengers – 0
Damage:	Minor	

6 Improper shot peening of the bearing bore radius resulted in fatigue failures on the redesigned wheels i.e. PN 2615480 (ATSB investigations AO-2019-062 and AO-2011-143 related to this type of failure).

Operational event involving a Boeing 737, VH-VUR

What happened

At about 0600 Central Daylight-saving Time (CDT) on 7 November 2014, a Boeing 737-800, registered VH-VUR and operated by Virgin Australia, departed Adelaide, South Australia, on a scheduled service to Brisbane, Queensland. The captain was the pilot flying and the first officer was the pilot monitoring.

The crew were cleared via the SEDAN 9 Standard Instrument Departure (SID). As the aircraft climbed through about 4,400 ft during the SID, air traffic control re-cleared the aircraft to track direct to waypoint UVUPU (north-east of Mildura, Victoria), and cancelled the standard airspeed restriction of 250 kt below 10,000 ft. The crew made appropriate changes in the Flight Management Computer (FMC),[1] following which the captain selected Lateral Navigation (LNAV)[2] and Vertical Navigation (VNAV) auto-flight modes (see VNAV mode). In these modes, the aircraft commenced tracking directly to waypoint UVUPU, and accelerated to the FMC-programmed airspeed of 280 kt.

The climb proceeded normally until the aircraft was passing about flight level (FL) 250[3] when the captain selected Level Change (LVL CHG) vertical auto-flight mode (see LVL CHG mode), and commanded a continued climb at the existing airspeed of 280 kt. The captain recalled that LVL CHG mode may have been selected to manage continued climb through a layer of turbulence. The crew intended to re-select VNAV mode when LVL CHG mode was no longer required, but inadvertently overlooked that selection, and the climb continued in LVL CHG mode at 280 kt.

Soon after the selection of LVL CHG mode, as the aircraft climbed through about FL 265, the auto-flight system sequenced automatically from climb at a constant airspeed, to climb at a constant Mach number,[4] consistent with normal system behaviour. Climb then continued above FL 265 at a constant Mach number of 0.69, which was the Mach number corresponding to 280 kt at the time the changeover occurred. As the aircraft continued to climb at the constant Mach number, the airspeed slowly reduced (as a function of the characteristics of the atmosphere and the relationship between Mach number and airspeed).

The slowly reducing airspeed went unnoticed by the crew until the auto-flight system was levelling the aircraft at the planned cruise altitude of FL 390. At about that time, the captain noticed that the magenta airspeed bug[5] on the primary flight display (PFD) airspeed indicator was at the top of the minimum manoeuvre airspeed amber bar. At that point, the top of the amber bar corresponded to an airspeed of about 216 kt. The crew also noticed a 'buffet alert' advisory message appear in the scratchpad of Control Display Unit (CDU).[6]

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1 The FMC uses information entered by the crew, aircraft systems data, and navigation and performance databases, to provide auto-flight and auto-throttle guidance and control.

2 In LNAV mode, the auto-flight system guides the aircraft along the FMC-programmed lateral track.

3 At altitudes above 10,000 ft in Australia, the height of an aircraft above mean sea level is referred to as a flight level (FL). FL 250 equates to 25,000 ft.

4 Mach number is the ratio of true airspeed to the speed of sound in the surrounding air.

5 In LVL CHG mode, the magenta airspeed bug on the PFD airspeed indicator points to the speed selected by the crew in the Indicated Airspeed (IAS)/Mach number (MACH) window on the Mode Control Panel (see later description).

6 Two identical CDUs (one available to each pilot) are used by the flight crew to enter data and control the FMC, and to display FMC data and messages. The scratchpad refers to the bottom line of the CDU screen, used among other things to display FMC advisory messages. When an advisory message such as 'buffet alert' appears, a message light on both CDUs also illuminates to draw attention to the CDU message. The operator's Flight Crew Operations Manual states that the 'buffet alert' message appears when the manoeuvre margin is 'less than specified'.

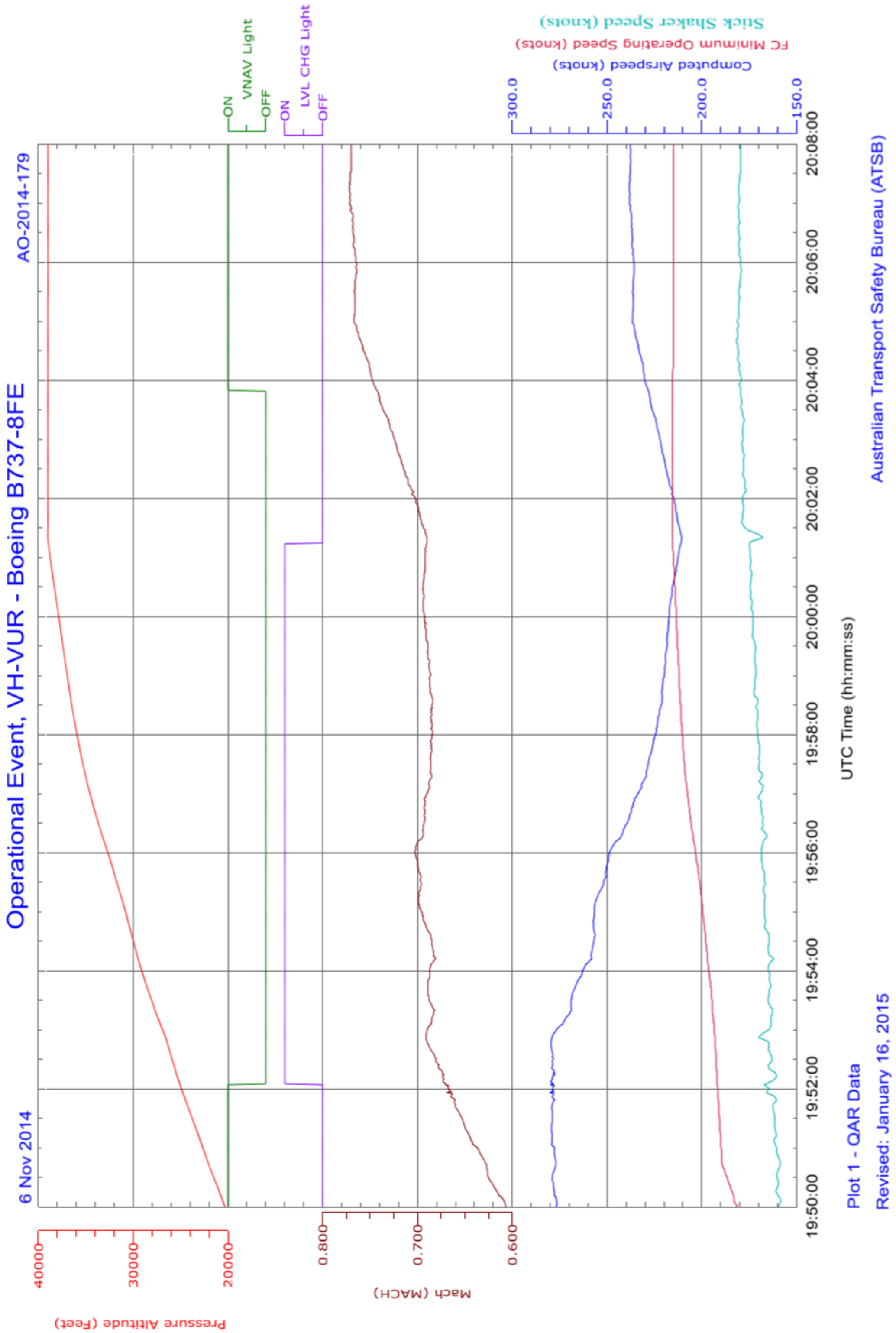
In response to the low airspeed condition, the captain selected Mach 0.77 on the Mode Control Panel (MCP)[7] to initiate acceleration towards the FMC-programmed cruise Mach number. As the aircraft accelerated through about Mach 0.74, the captain selected VNAV and the auto-flight system engaged in VNAV Path (VNAV PTH) (see VNAV mode), allowing the aircraft to continue accelerating to the FMC-programmed cruise Mach number of Mach 0.77 while maintaining FL 390. Under the existing conditions, a Mach number of 0.77 corresponded to an airspeed of about 240 kt. Having accelerated to Mach 0.77, the flight continued to Brisbane without further incident.

Figure 1 provides a graphical illustration of some relevant flight parameters and auto-flight system vertical modes from FL 200 until the aircraft had accelerated to Mach 0.77 in cruise flight at FL 390. Of particular note is the change from VNAV mode to LVL CHG mode soon after 1952 UTC.[8] The figure also shows the near constant Mach number and gradually decreasing airspeed from about 1953 UTC, until the aircraft reached the planned cruise altitude soon after 2001 UTC. The airspeed dips beneath the minimum manoeuvre airspeed for a short time as the crew initiated acceleration, reaching a minimum recorded airspeed of about 211 kt. From that point, the aircraft accelerates to the planned cruise Mach number of Mach 0.77, with VNAV re-engaged just before 2004 UTC. Note that the minimum operating airspeed referred to in Figure 1 is the same as the minimum manoeuvre airspeed (see below). The computed airspeed referred to in Figure 1 is the same airspeed that would have been displayed on the captain's PFD.

7 The MCP is used by the crew to control flight parameters such as altitude, speed and heading, and to select auto-flight and auto-throttle system operating modes.

8 UTC refers to Coordinated Universal Time. UTC is the time zone used for civil aviation. Local time zones around the world can be expressed as positive or negative offsets from UTC. At the time of this occurrence, CDT was UTC plus 10 hours and 30 minutes. For example, 1952 UTC on 6 November 2014 was 0622 CDT on 7 November 2014.

Figure 1: Selected flight parameters and auto-flight system modes.



Source: ATSB

Relevant technical information

The auto-flight system consists of an auto-pilot flight director system (AFDS) and an auto-throttle system. The AFDS and auto-throttles are controlled using the FMC and the MCP. The auto-flight system operates in various vertical modes according to the phase of flight, operating environment and crew requirements. Two commonly used vertical modes relevant to this occurrence are VNAV mode and LVL CHG mode.

VNAV mode

During a climb in VNAV mode, the auto-flight system guides the aircraft along the FMC-programmed vertical profile, at the speed (airspeed or Mach number) computed by the FMC, modified and selected by the crew as required according to operational circumstances. During normal operations, the FMC speed profile holds the airspeed at 250 kt up to 10,000 ft (normal procedural requirement in Australian airspace) followed by acceleration to the FMC-programmed climb airspeed (commonly the economy-optimised speed schedule computed by the FMC). As climb continues at a constant airspeed, Mach number increases as a function of the characteristics of the atmosphere and the relationship between Mach number and airspeed. Climb continues at the FMC-programmed airspeed until the Mach number reaches the FMC-programmed Mach number, from which point climb continues at that Mach number. The crew can change FMC-programmed climb speeds as required, by making the required changes on the appropriate page of the CDU. During this occurrence, the recorded data indicates that, had the crew continued to climb in VNAV mode (rather than selecting LVL CHG), the aircraft would have maintained 280 kt to about FL 320, from which point climb would have continued at a constant Mach 0.77.

VNAV mode is selected by pressing the VNAV pushbutton on the MCP. When selected, a green bar on the VNAV pushbutton illuminates. During a climb in VNAV mode, the flight mode annunciator (FMA)[9] indication at the top of each pilot's PFD indicates N1[10] as the auto-throttle mode and VNAV SPD (speed) as the vertical auto-flight mode (Figure 2). During a climb in VNAV mode, the FMC-programmed speed is displayed on the PFD, and the indicated airspeed/Mach number (IAS/MACH) window on the MCP is blank.

When the aircraft levels at the FMC-programmed cruise altitude, the auto-flight system vertical mode sequences to VNAV PTH (path) to maintain the cruise altitude, and the auto-throttle mode sequences to FMC SPD (speed) to hold the FMC-programmed cruise speed (Mach number). Similar annunciations appear when the auto-flight system levels the aircraft temporarily at an intervening FMC-programmed altitude constraint (there were no intervening altitude constraints relevant to this occurrence).

LVL CHG mode

During a climb in LVL CHG mode, the auto-flight system controls the aircraft pitch attitude in a manner that maintains the speed selected by the crew on the MCP. LVL CHG mode is sometimes used during a climb to allow a more active and typically short-term approach to vertical profile management. For example, rather than allowing the aircraft to accelerate in VNAV mode in accordance with the FMC-programmed speed profile, the crew may elect to temporarily retard acceleration or reduce speed using LVL CHG mode. Temporarily retarding acceleration or reducing speed may generate a higher short-term rate of climb, thereby facilitating an expedited climb through a layer of cloud or turbulence.

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9 Auto-flight modes are displayed on the FMA at the top of the PFD. Engaged modes are displayed at the top of the FMA in green letters. Armed modes are displayed in smaller white letters beneath the engaged modes. The mode annunciations, from left to right, are auto-throttle, roll (or lateral) mode, and pitch (or vertical) mode.

10 N1 auto-throttle mode engages automatically when LVL CHG or VNAV modes are engaged during climb. The auto-throttles then maintain engine speed at the N1 limit selected on the CDU.

LVL CHG mode is selected by pressing the LVL CHG pushbutton on the MCP. Like the VNAV pushbutton, a green bar illuminates on the pushbutton when LVL CHG is selected. The speed control knob on the MCP is then used to select the required climb airspeed or Mach number, which is displayed in the corresponding IAS/MACH window. When LVG CHG mode is selected, the FMA indicates N1 as the auto-throttle mode and MCP SPD (speed) as the vertical auto-flight mode (Figure 2).

Figure 2: Relevant example FMA annunciations (VNAV upper example and LVL CHG lower example)

Example of FMA annunciations during a climb in **VNAV mode**. In this case, VNAV SPD indicates that the auto-flight system is following the FMC-programmed speed profile. N1 indicates that the auto-throttle system is commanding a set engine speed limit and LNAV (lateral navigation) indicates that the auto-flight system is following a programmed lateral track.

Example of FMA annunciations during a climb in **LVL CHG mode**. In this case, MCP SPD indicates that the auto-flight system is maintaining the speed set on the MCP. As above, N1 indicates that the auto-throttle system is commanding a set engine speed limit and LNAV indicates that the auto-flight system is following a programmed lateral track.

Source: ATSB

Minimum manoeuvre airspeed

The minimum manoeuvre airspeed is represented as the top of an amber bar on the PFD airspeed indicator. Minimum manoeuvre airspeed is defined in the operator's Flight Crew Operations Manual (FCOM) as the airspeed that provides:

- 1.3g[11] manoeuvre capability to the stick shaker below approximately 20,000 ft.
- 1.3g manoeuvre capability to the low airspeed buffet (or an alternate approved manoeuvre capability entered into the FMC maintenance pages) above approximately 20,000 ft.

The FCOM adds the following caution:

> *Reduced maneuver capability exists when operating within the amber regions below the minimum maneuver speed or above the maximum maneuver speed. During non-normal conditions the target speed may be below the minimum maneuver speed.*

During this occurrence, the crew noticed that the airspeed was near the minimum manoeuvre airspeed on the PFD, and noticed the 'buffet alert' message on the CDU scratchpad, and responded accordingly. Other more salient system alerts and levels of protection were available had the crew not responded when they did, and the airspeed had continued to reduce. These include an aural 'airspeed low' alert and, following further airspeed reduction, a stick-shaker system.[12] Under some conditions the auto-flight system may also command a reduction in the aircraft pitch attitude (accepting a reduction in the rate of climb in return for airspeed management), if the airspeed reaches the minimum manoeuvre airspeed.

Crew comments

During the operator's investigation into the incident, the crew commented that a number of distractions may have contributed to the incident. The crew commented that sun glare was particularly problematic – the glare was directly through the windscreen for the duration of the climb. The crew also commented that they may also have been distracted by air traffic control and cabin-related communication requirements, and other air traffic in their vicinity. Additionally, both

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[11] 1.3g represents 1.3 times the force of gravity. In this context, 1.3g means that the aircraft can be manoeuvred at up to 1.3g without activating the stick shaker or generating a low airspeed buffet. Approximately 1.3g will be experienced during a level turn at 40 degrees angle of bank.

[12] A stick-shaker is a device that physically shakes the control column through a small angle in the fore and aft plane, providing an artificial warning of an approaching aerodynamic stall.

pilots consumed breakfast during the climb (at separate times), which may have provided a source of distraction.

ATSB comment

In a similar occurrence involving the same aircraft type, the crew inadvertently allowed the aircraft to continue to climb in LVL CHG mode at a constant Mach 0.62. On that occasion, the crew noticed the 'buffet alert' message and a small pitch attitude reduction as the aircraft climbed through about FL 350 and the airspeed neared the minimum manoeuvre airspeed. A copy of the report associated with that incident is available on the ATSB website at www.atsb.gov.au/publications/investigation_reports/2013/aair/ao-2013-041.aspx.

A recent report by the FAA Performance-based Operations Aviation Rulemaking Committee, (Commercial Aviation Safety Team Flight Deck Automation Working Group) titled *Operational Use of Flight Path Management Systems* made a number of findings and recommendations dealing broadly with vulnerabilities associated with flight crew management of automated systems. Further to a 1996 FAA report titled *The Interfaces Between Flightcrews and Modern Flight Deck Systems*, the more recent report commented that '…autoflight mode selection, awareness and understanding continue to be common vulnerabilities'. Both the 1996 report and the later Automation Working Group report are available on the FAA website at:

- www.faa.gov/aircraft/air_cert/design_approvals/csta/publications/.
- www.faa.gov/about/office_org/headquarters_offices/avs/offices/afs/afs400/parc/parc_reco/ (reference number 130908 under the 2013 tab).

ATSB Research Investigation B2004/0324 titled *Dangerous Distractions* found that pilot distraction contributed to 325 occurrences involving Australian-registered aircraft between 1997 and 2004. The report concluded:

> *… the findings have shown that distractions have the potential to significantly threaten flight safety across all sections of the industry and during all phases of flight. Clearly, strategies to minimise pilot distraction need to be developed and designed with particular attention to the operations being undertaken.*

The report, which includes some strategies for reducing pilot distraction, is available on the ATSB website at: www.atsb.gov.au/publications/2005/distraction_report.aspx

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 intended to highlight relevant human factors issues, such as the potential distractions associated with sun glare and communications, in future training programs.

Safety message

For flight crew, this incident highlights the importance of continued auto-flight system mode and aircraft energy state awareness. The incident also highlights the manner in which various distractions have the potential to adversely affect such awareness. For operators, the incident highlights the importance of robust auto-flight management procedures, supported by appropriately focussed crew training and standardisation.

In 2010, the European Aviation safety Agency issued a Safety Information Bulletin on the subject of *Flight Deck Automation Policy – Mode Awareness and Energy State Management*. The bulletin included a number of recommendations to operators addressing automation policies, procedures and training. A copy of the bulletin is available at http://ad.easa.europa.eu/ad/2010-33. Operators of highly automated aircraft are encouraged regularly review their own automation policies, procedures and training in the context of the recommendations included in the bulletin, and with the benefit of lessons learned from this and similar incidents.

General details

Occurrence details

Date and time:	7 November 2014 – 0631 CST	
Occurrence category:	Incident	
Primary occurrence type:	Aircraft control	
Location:	Near Renmark, South Australia	
	Latitude: 34° 20.09' S	Longitude: 140° 43.30' E

Aircraft details

Manufacturer and model:	Boeing 737-8FE	
Registration:	VH-VUR	
Operator:	Virgin Australia	
Serial number:	36606	
Type of operation:	Air transport – high capacity	
Persons on board:	Crew – Unknown	Passengers – Unknown
Injuries:	Crew – Nil	Passengers – Nil
Damage:	None	

Piston aircraft

Wheels-up landing involving a Cessna 210, VH-JGA

What happened

VH-JGA

Source: Aircraft operator

On 11 November 2014, at about 1130 Eastern Standard Time (EST), a Cessna 210 aircraft, registered VH-JGA (JGA), departed from Cairns Airport, Queensland, for a scenic flight over Green Island and Arlington Reef with the pilot and four passengers on board.

After about half an hour of local flying, the pilot returned JGA to Cairns Airport. During the approach, at about 1,000 ft above ground level, the pilot selected the landing gear down, however, the green landing gear down indicator light did not illuminate. The pilot observed via an inspection mirror that the left main landing gear was just out of the landing gear recess and not in the down and locked position. The nose landing gear and right main landing gear appeared to be in the down position. The pilot advised the Cairns Tower air traffic controller that JGA would conduct a missed approach and requested a clearance to hold over the sea to determine the reason for the malfunction.

While holding over the sea, in the vicinity of Cairns Airport, at about 1,000 ft, the pilot conducted a landing gear emergency extension, but the left main landing gear still did not lock in the down position. The pilot contacted the operator and maintenance organisation via a mobile phone and conducted extensive troubleshooting, but was unable to get the left main landing gear to lock in the down position.

JGA was then returned to Cairns Airport and the pilot conducted a low level pass over the runway so that the landing gear could be observed. The nose landing gear and right main landing gear were observed to be in the down position, while the left main landing gear was observed to be out of the landing gear recess and only extended to about a 45 degree angle. The pilot elected to hold over the sea and reduce the amount of fuel on board, before conducting a landing. The pilot consulted with the operator and the maintenance organisation and decided to land on the grass area, abeam runway 33, with the landing gear retracted.

The pilot of JGA conducted two practice approaches to assess the aircraft configuration and landing area before beginning the approach for a wheels-up landing. The pilot extended the flaps to help slow the aircraft and, after turning onto a long final, briefed the passengers for the landing and instructed them to take up the brace position. Just prior to touchdown, the pilot turned off the master switch and moved the engine mixture control to the cut-off position. At about 1416, the aircraft landed on the fuselage underside on the grass area abeam runway 33 and came to a stop. The pilot and four passengers were uninjured and the aircraft was substantially damaged (Figure 1).

Figure 1: Damage to JGA

Source: *Aircraft operator*

Pilot comment

The pilot had flown the aircraft on a previous flight that day and had not noticed anything unusual. The pilot commented that there was sufficient fuel on board the aircraft so that there was time to investigate the malfunction and to plan and prepare for the landing.

When conducting the emergency extension, the nose and right main gear went straight to the down and locked position before the emergency extension hand pump was used. The hand pump had no effect on moving the left main landing gear.

Operator comment

The operator conducted an investigation into the accident and determined that the housing of the left main landing gear had fractured (Figure 2), resulting in the gear not extending to the down and locked position. The operator reported that they conducted a visual inspection of the left and right main landing gear actuators for cracks and checked the tightness of the actuator mounting bolts at the periodic (100 hourly or 12-month) maintenance inspections with the actuator in-situ. The last inspection was conducted about 50 hours prior to the accident, with no defects found.

JGA was manufactured in 1981 and, at the time of the accident, the aircraft had about 12,882 hours total time in service. The aircraft was maintained under the Civil Aviation Safety Authority (CASA) maintenance schedule (*Civil Aviation Regulations 1988* (CAR) *Schedule 5*). The left main landing gear was a non-lifed component and had been on the aircraft since new. There was no record that the actuator had been overhauled.

Figure 2: JGA left main landing gear actuator showing the fractured housing

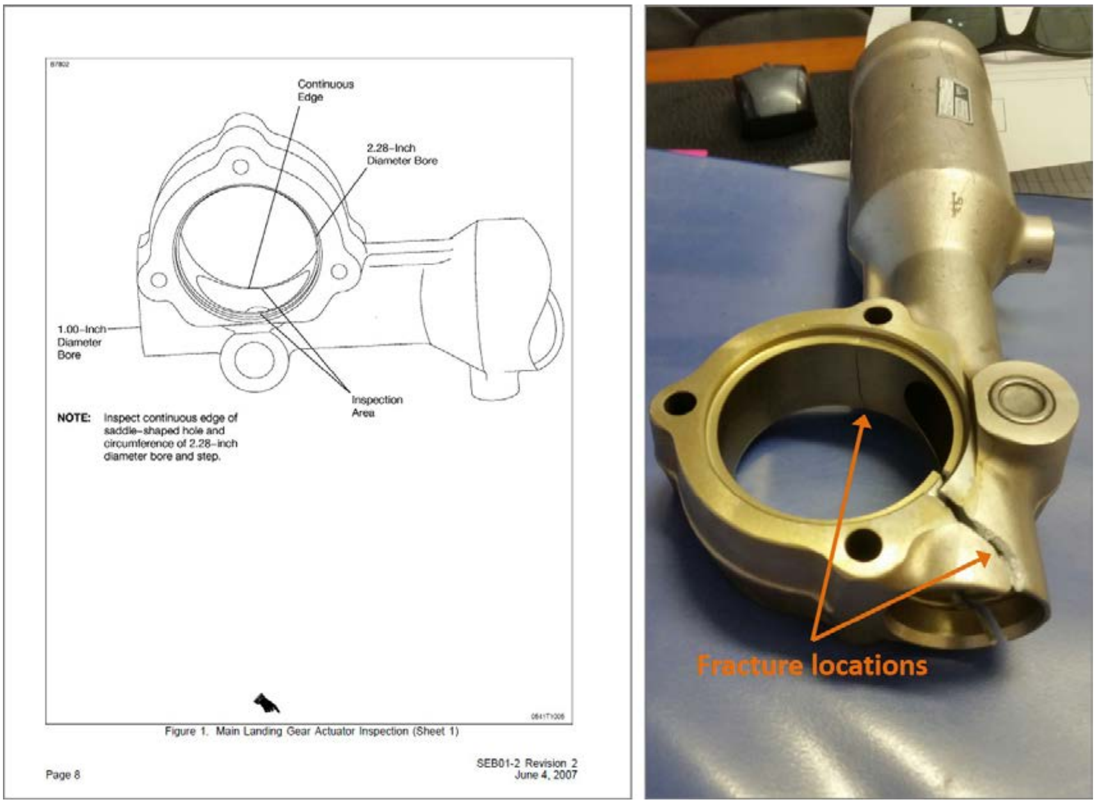
Source: *Aircraft operator*

Cessna service manual

The Cessna 210 aircraft service manual contained a Supplemental Inspection Document (SID) 32-10-01 (temporary Revision Number 10 dated 1 August 2011) with a compliance date by 31 December 2013 that directly related to the removal and detailed inspection of the main landing gear retraction system. The inspection was to be carried out initially every 3,000 hours total time in service or 10 years whichever occurred first and repeated every 500 hours or 5 years whichever occurred first (JGA was manufactured in 1981 and had about 12,882 hours total time in service). The SID also required verification that Cessna Service Bulletin SEB01-2 *Main Landing Gear Actuator Inspection* has been accomplished. The Cessna 200 series SIDs were introduced in August 2011 and the CASA current compliance dates have been extended until 30 June 2015 for aerial work and charter operations and 31 December 2015 for private operations to allow for sufficient time for full compliance.

Cessna Service Bulletin SEB01-2 *Main Landing Gear Actuator Inspection* revision 2 dated 4 June 2007, required the inspection of the main landing gear actuators for the presence of cracks. Indicating that non-compliance with the service bulletin could result in failure of the main landing gear actuator. The service bulletin required the removal and disassembly of the main landing gear actuators and a fluorescent penetrant inspection of the actuator body to be carried out using black light and a magnifying glass to detect any cracks (Figure 3). The inspection was to be carried out initially every 3,000 hours total time in service within the next 100 hours operation and subsequent inspections every 500 hours total time in service thereafter.

Figure 3: JGA left main landing gear actuator showing the fractured housing



Source: *Cessna* *Aircraft operator*

Aircraft maintenance

The aircraft operator reported that all Service Letters and Service Bulletins are reviewed by the maintenance organisation and implemented based on experience and at their request.

Information provided to the operator by the aircraft maintenance organisation was that the actuator fractured in what appeared to be one clean break and not a crack that slowly progressed, and that type of crack could occur in a sudden overload situation during the take-off when the landing gear is selected up and the wheels contact the ground. The maintenance organisation also recommended that the Service Bulletin requirements be carried out on aircraft that have exceeded 5,000 airframe hours.

ATSB comment

ATSB investigation AO-2011-115

The ATSB investigation AO-2011-115 *Flight control system event involving Cessna 210N, VH-JHF, 48 km West of Bourke Airport, NSW, 12 September 2011* found that reported elevator control input difficulties resulted directly from the fracture of the aircraft's two horizontal stabiliser rear attachment brackets. The nature of the failures was typical of the damage sustained by aircraft as they age and move beyond the manufacturer's originally intended design life.

The investigation found at the time, that some aircraft registration holders believed that their aircraft was exempt from the manufacturer's supplemental inspections, such as the Cessna SIDs when their aircraft was maintained using the CASA maintenance schedule (*Civil Aviation Regulations 1988* (CAR) *Schedule 5*). While the CASA maintenance schedule did not make any specific reference to the incorporation of the manufacturer's supplemental inspections, it was a CAR requirement that all aircraft be maintained in accordance with approved maintenance data that, by definition, included those inspections.

The ATSB investigation report AO-2011-115 is available at
www.atsb.gov.au/publications/investigation_reports/2011/aair/ao-2011-115.aspx.

CASA Airworthiness Bulletin (AWB) 02-048

CASA issued Airworthiness Bulletin (AWB) 02-048 *Compliance with Cessna Supplemental Inspection Documents (SIDs)* on 7 April 2014 to clarify the requirement to comply with Cessna SIDs. The AWB comprised Aviation Ruling 01/2014, which stated that compliance with the Cessna SIDs was mandatory, irrespective of the category of operation or the elected maintenance schedule for the aircraft, be it:

- CAR 42A Manufacturer's Maintenance Schedule,
- CAR 42B CASA Maintenance Schedule (Schedule 5), or
- CAR 42C Approved System of Maintenance.

The AWB also stated that:

> *Significantly, the SIDs were developed on the assumption that the aircraft had been maintained using the Manufacturer's Maintenance Schedule, or equivalent (including the incorporation of all applicable Service Bulletins), and do not necessarily take into account modifications or repairs made to the aircraft since manufacture. Therefore, all relevant Service Bulletins need to be incorporated to be in compliance with the SIDs inspections.*

Since the accident involving JGA, CASA released Issue 2 to AWB 02-048, dated 10 April 2015, to clarify that those service bulletins listed in the SIDs are required to be incorporated and confirmed that, where specified in the SIDs, on-going inspections are also required to be complied with.

The AWB further stated that:

> *Therefore, all Service Bulletins that directly relate to the structural integrity of the aircraft need to be incorporated to be in compliance with the SIDs inspections. Please note that some Service Letters and other information referred to in the SIDs requirements were originally discretionary in nature. These documents are now considered mandatory if referred to as part of the SIDs inspections requirements in relation to [principal structural elements (PSEs)] PSEs.*

Further information can be found in AWB 02-048, which is available at:
www.casa.gov.au/wcmswr/_assets/main/airworth/awb/02/048.pdf

US Federal Aviation Administration (FAA) Service Difficulty Reporting (SDR) database

A search of the US Federal Aviation Administration (FAA) Service Difficulty Reporting (SDR) database found about 65 entries dated from 1995 to 2014 of reported crack or cracks in the main landing gear actuator/s, in the same crack location as specified in the service bulletin or in that area and with the same part number as JGA's actuator or one of the actuator part numbers listed in the service bulletin. Five entries had originated from Australia. About 20 reports resulted in an inflight incident and eight mentioned landing with the landing gear in the up position or without both main landing gear in the down position.

Although most reports indicated that the crack or cracks were located in the same area specified in the service bulletin, about 15 indicted they originated from one or more of the actuator attachment bolt holes. About 13 cracks had been located while carrying out the requirements of the service bulletin and the same number again were located while conducting a fleet inspection of the actuator. Several mentioned that this is an ongoing issue and suggested that the actuator be redesigned. One report mentioned a loose actuator attachment bolt, while two mentioned that the bolts were correctly torqued.

Although some entries lacked details, about seven specifically mentioned they were found during a scheduled inspection. One mentioned that the actuator had failed 25 hours after a 100 hourly inspection, which specifically checked the actuators externally for cracks. About three entries reported that the actuator had failed subsequently from conducting the requirements of the service bulletin. One reporter indicated that an inspection should be conducted on the actuator any time that the landing gear contacts the ground in other than the fully extended or fully retracted position.

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.

Operator

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

Maintenance action

The operator's Cessna 210 aircraft fleet will undergo further examination to see if there is any evidence of other potential failures within the fleet.

Safety message

This accident highlights the importance of comprehensive, periodic maintenance inspections and the role of supplemental inspections in maintaining ageing aircraft. As aircraft age, the original maintenance schedules may not be sufficient to ensure the aircraft's ongoing safety. It is important to review the aircraft's maintenance schedule to ensure it is appropriate for the aircraft and that it adequately provides for the continuing airworthiness of the aircraft.

In 2007, the ATSB released research report B20050205 - *How Old is Too Old? The impact of ageing aircraft on aviation safety,* www.atsb.gov.au/publications/2007/b20050205.aspx. The report found that some aircraft manufacturers have recognised that the original maintenance schedules may not be sufficient to ensure the aircraft's (ongoing) safety and have developed supplementary inspection programs (such as the Cessna SIDs); other aircraft do not have the same level of airworthiness support. The report concluded that adequate maintenance of ageing aircraft requires the participation and ongoing cooperation of aircraft manufacturers, regulatory authorities, owners, operators and maintainers.

In addition, further information is detailed in CASA's Ageing Aircraft Management Plan (AAMP) that is available at www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_100381. CASA Flight safety Australia June 2014 Doing it right is available at: www.flightsafetyaustralia.com/2014/06/

CASA Flight Safety Australia December 2014 SIDS program finds dangerous defects is available at: www.flightsafetyaustralia.com/2014/12/ .

General details

Occurrence details

Date and time:	11 November 2014 – 1416 EST	
Occurrence category:	Accident	
Primary occurrence type:	Technical – Airframe – Landing gear	
Location:	Cairns Airport, Queensland	
	Latitude: 16° 53.15'S	Longitude: 145° 45.32' E

Aircraft details

Manufacturer and model:	Cessna Aircraft Company 210N	
Registration:	VH-JGA	
Serial number:	21064222	
Type of operation:	Charter - Passenger	
Persons on board:	Crew – 1	Passengers – 4
Injuries:	Crew – 0	Passengers – 0
Damage:	Substantial	

Engine failure and forced landing involving Cessna 210, VH-TWD

What happened

VH-TWD near Ringer Soak

Source: Pilot

On 28 November 2014, a Cessna 210 aircraft, registered VH-TWD (TWD), was being operated on a charter flight from Broome, Western Australia. On board were the pilot and four passengers.

At about 1135 Western Standard Time, the aircraft landed at Fitzroy Crossing to refuel before continuing to Balgo Hill Western Australia, where three of the passengers disembarked (Figure 1).

At 1202, the aircraft departed Balgo Hill for the Ringer Soak aeroplane landing area (ALA) Western Australia, where the remaining passenger was due to disembark. About 25 NM from Ringer Soak, while cruising at 5,500 ft, the pilot noticed a low oil pressure indication. He reported that all other engine instruments were within normal parameters. As Ringer Soak was only a few minutes away, he elected to continue and assess the situation after landing.

Figure 1: TWD flight route

Source: Google earth

Shortly after, the pilot detected a burning smell in the cockpit, followed by a loud bang from the engine. The engine started to vibrate and make an abnormal sound, and a small amount of white smoke emanated from the front section. The pilot immediately commenced the memory items from the emergency checklist, but there was no response from the engine. After shutting down the engine, he pitched the aircraft up slightly to both gain some altitude and to allow the speed to decrease. After configuring the aircraft for the best glide speed of about 80 kt, and with one stage of flap selected, he searched for a suitable landing area amongst the predominantly thick scrub and trees in the surrounding area. He eventually located an area that was more open, and during this time he also completed the emergency checklist to cover any items he may have missed during his initial actions.

Due to the intermittent communication at low altitudes in remote locations, the pilot then broadcast MAYDAY[1] on the Brisbane Centre frequency, and then switched on the emergency locator transmitter. Brisbane Centre gave assistance to the pilot and initiated a search and rescue phase. The pilot then briefed his passenger on the emergency procedures, and prepared for a forced-landing. Due to the rough terrain, he elected to keep the landing gear retracted and unlatched both doors and briefly turned on the master switch to fully extend the flaps.

He prepared the aircraft for touchdown with the tail in a lower than normal position. The aircraft impacted the ground firmly and slid forward at least 20 m before it came to rest. The passenger immediately exited using the right door, and after checking all switches were off, the pilot exited the left door.

The passenger reported he had a minor head injury while the pilot was uninjured. The aircraft was substantially damaged (Figure 2).

Post-accident activities

After retrieving the first aid kit, emergency rations and the Global Positioning System from the aircraft, the pilot set up a temporary shelter under the aircraft wing, while they awaited rescue. He communicated via very high frequency (VHF) radio with three separate aircraft deployed at different times by Air Traffic Control to overhead the accident. This enabled messages to be relayed to and from Brisbane Centre and the pilot. He conserved the aircraft battery by only turning on the power to communicate briefly which each aircraft and at one hourly intervals. At about 1500, a helicopter arrived to retrieve the pilot and passenger and ferry them to Halls Creek.

Figure 2: VH-TWD after emergency equipment had been retrieved

Source: Pilot

[1] Mayday is an internationally recognised radio call for urgent assistance

Weather

The weather enroute was fine with scattered cloud at about 7,000 ft. It was the wet season in northern Australia, and was typically hot and humid, with a temperature in excess of 38°C.

The aircraft

In July 2013, TWD was fitted with a factory rebuilt Continental IO-550 engine. Since installation of the engine, the aircraft had completed 1,059.5 hours. During this time, the operator had observed an unusually high oil consumption.

On 19 November 2014, the aircraft used 7 quarts[2] of oil during a 4.7 hour flight. This resulted in the aircraft being taken out of service for maintenance. Engineers found that cylinders number 3, 4 and 5 had glazed walls; these were honed and replaced. The piston rings were also removed and replaced. After a test flight, the aircraft was returned to service. The accident flight was the aircraft's first commercial flight since being returned to service.

The operator conducted a further trend analysis of the aircraft's oil consumption. They found that TWD had flown 168.3 hours, and used 152 quarts of oil which was about twice the typical consumption rate of about 0.43 quarts per hour.

Pilot experience and comments

The pilot had accrued about 3,270 hours total flight time with about 967 hours on Cessna 210 aircraft.

On the day of the flight, he had conducted the aircraft pre-flight inspection and submitted a flight plan as normal. The pilot checked the oil quantity as part of the pre-flight inspection at Broome and noted it was 8.6 quarts. The normal oil quantity range for this aircraft was 8-10 quarts. Due to the high weight of the payload, and as per normal procedure, the aircraft had to depart with less than full fuel and refuel at planned stops throughout the flight.

Due to the late arrival of one of the passengers, the flight was delayed for about one and a half hours. The pilot felt some concern about trying to regain some of this lost time in order to provide a timely service. He also reported that the passenger for Ringer Soak was quite anxious to get to his destination.

Engine examination

The insurance assessor advised the ATSB that the engine has been relocated to Perth for further examination. At the time of publication of this report, the reason for the engine failure had not been determined.

Operator comments

The operator conducted an internal investigation into the accident, and provided their report to the ATSB, where they raised concerns about the reliability of the factory overhauled IO-550 engines that had been installed in two of their C210 aircraft.

Major points from the company report are listed below.

- Although the pilot checked the fuel at every stop on the flight, he did not manually check the oil quantity. Due the late arrival of a passenger at Broome, the pilot had departed 1.5 hours behind schedule. It is likely this influenced the pilot's decision not to spend time manually checking the oil quantity at each stop.
- In hindsight, TWD may have been unsuitable for the long flights to/from the more remote ports. Even though the aircraft was considered serviceable it may have been more appropriate for TWD to remain on short flights to further analyse the oil usage rates.

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2 10 quarts is equivalent to 9.46 L

CASA Comment

The ATSB raised the issue of IO-550 engine failures with the Civil Aviation Safety Authority (CASA).

CASA completed a review of their database, and although there had been several failures of this engine type, there have been a number of different causal factors. After examining the information, they determined that there was no increasing trend of failures in this engine type.

Engine manufacturer

The ATSB contacted the engine manufacturer and will continue to liaise with them in regard the IO-550 engine.

ATSB comment

In the past 12 months, the ATSB has investigated three accidents involving engine failures of factory re-built IO-550 engine. At this stage, it has not been possible to determine any links between the accidents.

Safety actions

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.

The operator

As a result of this occurrence, the aircraft operator has advised the ATSB that they are taking several safety actions, some of which are listed below:

Flight restriction for other aircraft installed with a IO-550 engine

The company have placed a flight restriction on their other Cessna 210 aircraft fitted with an IO-550 engine. Until more trend data is available, they have restricted this aircraft to shorter, close to base flights.

Assistance from operations section

To promote better support from different sections of the company, the operations section will now assist flight crew when dealing with issues such as late passengers, loading and cargo problems and also to help determine a go-no-go time for delayed flights.

Maintenance controller

The maintenance controller is to more closely consider aircraft that have unusual, but acceptable usage of oil or other similar types of issues. These aircraft are to be flagged to the operations and safety section for closer trend monitoring, and also only utilised on shorter flights.

Chief pilot

The chief pilot will conduct flight crew refresher training on issues such as flight log and maintenance release entries, SARTIME and procedural requirements.

Chief engineer

The chief engineer will arrange for additional instruction to be available for engineers working on the IO-550 engine, and provide a go-to expert to contact for further information.

Company Procedures

The company noted that their operations manual detailing the correct operating procedures for the IO-550 engine contained some ambiguous instructions. The manual will be amended to better clarify the intent of its content.

Safety message

As was displayed in this instance, it is a timely reminder for pilots to be well rehearsed in both emergency procedures and to be pro-active in the post-accident survival phase, especially when operating in a remote area.

Section 5 – Emergency Procedures of the Visual Flight Rules (VFRG) guide gives an overview of planning for and dealing with emergency situations in aviation.

It is available at:

www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_90008

While no one ever plans to get into trouble, the possibility of an emergency situation should always be considered by all pilots before take-off. When faced with an engine failure in a remote area, there are extra survival considerations both prior to and immediately the aircraft has 'landed', as usually there will be an inevitable wait for assistance to arrive.

The Rescue Coordination Centre of the Australian Maritime Safety Authority (AMSA) produced a short booklet which highlights some of the considerations for preparedness for operations in remote areas.

The link to the publications is available at:

www.amsa.gov.au/forms-and-publications/Publications/AviationSearchandRescue.pdf

General details

Occurrence details

Date and time:	28 November 2014 1235 WST	
Occurrence category:	Accident	
Primary occurrence type:	Engine failure	
Location:	111 km south-east of Halls Creek Airport (near Ringer Soak ALA) Western Australia	
	Latitude: 18° 58.87' S	Longitude: 128° 22.38' E

Aircraft details

Manufacturer and model:	Cessna Aircraft Company 210N (IO-550 engine)	
Registration:	VH-TWD	
Serial number:	21064356	
Type of operation:	Charter - passenger	
Persons on board:	Crew – 1	Passengers – 1
Injuries:	Crew – Nil	Passengers – 1 (minor)
Damage:	Substantial	

Near collision involving a Diamond DA20, VH-YNB and a Mooney M20, VH-SJT

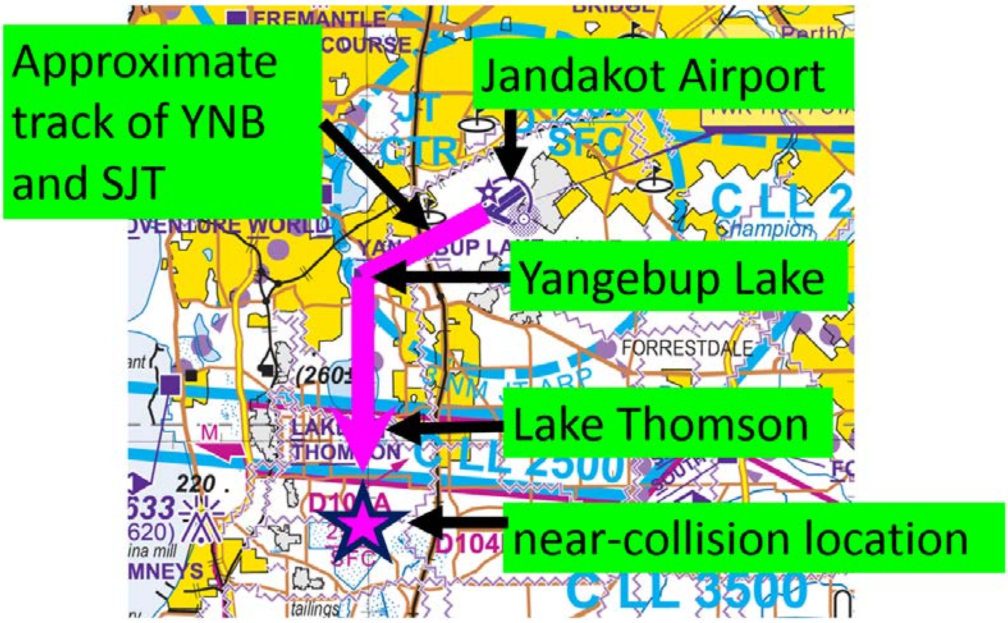
What happened

On 20 February 2015, at about 1130 Western Standard Time (WST), a Diamond DA20 aircraft, registered VH-YNB (YNB), taxied at Jandakot Airport, Western Australia, for a flight to the training area south of the airport, with a trainee instructor and a flight instructor on board. The instructor was seated in the left seat and acting as a student pilot, with the trainee instructor in the right seat. The sequence to be practiced was climbing and descending, with emphasis on keeping a good lookout and maintaining awareness of other traffic at all times.

At about the same time, the pilot of a Mooney M20 aircraft, registered VH-SJT (SJT), taxied for a private flight to Busselton Airport with three passengers on board. The instructor of YNB observed the Mooney taxiing. During the taxi, the pilot of SJT demonstrated to the front seat passenger, how to close the aircraft door. The pilot then elected to leave the door open to improve comfort in the aircraft as it was a warm day, and planned to have the passenger close the door prior to take-off.

At about 1136, the aerodrome controller (ADC) cleared YNB for take-off from runway 24 Right (24R) and advised the pilot of helicopter traffic ahead, which the trainee instructor reported in sight. About 16 seconds later, the pilot of SJT reported ready at the holding point for runway 24R. The ADC cleared SJT for take-off about 23 seconds later, at 1137, and did not advise of any traffic. The pilot of SJT then commenced the take-off run and directed the front seat passenger to close the door. The front seat passenger was unable to fully close the door, resulting in air flowing in on the passengers seated in the back seat and articles being blown around inside the cabin. The pilot continued with the take-off and asked the passengers to stay calm and silent, and the door was left partially open. Both aircraft departed Jandakot via Yangebup Lake at about 1,000 ft (Figure 1).

Figure 1: Perth Visual Terminal Chart with relevant points overlaid



Source: Airservices Australia annotated by the ATSB

After passing Yangebup Lake, the trainee instructor of YNB switched the radio from Jandakot Tower to Perth Centre frequency and changed the transponder code from 3000 to 1200.[1] The pilot of SJT did likewise, and when changing the transponder code, realised that he had departed with the transponder selected to 'Standby' rather than 'Alt'. He observed a high-wing aircraft about 2 NM away in his 2 o'clock position[2] and assumed it was the aircraft that had departed Jandakot ahead of him and assessed that his track to Lake Thomson would be well clear of that aircraft. He then turned onto a heading of 192° and established the aircraft in a climb to 1,500 ft.

When overhead Lake Thomson, the trainee instructor of YNB conducted a climb to 1,500 ft. At 1,500 ft, he lowered the aircraft nose and levelled off to check the area ahead was clear of traffic and both pilots scanned from right to left and did not see any aircraft. The instructor then observed SJT pass diagonally from behind and left to right about 20 ft above YNB. The trainee instructor sighted SJT as it appeared from overhead to pass YNB.

At about 1141, the instructor of YNB called the pilot of SJT on Perth Centre frequency and advised that SJT had just passed straight over the top of them. The pilot of SJT responded and looked behind but did not see YNB. He assumed that it was the pilot of the high-wing aircraft, some distance away, who had contacted him and did not believe there was any risk of collision. SJT continued to Busselton with the door partially open.

At about 1144, the instructor of YNB asked the Tower controller whether SJT had been given YNB as traffic and as the ADC had handed over to another controller, was told they would find out but did not subsequently provide a response.

Pilot comments

The pilot of SJT reported that in future he plans to absolutely identify the type, and maintain visual contact with, aircraft in the control zone. He had misidentified the aircraft he sighted and should have realised it was not the Diamond that had taken off in front of him. In future, he would close the door himself prior to commencing the take-off run. Despite the distraction from the passengers due to the open door, he maintained his focus on the take-off, initial climb and after take-off checks. The distraction may have resulted in his misidentifying the aircraft ahead.

Airservices Australia investigation

Airservices Australia conducted an internal investigation into the incident and found the following:

Both aircraft were operating under the visual flight rules (VFR) and the take-off clearance was issued to SJT about 60 seconds after the clearance was issued to YNB.

The Manual of Air Traffic Services (MATS) Version 30 section 9.1.5 Traffic Information, paragraph 9.1.5.1 stated that in Class D airspace VFR aircraft will be provided traffic information on other VFR aircraft. Section 9.1.6 Traffic information assessment and content, paragraph 9.1.6.2 stated to 'Pass traffic information to qualifying aircraft when data assessment indicates the possibility of conflict'.

No traffic information was passed to SJT on the preceding departure of YNB. The controller assessed that based on the existing separation at departure and the expected speed differential of the aircraft, no possibility of conflict existed inside Class D airspace between YNB and SJT.

The information available suggested that the aircraft came into conflict 2 NM beyond the Jandakot control zone boundary. The absence of secondary surveillance radar data for SJT was consistent with the pilot report that their transponder remained in standby mode until approximately the time of the conflict with YNB. As both aircraft were then outside controlled airspace they were not

[1] 3000 is the generic code used for civilian flights in class D airspace and 1200 is the code used for VFR flights in class G (or E) airspace.

[2] The clock code is used to denote the direction of an aircraft or surface feature relative to the current heading of the observer's aircraft, expressed in terms of position on an analogue clock face. Twelve o'clock is ahead while an aircraft observed abeam to the left would be said to be at 9 o'clock.

subject to a separation service. Due to the absence of surveillance data for SJT, no opportunity existed for a controller to identify the conflict.

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.

Operator of VH-YNB

As a result of this occurrence, the operator of YNB has advised the ATSB that they have reminded all students and company pilots to remain vigilant in looking outside for other aircraft.

Safety message

This incident highlights the importance of being aware of other aircraft operating in the area, particularly around airport departure points. While operating in Class D airspace, pilots and air traffic control have a dual responsibility to maintain situational awareness of other traffic. When departing into Class G airspace it is important for pilots to continue their awareness of other aircraft and to keep a good lookout at all times.

Distractions such as an open door can adversely affect the safety of a flight. The ATSB research report *Dangerous Distraction: An examination of accidents and incident involving pilot distraction in Australia between 1997 and 2004*, www.atsb.gov.au/publications/2005/distraction_report.aspx, stated that the most serious source of pilot distraction occurred as a result of an unexpected equipment malfunction.

Two similar incidents were investigated by the ATSB where an open door resulted in pilot distraction. The reports are available at the following links:

www.atsb.gov.au/media/4532960/ao-2013-191_final.pdf

www.atsb.gov.au/media/4082078/ao-2012-151_final.pdf

General details

Occurrence details

Date and time:	20 February 2015 – 1150 WST	
Occurrence category:	Serious incident	
Primary occurrence type:	Near collision	
Location:	near Jandakot Airport, Western Australia	
	Latitude: 32° 05.85' S	Longitude: 115° 52.87' E

Aircraft details: VH-YNB

Manufacturer and model:	Diamond Aircraft Industries	
Registration:	VH-YNB	
Serial number:	C0308	
Type of operation:	Flying training – dual	
Persons on board:	Crew –2	Passengers –Nil
Injuries:	Crew – Nil	Passengers – Nil
Damage:	Nil	

Aircraft details: VH-SJT

Manufacturer and model:	Mooney Aircraft Corporation	
Registration:	VH-SJT	
Serial number:	24-1537	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – 3
Injuries:	Crew – Nil	Passengers – Nil
Damage:	Nil	

Runway overrun involving an Aero Commander 500, VH-WZV

What happened

On 8 March 2015, the pilot of an Aero Commander 500 aircraft, registered VH-WZV, prepared to conduct a charter flight from Badu Island to Horn Island, Queensland, with five passengers. The aircraft had been refuelled earlier that day at Horn Island, where the pilot conducted fuel drains with no contaminants found. He had operated the aircraft for about 2 hours prior to landing at Badu Island with no abnormal performance or indications.

At about 1330 Eastern Standard Time (EST), the pilot started the engines and conducted the standard checks with all indications normal, obtained the relevant clearances from air traffic control, and taxied for a departure from runway 30. As the pilot lined the aircraft up on the runway centreline at the threshold, he performed a pre-take-off safety self-brief and conducted the pre-take-off checks. He then applied full power, released the brakes and commenced the take-off run. All engine indications were normal during the taxi and commencement of the take-off run.

When the airspeed had increased to about 80 kt, the pilot commenced rotation and the nose and main landing gear lifted off the runway. Just as the main landing gear lifted off, the pilot detected a significant loss of power from the left engine. The aircraft yawed to the left, which the pilot counteracted with right rudder. He heard the left engine noise decrease noticeably and the aircraft dropped back onto the runway. The pilot immediately rejected the take-off; reduced the power to idle, and used rudder and brakes to maintain the runway centreline.

The pilot initially assessed that there was sufficient runway remaining to stop on but, due to the wet runway surface, the aircraft did not decelerate as quickly as expected and he anticipated that the aircraft would overrun the runway. As there was a steep slope and trees beyond the end of the runway, he steered the aircraft to the right towards more open and level ground. The aircraft departed the runway to the right, collided with a fence and a bush resulting in substantial damage (Figure 1). The pilot and passengers were not injured.

Figure 1: Damage to VH-WZV

Source: Aircraft engineer

Engineering inspection

An engineering inspection was carried out following the incident. The engineer reported that both engines started and ran without problems and that he ran both engines to full power for sufficient time to establish that there were no obvious defects with the engines and that both engines produced full power. The magneto drop checks were within limits and fuel flows were normal. Both engines appeared to be in their normal configuration with the appropriate quantities of oil and no defects were noted.

The engineer also reported that there was adequate fuel on board the aircraft, and no contaminants were present in the fuel. The engineer verified that the propeller operation and feather checks were functional.

Pilot comments

The pilot reported that the fuel for both engines was selected to ON. At no time had either been selected to OFF, as it was not normal procedure to switch the fuel off when shutting the aircraft down.

Operator report

A report prepared by the aircraft operator, and provided to the ATSB, included the following:

- Due to the prevailing conditions of a wet runway and the extremely powerful brakes fitted to the aircraft type, the wheels locked up and the aircraft skidded off the end of the runway. The operator stated that it was easy to aquaplane or lock the brakes in wet or emergency situations.
- The aircraft was loaded within the weight and balance limitations and was 67 kg below the take-off weight for the available runway length, based on the approved performance charts.
- Passengers on the flight commented on a problem with the left engine at the time of the incident.
- Further engineering assessment of the engine and ancillaries will include fuel on board, fuel pumps (engine driven and electric), fuel control unit, magneto ignition systems, engine air intake system and other systems likely to contribute to a loss of engine power.

Safety message

In this incident the pilot had identified the safest run-off area in the event of an engine failure. Having completed a thorough pre-take-off safety briefing, following partial engine failure, the pilot was able to steer the aircraft to a relatively clear area that he had identified. This may have reduced the amount of damage the aircraft sustained, and the potential for injuries to the pilot and passengers.

The ATSB publication Avoidable Accidents No. 3 – *Managing partial power loss after takeoff in single-engine aircraft,* available at www.atsb.gov.au/publications/2010/avoidable-3-ar-2010-055.aspx, states that a pre-flight safety brief, including planning a rejected take-off, gives pilots a much better chance of maintaining control of the aircraft, and helps the pilot respond immediately in the event of a partial loss of engine power.

General details

Occurrence details

Date and time:	8 March 2015 – 1230 EST	
Occurrence category:	Accident	
Primary occurrence type:	Runway excursion	
Location:	Badu Island (ALA), Queensland	
	Latitude: 10° 09.00' S	Longitude: 142° 10.45' E

Aircraft details

Manufacturer and model:	Aero Commander 500-U	
Registration:	VH-WZV	
Serial number:	1656-11	
Type of operation:	Charter - Passenger	
Persons on board:	Crew – 1	Passengers – 5
Injuries:	Crew – Nil	Passengers – Nil
Damage:	Substantial	

Collision on the ground involving a Piper PA-28, VH-TXH and a Cessna 172, VH-EUU

What happened

On 11 April 2015, the student pilot of a Piper PA-28 aircraft, registered VH-TXH (TXH), prepared to conduct a solo, local flight, from Moorabbin Airport, Victoria. The flight was to be the pilot's second solo to the training area, where he was to practice simulated forced landings. The pilot inspected the aircraft, including checking the oil quantity and colour. He noted that the dipstick indicated 5.5 L of oil and the oil appeared to be of a golden colour. After completing the pre-flight checks, the pilot of TXH taxied the aircraft to the run-up bay and performed engine run-ups. He noted that all indications were normal and within the required performance limits.

At 11:29:06 Eastern Standard Time (EST), the pilot made a radio call to the Moorabbin surface movement controller (SMC) on the Ground frequency, advising that he was conducting a solo flight to the training area and requested a departure from runway 35 Right (35R). The SMC cleared TXH to taxi via taxiway A for a departure from runway 35R. TXH then taxied to the holding point for runway 35R, and, at 11:36:37, the pilot of TXH contacted the aerodrome controller – east (ADC1) on the Tower East frequency. He reported ready for take-off, and ADC1 cleared TXH for take-off.

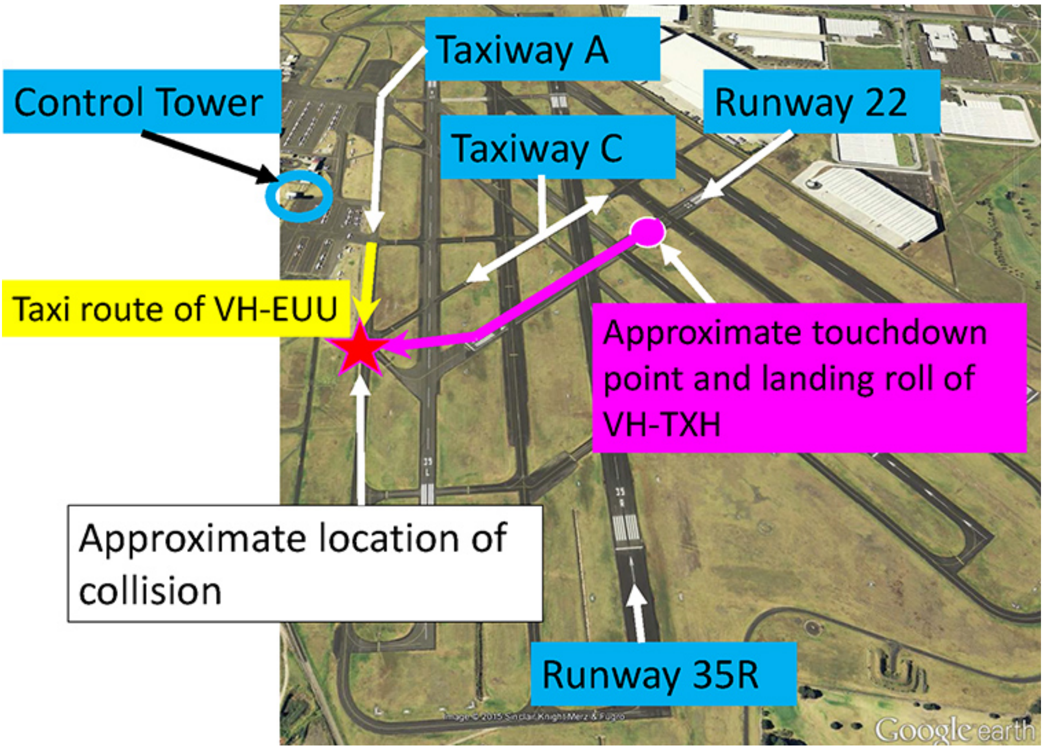
At 11:37:08, the pilot of a Cessna 172 aircraft, registered VH-EUU (EUU), contacted the SMC and requested a clearance to taxi for a local private flight, with three passengers on board. The SMC cleared EUU to taxi to runway 35R via taxiway A, and the pilot commenced taxiing.

The pilot of TXH reported that the take-off run was normal, with the engine indications in the normal range. After rotation, when about 150 ft above ground level (AGL), the engine began to run roughly. The pilot lowered the aircraft nose slightly and within 2-3 seconds, the engine regained full power and the aircraft continued to climb. When approaching 500 ft AGL, the engine again ran roughly and partially lost power. The pilot suspected a fuel issue to be the cause of the rough running, and, as the fuel pump was still on, changed the selected fuel tank. The engine returned to producing full power and the pilot initiated a right climbing turn, leaving the fuel pump switched on. As the aircraft climbed, the engine lost power again.

At 11:37:58, the pilot advised ADC1 that he had a 'spluttering engine' and requested a return to land. ADC1 had observed TXH in the initial climb and noted that it did not appear to be climbing out normally and was then quite low, at an estimated 300 ft AGL. ADC1 initially responded that TXH was number one for runway 35R and then offered runways 22 or 31 if required. The pilot responded that he would use runway 22 (Figure 1).

ADC1 gave TXH priority to land over all other aircraft, advised the SMC of an aircraft with engine trouble, requested runway 22, and coordinated with the SMC for release of runway 22 (see section: *Air traffic control*). The SMC checked the crossing taxiways, helicopter traffic and for any works in progress that may have conflicted with the use of runway 22, then handed ADC1 the green runway strip for runway 22. ADC1 then placed the strip in the runway bay on the console. ADC1 also coordinated with the aerodrome controller – west (ADC2), who instructed a couple of aircraft in the circuit for runway 35 Left (35L) to go-around to ensure they remained clear of the crossing runway. ADC1 instructed the pilots of two aircraft that were in the circuit for runway 35R to go-around and another to conduct a full stop landing. The SMC reported then focusing on checking the runways and taxiways crossing runway 22. Taxiway A did not cross runway 22, and as the SMC remained seated, was unable to see EUU on taxiway A as it was obstructed by the tower console.

Figure 1: Moorabbin Airport, aircraft tracks and collision point



Source: Google earth annotated by the ATSB

At 11:39:06, ADC1 cleared TXH to land on runway 22. The pilot of TXH conducted a tight right turn towards runway 22 and as he was concerned about clearing the buildings on the approach to runway 22, he did not select any flap. After passing over the buildings, the pilot reduced the power to idle. He reported that the aircraft touched down about one third of the way along runway 22. ADC1 observed that TXH appeared to land about half way along the runway and did not decelerate normally after touching down. The SMC observed that TXH appeared very low on final approach to runway 22 and crossed the threshold travelling very fast. The ADC1 stated to the SMC and ADC2 controllers 'he's landed long' and 'gee he's quick'.

The pilot of TXH assessed that he was not going to be able to stop the aircraft prior to the end of the sealed runway, but that there was a suitable grassed overshoot area beyond it, and maintained the aircraft on the runway centreline. ADC2 was standing up, and sighted EUU on taxiway A. ADC2 alerted the SMC to the Cessna (EUU) on taxiway A. ADC1 observed that EUU was then still north of the extended centreline of runway 22 on taxiway A.

As TXH approached the end of runway 22, the pilot of TXH sighted EUU taxiing on taxiway A to his right, and was unsure whether it was going to stop or not. He veered TXH to the right in an attempt to pass behind EUU and avoid a collision. At 11:39:25, the SMC directed EUU to 'hold position, STOP, STOP'. The pilot of EUU braked immediately and as his body moved forward in response to the aircraft braking, he sighted TXH in his left peripheral vision. The pilot of TXH saw EUU brake suddenly.

The pilot of EUU assessed that if he stopped there, TXH would collide squarely with EUU, so he released the brakes and progressed forwards. The left wing of TXH then struck the tail of EUU and spun EEU around through about 180°. TXH continued veering to the right for about 20 m further before coming to rest on a grassed area (Figure 2).

Figure 2: Accident site

Source: Airport Operator

The pilot of TXH observed fuel spilling from the ruptured fuel tank and immediately exited the aircraft and reported that he was not injured. The pilot of EUU reported that he momentarily lost consciousness at the time of the collision, but came to within seconds. He then observed fuel leaking, and although feeling disoriented, he conducted a normal aircraft shut down, including switching off the aircraft electrics and fuel. He and the passengers disembarked and were treated for minor injuries. Both aircraft sustained substantial damage (Figures 3 and 4).

Figure 3: Damage to VH-TXH

Source: Airport operator

Figure 4: Damage to VH-EUU

Source: Airport Operator

Pilot comments

The pilot of TXH provided the following comments:

- He did not declare an emergency as he assessed that he would be able to land the aircraft safely. He remained calm and focused on his approach to, and landing on, runway 22.
- He wanted to ensure that if the engine failed completely he would have sufficient height to clear the buildings in the approach path of runway 22.
- He did not have sufficient altitude to continue a circuit and land on 35R.
- He was unable to stop the aircraft before the end of runway 22, but if there had not been an aircraft on the taxiway, he would have been able to stop safely in the overshoot area.

The pilot of EUU commented that as he was on Ground frequency and the pilot of TXH was on Tower frequency, he was not aware of TXH until he sighted it immediately prior to the collision. He reported that if he had been directed to stop earlier, it may have averted the collision.

Controller comments

The ADC1 controller provided the following comments:

- The ADC1 offered the pilot of TXH the choice of runways to land on, but did not know what was achievable for the pilot or aircraft.
- The ADC1 and ADC2 controllers both stood up when the pilot of TXH reported engine trouble.
- The incident was a good example of how quickly things happen; about 90 seconds after an aircraft took off it was back on the ground and at least two aircraft had to be sent around in the interim.

The SMC reported checking the works strip under the runway designators in the console. The SMC scanned the eastern helicopter area, checked the taxiways that crossed runway 22 – 'F', 'B' and 'C' for any aircraft waiting to taxi, and did not see anything that may pose a risk to an aircraft landing on runway 22. Taxiway A was not a crossing taxiway for runway 22. The SMC reported that these scans were performed multiple times after the pilot of TXH advised of engine trouble. The SMC further commented that if TXH had maintained the runway centreline, the aircraft would not have collided.

Moorabbin Airport and weather conditions

Runway 22 at Moorabbin was 571 m in length, runway 35R was 1335 m. The wind was from 030° at about 7 kt, resulting in a tailwind on runway 22.

Air traffic control (ATC)

There were three ATC positions active at the time; a combined surface movement controller / coordinator position (SMC), an aerodrome controller – east (ADC1), and an aerodrome controller – west (ADC2). The three controllers were seated in the tower in that order from north to south facing towards the east, and were the only people in the control tower at the time. Runways 35L and 35R were the runways in use prior to the pilot of TXH reporting engine trouble. A runway in use is a runway under the control of an aerodrome controller. All runways are considered 'active' and a clearance is required to cross or enter any runway. The runways other than those in use, were held by the SMC. The ADC1 therefore required the release of runway 22 from the SMC prior to clearing TXH to land. The controller places the runway strips of the runways for which they hold responsibility, in the runway bay of the console.

Engineering inspection

A post-accident inspection of the engine of TXH found a small quantity of oil on the cylinders and some fouling of the spark plugs which may have led to the rough running.

Safety message

The ATSB publication Avoidable Accidents No. 3 – Managing partial power loss after takeoff in single-engine aircraft, found causes of partial power loss after take-off include fuel starvation, spark plug fouling, carburettor icing and pre-ignition conditions. A pre-flight safety brief that considers actions to take following a partial power loss after take-off, gives pilots a much better chance of maintaining control of the aircraft and of responding immediately. Such actions include landing immediately within the aerodrome, landing beyond the aerodrome, and conducting a turn back towards the aerodrome.

A copy of the report is available on the ATSB website here:

www.atsb.gov.au/publications/2010/avoidable-3-ar-2010-055.aspx

General details

Occurrence details

Date and time:	11 April 2015 – 1140 EST	
Occurrence category:	Accident	
Primary occurrence type:	Collision	
Location:	Moorabbin Airport, Victoria	
	Latitude: 37° 58.55' S	Longitude: 145° 06.13' E

Aircraft details: VH-TXH

Manufacturer and model:	Piper Aircraft Corporation PA-28	
Registration:	VH-TXH	
Serial number:	2842325	
Type of operation:	Flying training – solo	
Persons on board:	Crew – 1	Passengers – Nil
Injuries:	Crew – Nil	Passengers – Nil
Damage:	Substantial	

Aircraft details: VH-EUU

Manufacturer and model:	Cessna Aircraft Company 172S	
Registration:	VH-EUU	
Serial number:	172S10266	
Type of operation:	Private – pleasure/travel	
Persons on board:	Crew – 1	Passengers – 3
Injuries:	Crew – 1 (Minor)	Passengers – 3 (Minor)
Damage:	Substantial	

Runway excursion involving a Cessna 404, VH-JOR

What happened

On 12 April 2015, the pilot of a Cessna 404 aircraft, registered VH-JOR (JOR), conducted pre-flight preparations at Broome Airport, Western Australia. The planned task involved a positioning flight from Broome to Derby, before a charter flight with five passengers, from Derby to Pantijan aeroplane landing area (ALA), Western Australia. The distance from Derby to Pantijan was 117 NM, with an estimated flying time of 49 minutes. The pilot reviewed information about the Pantijan airstrip in company documentation and using Google earth (Figure 1). He also arranged for the condition of the runway to be assessed by a contact person at Pantijan and the pilot of a helicopter scheduled to arrive at Pantijan before JOR.

Figure 1: Pantijan ALA

Source: Google earth

Prior to departing Broome, the pilot received information regarding the serviceability of the airstrip at Pantijan, from the contact person at the airstrip. He was advised that the grass beside the landing area was long, with some termite mounds outside the wingspan of the aircraft. He was also advised that the threshold of runway 02 had grass cover and that midway along the strip the surface was soft. The pilot understood that the contact person had walked the strip to assess its condition, but that no vehicle had been available to drive across the landing surface. Due to rising terrain at the northern end of the airstrip, the pilot was advised to regard the strip as one-way and to land on runway 02, and depart from runway 20.

After arriving in Derby, the pilot weighed the passengers and baggage and loaded the aircraft for the flight to Pantijan. Baggage was loaded into the aircraft lockers and also stowed at the rear of the aircraft and secured with a cargo net. Some bags were placed on a rear seat and secured with seatbelts. After loading the baggage and passengers, the aircraft departed from Derby at 1346 Western Standard Time (WST).

When about 80 NM from Pantijan, the pilot of JOR heard the pilot of the helicopter, who he had spoken to prior to departure, broadcast that he was conducting an approach to the airstrip in the direction of runway 02. The pilot of JOR responded with his current position and did not receive any further communications from the pilot of the helicopter. As JOR approached Pantijan, the pilot observed fires in the area. The direction of the smoke indicated a tailwind of about 5 kt for a landing on runway 02.

At about 1430 WST, the aircraft arrived overhead Pantijan. The pilot slowed the aircraft, lowered the first stage of flap and descended to about 700 ft above ground level. He then conducted a circuit and a visual inspection of the entire length of the runway. The pilot observed that the runway was narrow and bordered by tall grass. The helicopter was parked adjacent to a shed about three quarters of the way along the runway and clear of the landing area. The sand on the airstrip appeared to be uniform in colour, with no obvious darker patches that may have indicated water. There was short grass at the threshold of runway 02 extending for about 200 m. A termite mound was located about half way along the runway and had been placed on its side and moved to the right of the runway centreline.

The pilot then conducted an approach to land on runway 02. The aircraft touched down at the pilot's aiming point, about 50 m beyond the threshold, and the pilot applied moderate braking. The aircraft continued along the centre of the runway and, as it slowed through about 60 kt, the pilot applied left rudder to turn the aircraft slightly to the left and increase separation from the overturned termite mound. He felt the rudder pedals move to the full left position and the aircraft turned to the left. The pilot immediately applied right rudder in an attempt to counteract the turn, but the aircraft initially continued to veer left towards the edge of the runway.

The left main landing gear momentarily lifted off the ground and the aircraft tipped to the right. As the aircraft veered off the runway and entered longer grass, the pilot regained control of the aircraft and it started to turn right and return towards the runway. The nose wheel then collided with a runway marker and collapsed, resulting in the aircraft nose contacting the ground and the aircraft skidded to a stop (Figure 2). The pilot secured the aircraft and assisted the passengers to disembark. One passenger had a cut to the back of the head from a loose object and another sustained a bleeding nose. Three other passengers and the pilot were not injured, however the aircraft sustained substantial damage.

Figure 2: Accident site

Source: Aircraft operator (edited by the ATSB)

Pilot comments

Following the accident, the pilot found that where he had commenced the left turn on the runway, the ground was soft and appeared to have previously held standing water, although the surface was dry at the time. The runway marker was a 44 gallon drum, cut in half longitudinally and laid on the ground and it was obscured by long grass (Figure 3).

None of the baggage had come loose in the cabin; the only unsecured objects were phones, cameras and water bottles.

The pilot stated that when facing similar circumstances, he would select a landing path that did not require any planned directional changes during the landing roll, until the aircraft has decelerated to a safe taxi speed.

Figure 3: Drum runway marker

Source: Aircraft operator

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:

- Company pilots operating beyond mobile phone coverage will be issued with a satellite phone. In this incident, access to a satellite phone may have enabled the aircraft pilot to communicate with the helicopter pilot on the ground and obtain further details regarding the condition of the airstrip.
- The operators of remote airstrips will be reminded to follow the company's runway inspection guide, which required a vehicle to assess the condition of the landing surface.
- All company pilots will be reminded of the importance of maintaining directional control on unimproved (sand or gravel) airstrips.

Safety message

Airfields that are used infrequently or seasonally, potentially pose significant hazards to aviation. This incident highlights the importance of identification and management of any risks that might be associated with such an airfield. Potential hazards may be hard to identify, with objects possibly obscured by vegetation. Changes in the runway surface can be hard to detect visually and without a vehicle or some means to apply a similar force to that of a landing aircraft.

General details

Occurrence details

Date and time:	12 April 2015 – 1432 WST	
Occurrence category:	Accident	
Primary occurrence type:	Runway excursion	
Location:	Pantijan (ALA), Western Australia	
	Latitude: 15° 57.15' S	Longitude: 125° 03.23' E

Aircraft details

Manufacturer and model:	Cessna Aircraft Company 404	
Registration:	VH-JOR	
Serial number:	4040642	
Type of operation:	Charter – passenger	
Persons on board:	Crew – 1	Passengers – 5
Injuries:	Crew – Nil	Passengers – 2 (Minor)
Damage:	Substantial	

Helicopters

Collision with terrain involving a Schweizer 269C-1, VH-FTY

What happened

On the morning of 24 December 2014, an instructor and student were conducting circuits and emergency training in a Schweizer 269C-1 helicopter, on the grass area south of runway 08 at Parafield Airport, South Australia. The weather was clear at the time, with a temperature of 19^0 C. The wind was initially light and variable, but as the flight progressed, the wind became a south-easterly at about 10 kt. After a number of exercises, including simulated engine failures, the instructor assumed control of the helicopter to demonstrate how to respond to a tail rotor failure while hovering.

To assist the student's understanding of what to expect, the instructor planned to slow the exercise down and highlight the component parts of the sequence. Accordingly, the instructor intended to initially demonstrate the yawing motion (main rotor torque effect) that could be expected in the event of a tail rotor failure. To add emphasis, the instructor intended to allow the yawing motion to continue through 360 degrees. As the helicopter neared 360 degrees of rotation, the instructor intended to reduce the throttle setting (reduce the main rotor torque effect) to eliminate the yawing motion. Then he planned to demonstrate how to control the ensuing descent using the remaining inertia of the main rotor.

While in the hover with the skids about 5 ft above ground level (AGL) and the helicopter facing into wind (toward the south-east), the instructor commenced the demonstration by adjusting pedal pressure to initiate a yaw to the right. As planned, the instructor allowed the yaw to continue through about 360 degrees, with the helicopter still about 5 ft AGL. As the helicopter neared 360 degrees of rotation, again facing into the wind, the instructor began reducing engine power by slowly closing the throttle. Contrary to the instructor's intent, as he closed the throttle, the helicopter began yawing rapidly in the opposite direction (to the left), and also drifting sideways to the left. The instructor believed that the drift was probably in part due to the influence of the wind which, because of the unintended yaw to the left, was now a crosswind from the right.

After about 90 degrees of rotation to the left, the instructor was able to arrest the unintended yaw, but despite the application of right cyclic,[1] he was unable to stop the left drift. With the helicopter now descending, the instructor applied full throttle and raised the collective[2] in an attempt to recover the situation. He heard the engine respond to the throttle application, but at that point main rotor RPM had probably decayed substantially, limiting the immediate effectiveness of throttle application. Even with full right cyclic, the left drift continued as the helicopter touched down on the left skid. The skid initially scuffed the ground and lifted off, then touched down again as the helicopter rolled over the skid onto its left side.

After the helicopter had rolled onto its side, the instructor switched the battery off and activated the Emergency Location Transmitter.[3] The instructor directed the student to shut the fuel off, and then assisted the student to evacuate the helicopter through the right door. The instructor then evacuated the helicopter behind the student. Apart from some minor bruising, both the instructor and student were uninjured. The helicopter main rotor assembly and upper-left cabin area were damaged in the accident (Figure 1). The tail rotor also showed some evidence of having scuffed the ground during the accident sequence.

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

2 Collective is a 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.

3 The instructor was unsure at the time if Air Traffic Control staff located in the tower had witnessed the accident.

Figure 1: Orientation of helicopter following accident, facing to the north-east

Source: Helicopter operator

Note: Absorbent material placed next to the fuel tank by emergency services personnel, and the panel on the ground visible in the photograph behind the helicopter, was removed by emergency services personnel following the accident.

Operator's report

The operator's report dealing with the accident found that the instructor introduced complications by endeavouring to slow down the sequence and break it into component parts. These complications placed the helicopter in a situation from which the instructor was unable to effectively recover.

The report noted that the demonstration on this occasion varied from the manner in which a tail rotor failure while hovering would normally be simulated. The exercise normally involved introducing a yaw to the right by varying pedal pressure, then arresting the yaw by smartly closing the throttle to eliminate main rotor torque. The yaw would normally be arrested after less than about 90 degrees of rotation, and the helicopter would then be allowed to sink onto the ground, with the landing cushioned by increasing collective (using existing main rotor inertia). During a normal simulation of tail rotor failure while hovering, the time taken from closing the throttle to touch down is relatively brief (around 2 seconds), allowing the main rotor RPM to be sufficiently preserved to ensure effective control.

On this occasion, slow power reduction would have resulted in a gradual decrease in main rotor RPM and reduced the effectiveness of the instructor's attempts to subsequently control the helicopter. The report noted that, although the instructor applied power and collective in an attempt to recover the situation, main rotor RPM had probably decayed to the point that his control inputs were ineffective. As engine power was increasing, the final motion of the helicopter as it tipped onto its side may have been the result of dynamic rollover.[4]

Instructor's comments

The instructor was concerned that the student did not fully understand the theory behind the recovery technique associated with a tail rotor failure while hovering, even though they had covered the technique during the pre-flight brief. He therefore considered it important to slow the

4 In brief, dynamic rollover is the occurrence of a rolling motion while part of the landing gear is acting as a pivot. If the helicopter exceeds a critical angle it will roll onto its side.

exercise down and clearly demonstrate the various stages of the sequence, in order to eliminate any confusion or misunderstanding.

Although the instructor had considerable experience as a fixed wing instructor, he had relatively limited experience in rotary wing instruction, and this was the first time he had taught this particular sequence. He commented that even though he considered himself to be a cautious pilot, his decision to modify the training sequence may have been influenced by a level of confidence that stemmed from his considerable fixed wing experience. The instructor added that with the benefit of hindsight, he would not have broken the sequence down in the manner he attempted.

The instructor indicated that he generally preferred to hover slightly high during some training exercises, to provide a margin for error in the event of any handling difficulties. The instructor recalled that having commenced the demonstration at a height of about 5 ft AGL, and closing the throttle slowly at about that height, there was insufficient main rotor inertia to effectively control the helicopter during the ensuing descent. The instructor believed that the accident may have been avoided if he had commenced the demonstration at a lower height. Less main rotor inertia would have been required to control descent from a lower height, and the crosswind would probably have had less time to influence the motion of the helicopter.

Although the student did not believe that he was applying any force to the controls at the time of the accident, the instructor recalled that the controls felt relatively heavy during the demonstration. Heaviness of the controls may have adversely affected the instructor’s ability to control the helicopter, particularly as the unintended yaw and lateral drift developed.

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

In response to this occurrence, the helicopter operator planned a number of actions, including reinforcing appropriate conventions when instructors are demonstrating sequences that involve an increased level of risk. The operator also intended to highlight the importance of appropriate threat and error management to instructors and students engaged in training exercises of this nature.

Safety message

This incident serves to highlight the importance of standardised instructional sequences, and the provision of comprehensive guidance with respect to the associated demonstrations, and the potential safety risks involved. This is particularly important where a demonstration involves substantial manipulation of flight controls and engine power near the ground. Under those circumstances, any mishandling leaves little opportunity for an effective recovery.

Where there is any doubt about the best way to demonstrate a particular sequence to a student, instructors are encouraged to seek guidance from the Chief Flying Instructor. While the training effectiveness of a demonstration is undoubtedly important, of even greater importance is the need to ensure that any associated hazards are identified and effectively managed.

The instructor's comments regarding fixed wing and rotary wing experience are important and insightful. A Safety Information Notice published by Eurocopter (No 2418-S-00) titled Helicopter Airmanship includes the comment:

> *… A more cautious approach is necessary in the case of experienced fixed wing pilots, who have little helicopter experience. You may be confident and relaxed in the air but will not yet have developed the reflex responses, control feel, coordination and sensitivity necessary in a helicopter ….*

This document is available on-line at www.airbushelicopters.com/website/docs_wsw/pdf/SIN2418-S-00-R0-EN.pdf

Rotary wing flying instructors may find the CASA *Flight Instructor Manual (Helicopter)* and the Federal Aviation Administration *Helicopter Flying Handbook* to be valuable references. These documents are available on-line at:

- www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_90306
- www.faa.gov/regulations_policies/handbooks_manuals/aviation/helicopter_flying_handbook/

General details

Occurrence details

Date and time:	24 December 2014 – 0858 CST	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	Parafield Airport, South Australia	
	Latitude: 34° 47.8' S	Longitude: 138° 37.75' E

Aircraft details

Manufacturer and model:	Schweizer 269C-1	
Registration:	VH-FTY	
Serial number:	0368	
Type of operation:	Flying training	
Persons on board:	Crew – 2	Passengers – nil
Injuries:	Crew – 1 (minor)	Passengers – nil
Damage:	Substantial	

Collision with terrain involving Robinson R44, VH-YMD

What happened

During the morning of 9 January 2015, the pilot of VH-YMD was operating in support of the Northern Territory Police. As part of the operation, the pilot conveyed two passengers to a site on the Todd River, just north of Alice Springs. The pilot landed on the sandy surface of the river bed where the passengers disembarked, then flew the helicopter from that location to a local landmark known as the Telegraph Station, about 3 km away. The pilot then conveyed another two passengers from the Telegraph Station to the site, and again landed on the sandy surface of the river bed, facing in a westerly direction (Figure 1).

Figure 1: VH-YMD landing site on the river bed

Source: Northern Territory Police

Soon after, the pilot was asked to convey three passengers back to the Telegraph Station, as a continuing part of the police operation. When all three passengers had boarded the helicopter, the pilot lifted off from the river bed. Lift-off was normal, and the pilot commenced departure in a southerly direction over the river (Figure 2) to follow what he assessed to be the most clear and suitable departure route from the river bed. As the helicopter climbed away from the river bed, the pilot became aware that the main rotor RPM was decaying. In response, he overrode the governor and applied full throttle.

The pilot needed to maintain height to clear the rocks and shrubs on the southern side of the river, but was acutely aware that rotor RPM would be further compromised by the application of more collective.[1] The pilot carefully managed the collective and the helicopter cleared the rocks and shrubs, but with decaying rotor RPM, he realised that continued climb was not possible. The pilot steered the helicopter toward a flat area, just above the river bed on the southern side of the river, and conducted a run-on landing[2] (Figure 3).

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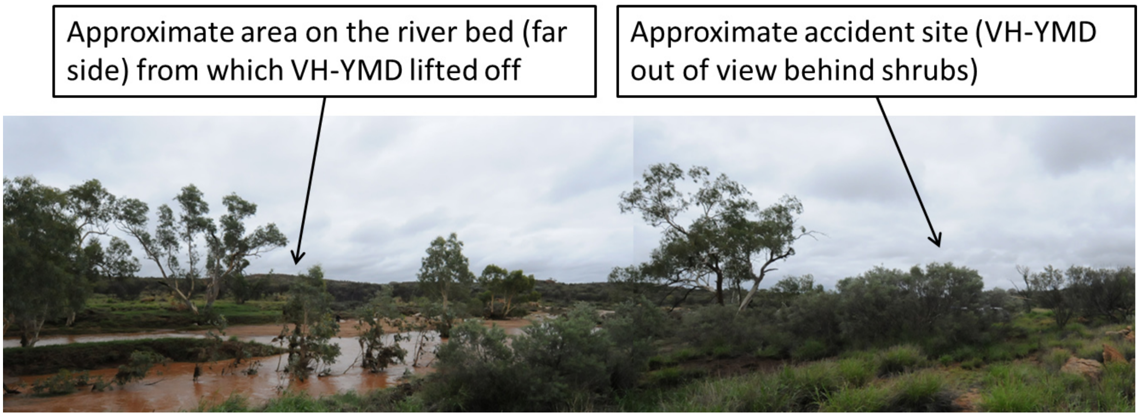
1 The collective is a primary helicopter flight control that simultaneously affects the pitch of all blades of the lifting rotor. Increasing collective increases blade pitch, which increases the lift force generated by the blades. Increasing the collective also increases drag on the rotor blades, which can only be overcome by increasing power.

2 A run-on landing is a landing where the helicopter lands with forward speed.

Figure 2: Photograph taken from the left side of VH-YMD as it crossed the river

Source: Northern Territory Police

Figure 3: Take-off and landing area

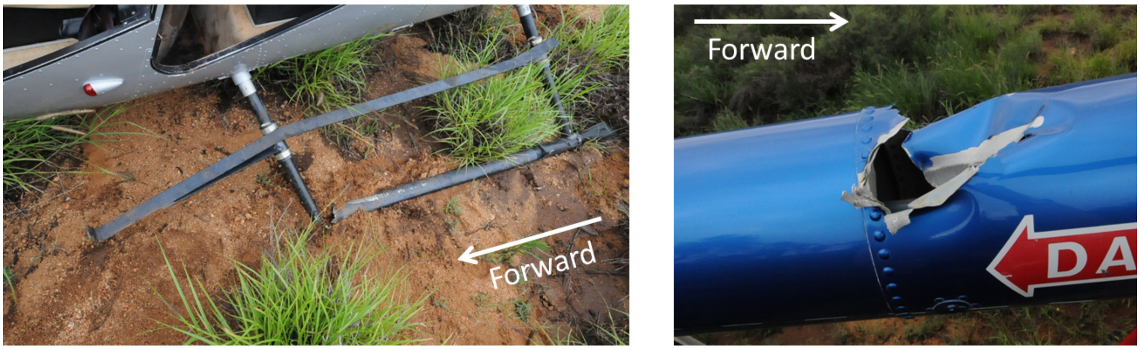


Source: Northern Territory Police (two photographs joined and edited by the ATSB)

During the run-on landing, the left skid sank into mud and struck a rock. The left skid was substantially damaged by the impact (Figure 4) and the helicopter tipped precariously. As the helicopter came to a stop, it was on a substantial lean. The pilot reported that he considered the situation to be unsafe, so he immediately lifted off again and repositioned the helicopter on the ground with a level attitude. During the second lift off, a passenger recalled that the main rotor of the helicopter struck the limb of a tree, and that this was when damage to the tail boom occurred[3] (Figure 4). The pilot then shut down the engine and the passengers evacuated the helicopter.

[3] Damage to the tail boom is consistent with damage that could be expected if the main rotor struck the tail boom.

Figure 4: : Damage to VH-YMD skid (left) and tail boom (right)



Source: Northern Territory Police (edited by the ATSB)

Weather conditions

At the time of the accident, weather conditions were overcast, with showers in the area and a temperature of about 25 °C. The wind at Alice Springs Airport (about 18 km to the south) was from the north-west at about 15 kt, and the QNH[4] was about 1003 hectopascals. While the pilot was aware that the wind was generally a north-westerly, he assessed the wind at the site as relatively light and variable. The relative humidity at Alice Springs Airport was around 80%, and the pilot reported humid conditions at the accident site.

Pilot comment

The pilot commented that he believed that the accident resulted from a combination of a relatively heavy take-off weight, the prevailing conditions, and limited departure options because of surrounding terrain and obstacles. The pilot indicated that, with the benefit of hindsight, he should have taken two trips to move the three passengers, rather than attempt to take off with three passengers on board. He believed that he would have been able to complete the departure safely at a lower take-off weight.

Power required and power available

A number of factors related to the power required and the power available warrant consideration in understanding the probable reasons for which the pilot experienced decaying main rotor RPM during departure from the river bed, as the helicopter moved out of ground effect[5] and transitioned into forward flight. These factors include density altitude, take-off weight and the wind component.

- ***Density altitude***. Increasing density altitude adversely affects helicopter performance through the combined effects of reducing the power available and increasing the power required. Considering elevation and temperature, and barometric pressure in the area, the density altitude at the accident site would have been around 4,000 ft. High relative humidity would have had the effect of further increasing the density altitude.
- ***Take-off weight***. Increasing the take-off weight increases the power required. The greater lifting force demanded of the main rotor, and the requirement to counter the associated increased torque effect[6] with the tail rotor, both contribute to an increased power requirement. The pilot estimated the weight of the helicopter at the time of the accident to be less than the maximum permitted take-off weight, however subsequent calculations by the operator using actual data, indicated that the take-off weight was marginally above the maximum permitted take-off weight.

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4 QNH is the altimeter barometric pressure subscale setting used to provide an altimeter indication of height above mean sea level in that area.

5 Ground effect refers to the apparent improvement in helicopter performance near the ground which results from a modification of the airflow through the main rotor due to the interaction of that flow with the ground beneath.

6 In this context, torque effect is the reaction of the helicopter to the torque applied by the main rotor. This effect is countered by the tail rotor.

- ***Wind component***. Taking off with a tailwind component increases the power required because of the diminished or delayed influence of translational lift.[7] Additionally, a tailwind or crosswind component may require greater tail rotor force to maintain directional control during departure, which places an increased power demand on the engine. Although the pilot commented that the wind seemed light and variable prior to departure, the helicopter may have encountered a tailwind component as it climbed away from the river bed during the accident flight.

The following references discuss factors affecting helicopter performance, and provide some guidance to pilots regarding the associated considerations:

- A 'Good Aviation Practice' booklet titled *Helicopter Performance,* produced by the Civil Aviation Authority (CAA) of New Zealand. The booklet is available via the CAA website: www.caa.govt.nz/safety_info/good_aviation_practice.htm
- The Federal Aviation Administration (FAA) *Helicopter Flying Handbook* (chapter 7 deals with helicopter performance). The handbook is available on the FAA website: www.faa.gov/regulations_policies/handbooks_manuals/aviation/helicopter_flying_handbook/

Safety message

The Robinson R44 Pilot's Operating Handbook includes a number of important safety tips and notices. Pilots (particularly those who fly Robinson helicopters) are encouraged to carefully reflect on these safety tips and notices – the tips are suggestions intended to improve safety, while the notices have been issued as a result of various accidents and incidents. The safety tips and notices are available in the R44 Pilot's Operating Handbook on the Robinson Helicopter Company website (www.robinsonhelicopter.com) under the Publications tab. Two Safety Notices with relevance to this accident are Safety Notice 10 (*Fatal accidents caused by low RPM rotor stall)* and Safety Notice 24 (*Low RPM rotor stall can be fatal*). One safety tip with particular relevance to this accident is:

> *Never allow rotor RPM to become dangerously low. Most hard landings will be survivable as long as the rotor is not allowed to stall.*

Three other ATSB investigation reports that identified helicopter performance and low main rotor RPM as possible factors include AO-2013-203, 200600979 and 199900833. These investigation reports are available on the ATSB website:

- www.atsb.gov.au/publications/investigation_reports/2013/aair/ao-2013-203.aspx
- www.atsb.gov.au/publications/investigation_reports/2006/aair/aair200600979.aspx
- www.atsb.gov.au/publications/investigation_reports/1999/aair/aair199900833.aspx

This accident provides a reminder of the effect on helicopter performance of density altitude, weight, and possibly wind. Pilots are encouraged to carefully and accurately assess these factors before committing to any departure. Careful assessment of these factors is essential to ensure that an adequate performance margin is maintained, particularly under high density altitude conditions, when the helicopter is near its maximum take-off weight, or where the direction of departure is downwind. When performance is likely to be adversely affected by a combination of these factors, extreme caution is warranted.

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[7] Translational lift is the additional lift resulting from induced airflow through the main rotor as a result of forward airspeed (oncoming flow of air through the main rotor).

General details

Occurrence details

Date and time:	09 January 2015 – 1120 CST	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	8 km north of Alice Springs, Northern Territory	
	Latitude: 23° 38.8' S	Longitude: 133° 53.5' E

Aircraft details

Manufacturer and model:	Robinson Helicopter Co R44	
Registration:	VH-YMD	
Serial number:	1887	
Type of operation:	Aerial work	
Persons on board:	Crew – 1	Passengers – 3
Injuries:	Crew – Nil	Passengers – 1 (minor)
Damage:	Substantial	

Loss of control, involving a Robinson R22, VH-YLP

What happened

VH-YLP damage

Source: Operator

On 10 February 2015, at about 1145 Eastern Daylight-saving Time (EDT), an instructor and student were conducting an in-ground-effect[1] hover lesson in a Robinson R22, registered VH-YLP (YLP) at Orange Airport, New South Wales.

The lesson had covered individual effect and use of the pedals, the collective[2] and the cyclic[3] and included student practice immediately after each instructor demonstration. Throughout the lesson, the student had progressed from individual use of each control separately, to coordinating combinations of the three controls.

The instructor reported that at times during the student practice, the student allowed the helicopter to hover sideways or forwards, and instead of easing the cyclic or pushing the cyclic in the opposite direction to counter this movement, the student incorrectly pushed it in the direction of movement. Hence on a couple of occasions, the instructor re-briefed the correct procedure.

In the last few minutes of the hour long lesson, the student requested a little more time to practice the new sequences. A few moments into this practice, at about 3 ft above ground level (AGL), with the student controlling the cyclic and the instructor lightly controlling the pedals and collective, the helicopter began to roll to the right and move rearwards. The student reacted quickly, but moved the cyclic further backwards and to the right, which resulted in an increase in the rearward speed in this direction. The instructor attempted to regain control, but due to the sudden rearward movement of the cyclic, his thumb had bent back behind his wrist. The instructor managed to ‘grab’ the collective and lift it up a small amount, but by the time any significant control input could be applied, the right skid had struck the ground (Figure 1). The helicopter rolled further to the right, and fell onto the ground. The manner in which the helicopter had pivoted around the right skid and fallen onto its side was described by both the instructor and operator as dynamic rollover[4].

The student and instructor exited the helicopter and moved clear. The instructor was not injured, however the student received minor injuries and the helicopter was substantially damaged.

Instructor experience and comments

The instructor had about 735 hours of helicopter flying experience, with the majority of their commercial experience working as an instructor.

Prior to the lesson, the instructor had conducted a 45 minute pre-flight briefing with the student. This covered the aims, objectives and sequences to be covered in the flight lesson, and also looked at preventative measures to assist in mitigating against any potential threats and errors, including dynamic rollover.

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1 Ground effect refers to the apparent improvement in helicopter performance near the ground which results from a modification of the airflow through the main rotor due to the interaction of that flow with the ground beneath.

2 Collective - a primary helicopter flight control that simultaneously affects the pitch of al blades of a lifting rotor. Collective input is the main control for vertical velocity

3 Cyclic - a primary helicopter flight control that is similar to an aircraft control column. Cyclic input tilts the main rotor disc varying the attitude of the helicopter and hence the lateral directions

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

During the flying component of the lesson, the in-ground-effect hover had been practiced at about 3ft. The instructor also reported that with the high temperature and density altitude on the day, the helicopter had limited excess power available.

Figure 1: VH-YLP showing initial contact point

Source: Operator

At the time of the accident, the instructor reported that the student was using all three controls and the instructor was lightly on the collective and pedals, monitoring the student's performance.

Due to the hot and dry conditions in the previous few weeks, the ground was very hard and dry and caused the helicopter to bounce when the skid first impacted the ground. This further exacerbated the helicopter's instability.

The instructor felt that as soon as the helicopter tilted to the right, the blades probably struck the ground; the instructor also commented how quickly the whole event happened.

In hindsight, the instructor felt that as the student had progressed so well throughout the lesson, this had possibly influenced the decision for a little less intense instructor engagement, with a belief that with direction, the student would be able to recover the helicopter from the rearward motion. This allowed critical moments of delay when attempting to regain control when it was required.

Student experience and comments

The student had a total of about 5 flying hours, all on helicopters. This was the student's first lesson in hovering and fifth lesson overall. The student reported that, with the intense instruction throughout the session, it is possible that they both lost situational awareness in relation to proximity to the ground. The student reported that at the time of the loss of control, the instructor had control of the collective and the pedals while they retained control of the cyclic.

The student commented that they felt it would be advantageous to practice sequences such as effects of controls at a higher altitude, gradually moving closer to the ground with increased competence.

The student also noted that they often felt quite tired at the end of an hour long lesson, as there was so much new information to understand and put into practice.

Figure 2: Detached right door and damaged rotor blades

Source: Operator

Operator comments

During the last ten minutes of the dual lesson, the heel of the right skid contacted the ground and the helicopter moved approximately 4 m to the right before coming to rest on its right side.

It is most likely that applied collective pitch may have been the reason for the movement laterally. When the helicopter moved rearward, the student was instructed to correct the unwanted movement. Initially the student applied incorrect aft cyclic, which increased the velocity of the unwanted movement and a subsequent sink off the 'ground cushion' created by the downwash from the rotor blades.

The company also identified that the hover height for the sequence was too low.

ATSB Comment

As noted by the instructor and the operator, the pivoting roll by the helicopter to the right, around the skid in contact with the ground, and subsequent loss of control is consistent with the phenomenon known as dynamic rollover.

A helicopter is susceptible to this later roll, but some factor must first cause the helicopter to roll or pivot around a skid until its crucial rollover angle is reached. This angle is around 5° to 8 ° dependent on the type of helicopter, winds and loading.

Once started, dynamic rollover cannot be stopped by application of opposite cycle control alone. Even with full left cyclic applied, the main rotor thrust vector and its moment follows the aircraft as it continues rolling to the right. Quickly reducing collective pitch is the most effective way to stop dynamic rollover from developing.

Further reading on situations leading to dynamic rollover is available at:

www.faa.gov./regulations_policies/handbooks_manuals

Safety Message

The role of the instructor as pilot in command is a dynamic and complex one. There remains a fine balance between providing an interesting and beneficial learning experience for your student and keeping the situation safe.

A manual produced by the Civil Aviation Safety Authority (CASA) Australia and the Civil Aviation Authority (CAA) New Zealand for helicopter instructors has many useful tips and tools relating to the principles and methods of flight instruction. It includes 28 chapters on flying sequences from ab initio through to mountain flying awareness.

The manual discusses the need to always closely supervise student practice sequences and to not allow students to make mistakes. It also highlights the necessity of using the correct handing over and taking over model, so there is never any doubt as to who has control at any one time.

In relation to the hovering sequence, it notes that this exercise demands a high degree of coordination and should not be taught until the student has acquired a reasonable state of competence in the first five lessons. An alternative technique is to use slow flight to introduce hovering. This procedure take the form of low, slow flight into the wind across a suitable clear area. Speed and height are progressively reduced in successive passes until the helicopter is creeping forward at a walking pace in ground effect and is then momentarily halted before transitioning into forward flight again. These momentary pauses are in fact periods of hovering, and are gradually extended as competency improves.

The manual is available online at:

www.casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_90306

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.

Operator

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

Flight training operations

- Since the accident, the company has advised that the hover height should not be below about 1.5 – 2.0 m (5.0 – 6.5 ft) of skid height, particularly in the first or second hover lesson
- Instructor’s hand position must be kept closer to the cyclic during a student’s early training and control should be taken as soon as an unwanted movement starts; do not allow rearward movement of the helicopter at this stage of training
- Care should be taken to adhere to the power limits in the pilot operating handbook and guidance in the operations manual. Caution should be applied to monitor the helicopter’s height above the ground.

General details

Occurrence details

Date and time:	10 February, 2015 1150 EDT	
Occurrence category:	Accident	
Primary occurrence type:	Loss of control	
Location:	Orange Airport, NSW	
	Latitude: 33° 22.90' S	Longitude: 149° 07.98' E

Aircraft details

Manufacturer and model:	Robinson Helicopter Co R22 BETA	
Registration:	VH-YLP	
Serial number:	3860	
Type of operation:	Flying Training - Dual	
Persons on board:	Crew – 2	Passengers – Nil
Injuries:	Crew – 1, Minor	Passengers – Nil
Damage:	Substantial	

Collision with terrain involving a Robinson R22, VH-CMK

What happened

On the morning of 28 February 2015, an instructor and student were conducting a training flight in a Robinson R22, registered VH-CMK, at Archerfield Airport, Queensland. The objective of the flight was to teach the student how to manage jammed anti-torque pedal[1] and jammed collective[2] emergencies. Conditions were fine and clear with a light and variable wind.

The flight commenced with the instructor flying the helicopter in a set direction, demonstrating how to effectively control the helicopter with the pedals jammed in position. The jammed pedal condition was simulated by holding the pedals in a set position with foot pressure, then manipulating the other flight controls and adjusting engine power and airspeed to control the helicopter. Satisfied that the key elements of the demonstration had been effectively addressed and nearing the boundary of the area in which the helicopter had been cleared to operate, the instructor turned the helicopter through about 180 degrees and commenced a similar demonstration travelling in the opposite direction.

During the second demonstration, the helicopter was established in forward flight around 15 ft above the ground at an airspeed of about 40 kt. The instructor simulated a jammed pedal condition, setting the left pedal slightly forward of the neutral position. As the demonstration progressed, the instructor elected to complete the exercise by conducting a simulated jammed pedal run-on[3] landing. The helicopter touched down on a grass surface near the northern boundary of the airport, just outside the runway strips associated with runways 22R/04L and 22L/04R. The grass in the area where the helicopter touched down was slightly longer than the grass on the runway strips, but the instructor was comfortable continuing with the run-on landing, noting that it was not uncommon to operate helicopters on that surface.

The demonstration went as expected up until the point that the helicopter touched down. Still travelling forward at about 10 to 15 kt, the helicopter bounced slightly and yawed to the left. The instructor discontinued the demonstration at that moment, allowing himself full use of the pedals, but he was unable to correct the yaw before the helicopter touched down again. When the helicopter touched down a second time after a very short and shallow bounce, even though the helicopter was level, the forward part of the right skid dug into a surface undulation. The right skid then effectively acted as a pivot, tipping the helicopter to the right. The instructor fully lowered the collective but the roll continued. The instructor then applied left cyclic[4] but he was unable to stop the helicopter rolling onto its right side.

Aware that a fuel leak had developed, the instructor closed the fuel shut-off valve and turned the master electrical switch off. The instructor and student moved to a safe distance following which the instructor contacted air traffic control (who alerted emergency services). The instructor and student suffered minor injuries and the helicopter was substantially damaged.

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1 The anti-torque pedals are used in a conventional helicopter to adjust the pitch of the tail rotor blades, thereby adjusting the tail rotor thrust which counters the torque effect of the main rotor and controls the helicopter in the yawing plane. Pedal pressure is varied in response to changing conditions such as power changes and airspeed, to maintain coordinated flight. A jammed pedal condition denies the pilot the ability to use the pedals to vary tail rotor thrust.

2 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.

3 A run-on landing is a helicopter landing that is made with forward speed.

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

Instructor comment

The instructor made the following comments in relation to the accident:

- The nature of the surface (outside the runway strips) probably contributed to the accident, given the manner in which the right skid dug into a surface undulation. There was a current NOTAM[5] at the time of the accident stating that grass areas were soft and wet, but the reason the skid dug in rather than skipped forward, seemed to relate more directly to the slightly undulating nature of the surface, rather than how firm the surface was. During future similar exercises involving run-on landings on unprepared surfaces, the instructor intends to inspect the surface for suitability beforehand.
- The instructor was mindful of the possibility of dynamic rollover[6] under the circumstances, so consciously avoided applying power and collective as the helicopter tipped.
- The instructor had invited the student to place his hands and feet lightly on the controls during the demonstration, to maximise the training benefit of the exercise. The instructor commented that the student may have inadvertently applied some pressure on the pedals during the accident, which could have reduced the effectiveness of the instructor's attempt to correct the yaw after the initial bounce.

Safety message

This accident highlights the manner in which some hazards may not be immediately obvious. Helicopter training organisations are encouraged to consider the quality of the landing area surface during hazard identification and risk assessment processes associated with training operations, particularly those that involve run-on landings.

General details

Occurrence details

Date and time:	28 February 2015 – 0750 EST	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	Archerfield Airport, Queensland	
	Latitude: 27° 33.8' S	Longitude: 153° 00.8' E

Aircraft details

Manufacturer and model:	Robinson R22	
Registration:	VH-CMK	
Serial number:	4223	
Type of operation:	Flying training	
Persons on board:	Crew – 2	Passengers – Nil
Injuries:	Crew – 2 (minor)	Passengers – Nil
Damage:	Substantial	

5 A NOTAM (Notice to Airmen) advises personnel concerned with flight operations of information concerning the establishment, condition or change in any aeronautical facility, service, procedure or hazard, the timely knowledge of which is essential to safe flight.

6 In brief, dynamic rollover is the occurrence of a rolling motion while part of the landing gear is acting as a pivot. If the helicopter exceeds a critical angle it will roll onto its side.

Collision with terrain involving a Robinson R22, VH-HUA

What happened

On 20 March 2015, at about 1140 Eastern Standard Time (EST), a Robinson R22 helicopter, registered VH-HUA, departed from Stanbroke Station for a private flight to Devoncourt Station, Queensland. On board were a pilot and one passenger. The main fuel tank was filled to capacity prior to departure, with 68 L of fuel. While en route between the two stations, the pilot was assessing the water available for stock by overflying water holdings.

At about midday, while about 500 ft above ground level, the helicopter approached a gorge. To assess the water quantity in the gorge, the pilot conducted a descent to about 100 ft and slowed the helicopter to a hover. As the pilot shifted his focus outside, the rotor revolutions per minute (RPM) decreased, the low rotor RPM warning horn sounded and the helicopter commenced descending. The pilot immediately lowered the collective[1] and turned the helicopter away from the higher gorge walls in an attempt to increase forward speed and rotor RPM. He was unable to regain sufficient rotor RPM and the helicopter continued to descend.

The right skid landed heavily on uneven ground, followed by the left skid. The main rotor then collided with a rock and the helicopter rolled onto its right side. The pilot and passengers exited the helicopter and were not injured. The helicopter sustained substantial damage (Figure 1).

Figure 1: Damage to VH-HUA

Source: Aircraft operator

Local conditions

The temperature at the time was about 42 °C and the elevation of the area was about 1,000 ft above mean sea level. The pilot reported the wind was southerly at about 10-15 kt, but the gorge was sheltered and the wind in the vicinity of the accident was calm.

1 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.

Pilot comments

The pilot reported that his attention was momentarily diverted outside checking the water, when he would normally be watching the gauges and monitoring the rotor RPM. He usually operated without a passenger on board, so the extra weight of the passenger had reduced the helicopter's performance, particularly its ability to maintain a hover out of ground effect.

Power required and power available

A number of factors related to the power required and the power available may have contributed to the decaying main rotor RPM during a hover out of ground effect.[2] These factors include density altitude, take-off weight and the wind component.

- ***Density altitude***. Increasing density altitude adversely affects helicopter performance through the combined effects of reducing the power available and increasing the power required. Considering elevation and temperature, and barometric pressure in the area, the density altitude at the accident site would have been around 4,000 ft. High relative humidity would have had the effect of further increasing the density altitude.
- ***Operating weight***. Increasing the helicopter weight increases the power required. The greater lifting force demanded of the main rotor, and the requirement to counter the associated increased torque effect[3] with the tail rotor, both contribute to an increased power requirement. The weight of the helicopter at the time of the accident was less than the maximum permitted operating weight, but reduced the ability to hover out of ground effect.
- ***Wind component***. A nil wind component increases the power required because of the diminished or delayed influence of translational lift.[4]

The following references discuss factors affecting helicopter performance, and provide some guidance to pilots regarding the associated considerations:

- A 'Good Aviation Practice' booklet titled *Helicopter Performance,* produced by the Civil Aviation Authority (CAA) of New Zealand. The booklet is available via the CAA website: www.caa.govt.nz/safety_info/good_aviation_practice.htm
- The Federal Aviation Administration (FAA) *Helicopter Flying Handbook* (chapter 7 deals with helicopter performance). The handbook is available on the FAA website: www.faa.gov/regulations_policies/handbooks_manuals/aviation/helicopter_flying_handbook/

Safety message

The Robinson R22 Pilot's Operating Handbook includes a number of important safety tips and notices. Pilots (particularly those who fly Robinson helicopters) are encouraged to carefully reflect on these safety tips and notices – the tips are intended to improve safety, while the notices have been issued as a result of various accidents and incidents. The R22 Pilot's Operating Handbook – Section 10 Safety Tips and Notices is available at: www.robinsonheli.com/manuals/r22_poh/r22_poh_10.pdf.

The Robinson Helicopter Company Safety Notice SN-10: *Fatal accidents caused by low rpm rotor stall*, advised that a 'primary cause of fatal accidents in light helicopters is failure to maintain rotor RPM. To avoid this, every pilot must have his reflexes conditioned so he will instantly add throttle and lower collective to maintain RPM in any emergency'.

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2 Ground effect refers to the apparent improvement in helicopter performance near the ground which results from a modification of the airflow through the main rotor due to the interaction of that flow with the ground beneath.

3 In this context, torque effect is the reaction of the helicopter to the torque applied by the main rotor. This effect is countered by the tail rotor.

4 Translational lift is the additional lift resulting from induced airflow through the main rotor as a result of forward airspeed (oncoming flow of air through the main rotor).

Three other ATSB investigation reports that identified helicopter performance and low main rotor RPM as possible factors include AO-2013-203, 200600979 and 199900833. These investigation reports are available on the ATSB website:

- www.atsb.gov.au/publications/investigation_reports/2013/aair/ao-2013-203.aspx
- www.atsb.gov.au/publications/investigation_reports/2006/aair/aair200600979.aspx
- www.atsb.gov.au/publications/investigation_reports/1999/aair/aair199900833.aspx

This incident provides a reminder of the effect of density altitude, weight, and wind on helicopter performance. Pilots are encouraged to carefully and accurately assess these factors to ensure that an adequate performance margin is maintained. When performance is likely to be adversely affected by a combination of these factors, extreme caution is warranted.

General details

Occurrence details

Date and time:	24 March 2015 – 1100 EST	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	93 km SE Mount Isa Aerodrome, Queensland	
	Latitude: 21° 18.83' S	Longitude: 140° 02.95' E

Helicopter details

Manufacturer and model:	Robinson Helicopter Company R22	
Registration:	VH-HUA	
Serial number:	3973	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – 1
Injuries:	Crew – Nil	Passengers – Nil
Damage:	Substantial	

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 15,000 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

Enquiries 1800 020 616
Notifications 1800 011 034
REPCON 1800 011 034
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Investigation

ATSB Transport Safety Report
Aviation Short Investigations
Aviation Short Investigations Bulletin Issue 41
AB-2015-043
Final – 10 June 2015