Australian Government
Australian Transport Safety Bureau

In-flight break-up involving Cessna 210B, VH-DBU

30 km NW Albany, WA on 24 October 2017

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Postal address: PO Box 967, Civic Square ACT 2608
Office: 62 Northbourne Avenue Canberra, Australian Capital Territory 2601
Telephone: 1800 020 616, from overseas +61 2 6257 2463 (24 hours)
Accident and incident notification: 1800 011 034 (24 hours)
Email: atsbinfo@atsb.gov.au
Internet: www.atsb.gov.au

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Addendum

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Safety summary

What happened

On 24 October 2017, the owner-pilot of a Cessna 210B, registered VH-DBU, was operating the aircraft on a private flight without passengers from Albany to Bunbury, within Western Australia. Following take-off, the pilot made a radio broadcast at 1033 Western Standard Time, which was the last recorded transmission from the pilot. The pilot did some local flying before tracking to the north-west of Albany in the general direction of the destination.

At about 1100, people on properties about 30 km to the north-west of Albany heard and in some cases saw the aircraft fly over, and shortly afterwards, witnesses heard a loud cracking sound then one witness saw the aircraft in a steep descent until it disappeared out of sight. Smoke indicated a post-impact fire.

Aircraft wreckage was located in Mount Lindesay National Park and it was established that the pilot was deceased. The wreckage was dispersed over an area of approximately 700 m by 250 m and the fuselage, detached from each wing, was significantly fire affected.

What the ATSB found

The ATSB found that for reasons that were not established, abnormal operation of the aircraft produced high levels of unusual aerodynamic loading on the right wing that exceeded the strength of the wing and initiated an in-flight break-up and impact with terrain.

The aircraft did not have a pre-existing structural deficiency or damage that would have contributed to the in-flight break-up and the local meteorological conditions were not conducive to inadvertent aircraft overstress.

The ATSB found that the presence of methylamphetamine in the pilot’s system increased the risk of operational misjudgements and aircraft mishandling, and pilot incapacitation. This did not necessarily contribute to the accident.

The pilot had worked for a number of organisations which had the required risk controls for problematic alcohol and other drug (AOD) use in place. There was no data that indicated a systemic problem with problematic AOD use in Australian aviation.

What's been done as a result

No safety issues were identified and no proactive safety action was reported to the ATSB. Nonetheless, the ATSB considered that there were opportunities for aviation organisations to collect more data and to enhance the extant risk controls for problematic AOD use.

Safety message

The ATSB acknowledges that self-referral by a pilot with problematic AOD use to a Designated Aviation Medical Examiner, a Drug and Alcohol Management Plan, or the Civil Aviation Safety Authority (CASA), may be perceived as a threat to ongoing employment in aviation. However, the risks to pilots associated with self-referral are less than the health, safety, and legal risks of continuing to operate with problematic substance use.

A defined protocol exists within the CASA aviation medical framework for pilots in stable remission from the problematic use of substances to return to work. Employer and independent peer support organisations are becoming more widely available to assist pilots with the safe return to work.

The ATSB suggests that operators and industry associations consider the availability of information and services to pilots and safety sensitive aviation activities within their area of influence.

The occurrence

Sequence of events

On 24 October 2017, the owner-pilot of a Cessna 210B, registered VH-DBU was intending to operate the aircraft on a private flight from Albany to Bunbury, within Western Australia (Figure 1). The pilot was travelling to Bunbury to participate in training and assessment activities in preparation for the forthcoming aerial firefighting season.

Figure 1: Nominal intended flight path

Source: Google Earth (modified by the ATSB)

According to the aviation forecasts, there was no significant weather expected on the intended route at the time of the flight. The lower-level winds were from the west at between 10 and 15 kt, and cloud was broken cumulus or stratocumulus cloud between 2,500 and 7,000 ft. Visibility was reduced to 8 km in smoke. The observed conditions were consistent with the forecast and considered suitable for operation under the Visual Flight Rules.

Information about the pilot's activities before the flight was limited. The ATSB is aware that on the day of the accident the pilot conversed with three people at different times who recalled that the pilot appeared to be in good spirits. The pilot did not discuss the forthcoming flight with anyone.

It was reported that the pilot kept the aircraft in a hangar at Albany Airport. There is no information about the pilot preparing the aircraft for the flight; however, someone did observe the aircraft near the hangar with the wheels chocked, engine operating, and the pilot outside of the aircraft nearby. No one was observed at the controls and no one has reported being at the controls at that time.

This was contrary to safe practice and the regulatory requirement that a pilot needs to be at the controls while an engine is operating and no reason for this action was identified.

The pilot taxied the aircraft to the fuel bowser and was seen to refuel the aircraft. From there, the pilot was observed to taxi for departure.

The pilot made routine transmissions to check his radio and on entering the runway to position for take-off. Then, at 1033 Western Standard Time (WST), the pilot transmitted that he was airborne from runway 14, maintaining runway heading to the south-east, intending to make a right turn at 1,500 ft above mean sea level (AMSL) to track to Bunbury and climb to 6,500 ft AMSL. That was the last recorded radio transmission from the pilot.

People who observed the aircraft start, taxi, and take-off did not notice anything abnormal about the aircraft. From aerial photos of coastal scenery around Albany that the pilot sent to an acquaintance and a report from an Albany resident, it appears that the pilot undertook some local flying before departing the area (Figure 2).

A few people between Albany and the accident site area heard an aircraft that could have been VH-DBU, but there was insufficient information to establish the aircraft's flight path.

The key witnesses were located between 3 km and 5 km from the accident site in the general direction of Albany. Some witnesses related that prior to any apparent problem with the aircraft, the noise from the aircraft was loud and the aircraft seemed to be lower than was usual for aircraft operating in that area. Some witnesses described the noise as indicative of an aircraft manoeuvring.

With regard to weather, the witnesses reported some cloud but generally clear and calm conditions.

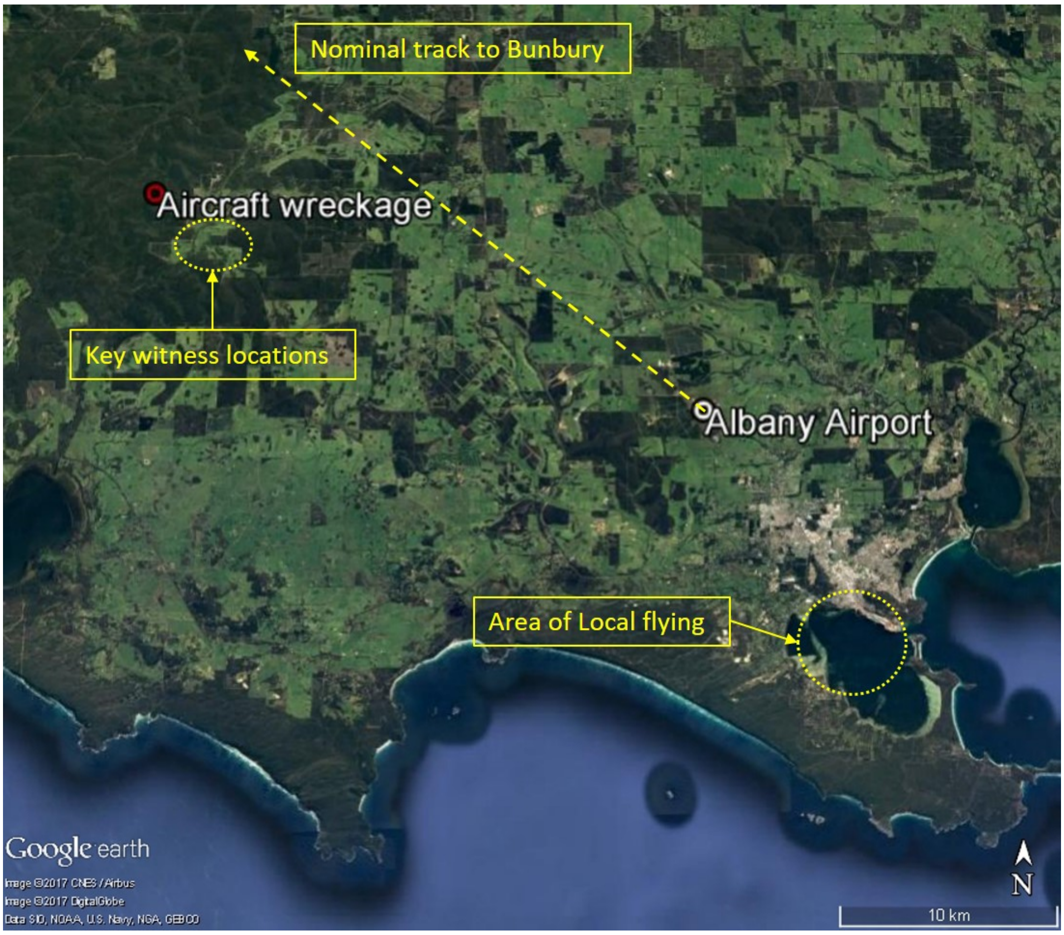
The first sign of a problem with the aircraft was a loud and distinctive noise that witnesses described as a sharp bang, crack of a whip, gunshot, and thunder or lightning. Some witnesses associated the noise with the aircraft they had just seen or heard, drawing their attention and prompting them to look for the aircraft.

Only one of the witnesses, located about 4 km from the accident site, saw the aircraft following the sharp noise. That witness recalled the aircraft was in a nose-down vertical descent rotating to the right and the engine noise was rising and falling. The witness watched the aircraft until it disappeared from sight due to terrain and trees. The witness did not recall seeing anything separate from the aircraft, nor did they recall any smoke or vapour coming from the aircraft.

Other witnesses recalled hearing a series of sounds over an extended period following the initial sharp noise. The sounds, over a period of about 10 to 15 seconds, according to one witness, were described as similar to angle grinding or crashing through trees. Other descriptions were chopping, whirring, striking, whining, and high-pitched. One witness also recalled the engine revving during this time. These irregular noises were reported as stopping suddenly, probably upon impact with the terrain. Smoke was observed in the area shortly afterwards.

These events were reported to the authorities and the pilot of a nearby aircraft was diverted to conduct an aerial search. Aircraft wreckage was located in dense bushland within the Mount Lindesay National Park and the deceased pilot was found in the main wreckage.

Figure 2: Accident site and other locations of interest



Source: Google Earth (annotated by the ATSB)

Accident site information

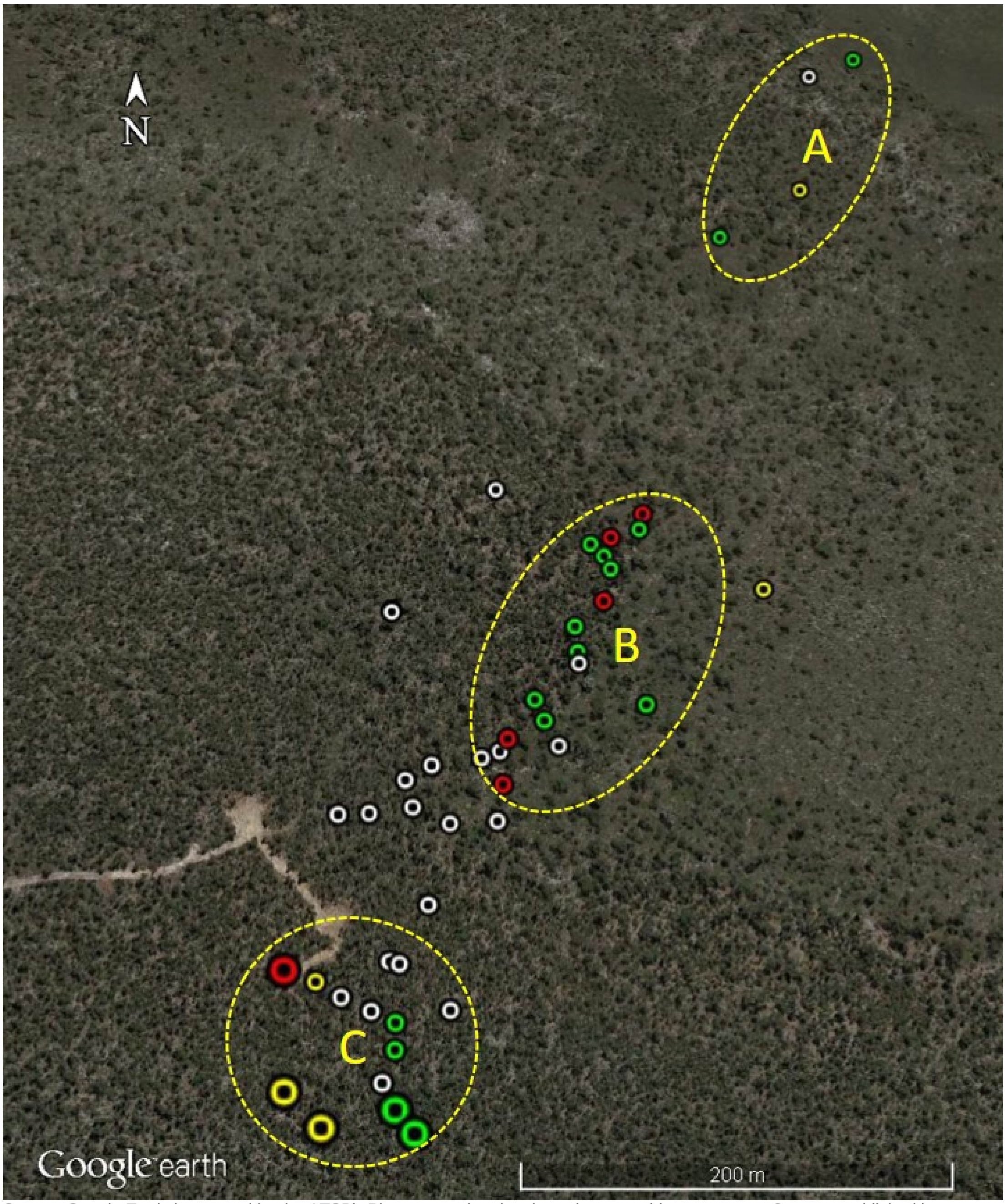
ATSB investigators gained access to the accident site and located wreckage during ground and air searches with the assistance of Western Australia Police and the Parks and Wildlife Service. A subsequent ground search of the accident site by local State Emergency Service personnel located some more pieces of wreckage.

As the pieces were located and identified, their position was recorded on a GPS receiver. Those positions have been referenced to a Google Earth image (Figure 3) and the icons for the pieces coded according to the following:

- Green Right wing pieces
- Red Left wing pieces
- Yellow Fuselage and tailplane
- White Nil significant and unidentified pieces
- Small Fragments and smaller pieces
- Large Significantly sized assemblies

For ease of reference and interpretation, three zones were delineated and named according to likely chronology of events from A to C.

Figure 3: Wreckage plot



Source: Google Earth (annotated by the ATSB). Please note that the cleared areas evident near zone C were established in response to the accident.

From examination of the aircraft wreckage at the accident site and interpretation of the wreckage plot, the ATSB has made the following observations about the disposition of the wreckage:

- most but not all of the aircraft parts have been identified and these were found within an area of about 700 m long and 250 m wide that was oriented in a south-westerly direction
- not accounted for are the right cabin door and small sections of the right wing (areas identified in Figure 7)
- the main wreckage, that included the fuselage, engine and propeller, was severely affected by fire (Figure 4)
- the left wing (Figure 5), inboard right wing (Figure 6), tailplane, and fuselage (main wreckage) were grouped in zone C but not structurally contiguous, which is consistent with an in-flight break-up

- the items furthest from the main wreckage were pieces of right wing skin and rear fuselage skin (zone A)
- many of the major parts of the aircraft had been damaged in-flight and during the ground impact
- the right wing outboard of the fuel tank had fragmented in-flight (Figure 6).

Figure 4: Fuselage viewed from front to rear

Source: ATSB

Figure 5: Left wing in as found position

Source: ATSB

Figure 6: Right wing inboard section in as found position (zone C)

Source: ATSB

Wreckage examination

The ATSB recovered the wing, tailplane, and selected fuselage pieces and moved them to a secure storage location for further examination. With the parts loosely reassembled (Figure 7), the ATSB mapped the damage and inspected the fracture surfaces in context. The ATSB summarises the results of that process in the dot points following.

Overall:

- no signs of pre-existing material deficiencies such as corrosion or metal fatigue
- all fractures were consistent with over-stress of the material
- all flight controls were connected or disrupted during the break-up.

The left wing was mostly intact but exhibited the following characteristics:

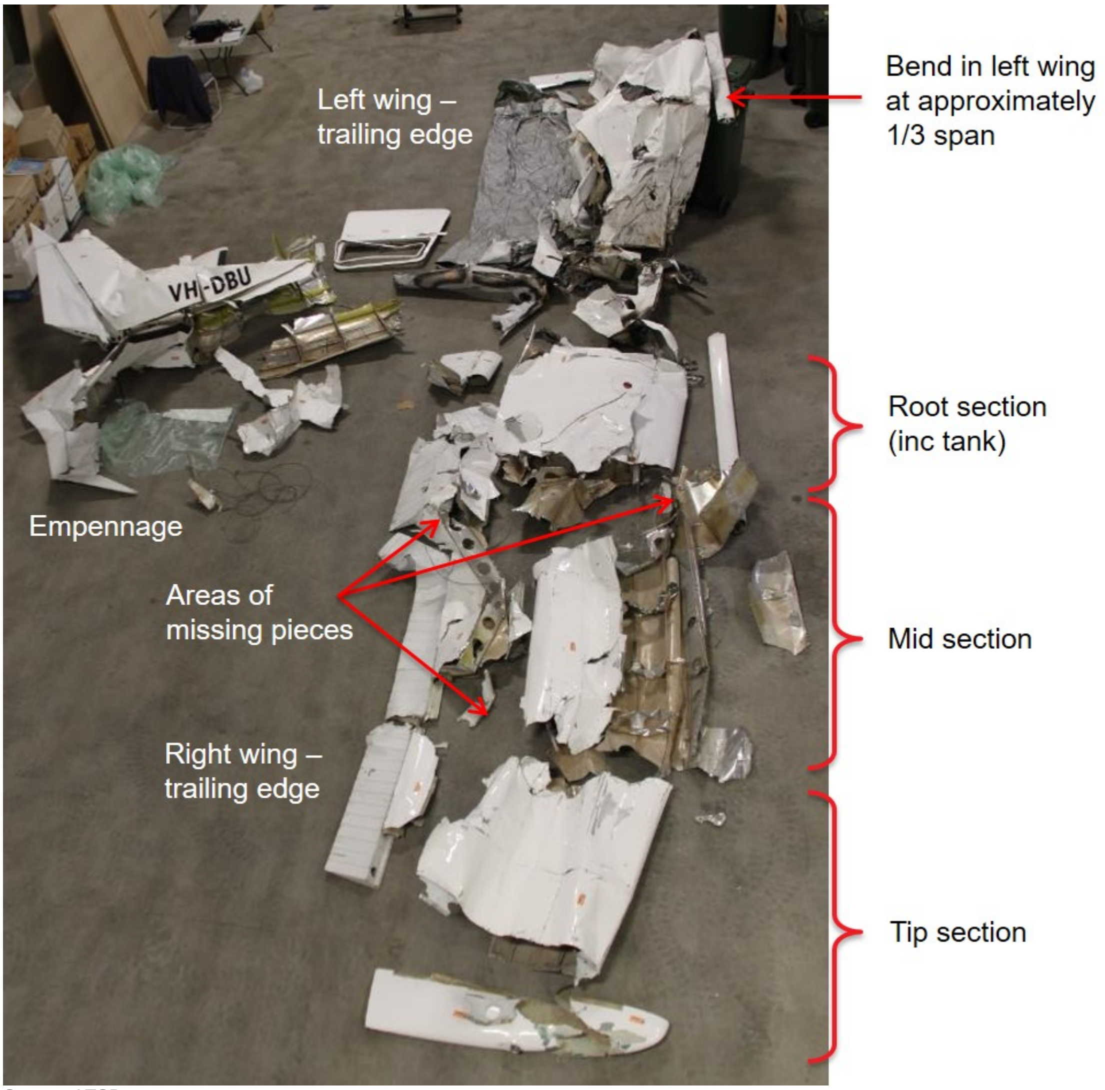
- separation of the outboard leading edge skin, outboard aileron section and wing tip fairing
- a downward bend near the wing strut attachment and general nose-up twisting of the outboard section. Some distortion was related to post-break-up impact with vegetation and the ground.
- overload failure of the wing-fuselage attachments.

The right wing exhibited the following characteristics:

- significant fragmentation and distortion with two primary fracture lines in front to rear orientation
- bending in multiple directions with some torsional effects
- overload failure of the wing-fuselage attachments.

The tail section separated from the rear fuselage as a mostly intact assembly bending in multiple directions; with some distortion related to contact with another object—probably from the right wing.

Figure 7: Wreckage loosely reassembled at storage facility



Source: ATSB

To characterise the break-up sequence, the ATSB considered the observations derived from examination of the wreckage and the disposition of the wreckage at the accident site. Due to the wreckage fragmentation and complexity of wreckage indications, this analysis was constrained.

The ATSB was able to establish that the break-up occurred rapidly with high stresses generated over a large area of the aircraft. The break-up sequence likely began with separation of the right wing tip and progressed inboard, with some fragments striking the tail section. As the right wing broke up, it was subject to a high level of torsion and reverse—both upward and downward—bending. There was no evidence that the un-located right door and right wing parts had any primary role in the break-up.

The ATSB notes that the orientation of the wreckage trail on a south-westerly heading was about 90 degrees to the nominal north-westerly track to Bunbury. This was not necessarily significant as the pilot's intentions and aircraft track immediately before the break-up are unknown and the trajectory of the aircraft during and after the break-up would be unpredictable.

Context

Aircraft information

Cessna 210B design characteristics

The Cessna 210 is a single-engine high-wing aircraft with retractable landing gear. In the earliest models of the aircraft, including the B model manufactured in 1962, the Cessna Aircraft Company[1] designed and built 210s with strut-braced wings and with ailerons that were comparatively longer in span than the flaps.

Changes introduced (after the manufacture of VH-DBU) for the D model produced in 1964 included a redesign of the wing structure. Although strut-bracing was retained, Cessna changed the type of aileron control surfaces so that the ailerons were comparatively shorter in span and the flaps were correspondingly longer in span. Then, in the G model produced in 1967, Cessna introduced a new cantilever wing design that removed the strut-bracing. This configuration was retained for subsequent models.

The Cessna 210B was certified as a normal category aircraft and was not approved for acrobatics (aerobatics) or spins. The specified limits included:

- Never exceed airspeed (Vne) 196 kt (red line on airspeed indicator)
- Maximum structural cruising airspeed (Vno) 165 kt (green line on airspeed indicator)
- Manoeuvring airspeed (Va) 115 kt (132 mph[2] on placard & *Owner's Manual*)
- Maximum flight manoeuvring load factors (G) +3.8, -1.52 (flaps up)

These airspeed limitations are defined as calibrated airspeeds (CAS) in the Cessna 210B *Owner's Manual*. In general, the CAS of a Cessna 210B corresponds closely to the airspeed indicator readings (IAS).[3] The IAS at any particular point in a flight will vary according to selected engine power, aircraft angle of attack, aircraft configuration, and environmental conditions.

In the *Owner's Manual*, manoeuvring speed was described as the maximum airspeed at which abrupt control travel can be used without exceeding the design load factor. The ATSB estimated that the aircraft weight was about 200 kg below the maximum take-off weight (MTOW) of 1,361 kg. At weights below MTOW, the effective Va will be marginally less than the specified limit.

Load factors are defined in terms of G loading, which is a measure of the forces acting on the aircraft structure to produce the accelerations involved in changing speed and direction in flight. One-G is the loading on the aircraft structure in un-accelerated straight and level flight produced by the lift force needed to balance the gravitational force, or the weight of the aircraft.

Given the potential relevance of IAS, the ATSB sought to establish some reference points. In the *Owner's Manual*, the top (cruise) speed at sea level was specified as 198 mph (172 kt) and maximum cruise speed at 7,000 ft specified as 189 mph (164 kt). These speeds are true airspeeds (TAS) that correspond to IAS values that diminish as air density reduces with elevation

1 The Type Certificate Holder transferred from the Cessna Aircraft Company to Textron Aviation Inc. on 29 July 2015. All of the actions and data relating to the aircraft manufacturer in the report pre-dates the transfer.

2 When the C210B was manufactured in 1962, the Cessna Aircraft Company specified speed in (statute) miles per hour (mph). For operation of the aircraft in Australia, the airspeed indicator was modified to indicate knots (kt), which is nautical miles per hour. The placards on the instrument panel and extant documentation produced by Cessna were unmodified.

3 The airspeed parameters specified as calibrated airspeeds (CAS) are accurate values derived during the aircraft certification process using specialised equipment. On production aircraft, there are known variations between CAS and IAS associated with the position of the sensing devices and calibration of the airspeed indicator instrument. For the Cessna 210B, there was minor variation between CAS and IAS except when flap was extended and at low airspeeds.

in altitude and/or temperature. For example, a true airspeed of 164 kt at 7,000 ft above mean sea level (AMSL) at a temperature of 10 degrees above standard corresponds to an IAS of 145 kt.

History of VH-DBU pre-2012

The aircraft was registered in Australia as VH-DBU in July 1962. In the first decade of operation, there were no reports of any serious incidents or accidents until the end of that period.

The ATSB database recorded that on 31 March 1972, the aircraft was overstressed when a non-instrument rated pilot became disoriented in cloud near Moruya, New South Wales (NSW). According to the aircraft history file held by the Civil Aviation Safety Authority (CASA), the upper surfaces of both wings sustained stress deformation. Both wings were removed for repair and the aircraft was returned to service later that year.

Details about the wing repair were not available as the original aircraft logbook that would have contained the applicable certifications was reported as lost in the mail in early 1973. The extant aircraft logbook recorded maintenance from December 1972 onwards, when the aircraft total time in service was recorded as 3,800 hours.

During a flight on 26 March 1983, the main landing gear did not extend fully. On landing at Canberra, Australian Capital Territory, the main landing gear folded up completely with consequent damage to the lower surface of the fuselage, landing gear doors, and tailplane. That damage was repaired and other work carried out to both wings before the aircraft was returned to service on 29 July 1983 (aircraft total time in service recorded as 5,708 hours).

The only other recorded incident or accident of any significance was a propeller strike during taxi on 11 December 2004. The engine and propeller were overhauled and the aircraft returned to service on 20 May 2005 (aircraft total time in service recorded as 8,988 hours).

In general, certifications in the aircraft logbook indicated a pattern of periodic and major inspections, including compliance with airworthiness directives and rectification of defects. This was consistent with the maintenance regulations prevailing at the time and with the age and total time in service of the aircraft. It was noted that there was no maintenance recorded in 2006, 2008, 2009, and 2012, which indicates that the aircraft was not operated for some or all of that time.

History of VH-DBU from 2012 onwards

In February 2012, the aircraft was registered to a company owned by the pilot involved in this accident. As the registration holder, the company was required to manage the airworthiness of VH-DBU, which included ensuring that suitably qualified personnel carried out the required maintenance in accordance with approved data (instructions for continuing airworthiness).

The aircraft was initially based in NSW and operated by the new owner, and flown by other pilots in 2012. Other than a landing gear problem that was resolved before landing at Albury there were no reports of any defects or anomalies.

During 2013, the owner-pilot operated the aircraft on a number of flights and there were two periodic inspections carried out. By the end of 2013, the pilot had transferred the aircraft to Albany, Western Australia (WA).

There is no record of the aircraft being operated in 2014 or in 2015 up to December of that year. It was reported that during this period the owner paint-stripped the aircraft and made minor cosmetic repairs.

Cessna have developed a program of Supplemental Inspection Documents (SIDs) to ensure that any damage or defect related to time in service from fatigue, overload, or corrosion is found and rectified. The focus of the SIDs was on principal structural elements and control systems including the wings, wing/strut attachment fittings, and aileron mechanisms. In the 29 supplemental inspections for the Model 200 Series (1960-1965), Cessna specified removal of access panels, fairings, or interior linings and visual inspection of the applicable area. If anomalies were identified and/or aircraft hours exceeded a threshold figure (in some cases 12,000 hours), the applicable area was subject to detailed inspection that could involve disassembly and specialised non-destructive inspection techniques.

CASA ruled that, irrespective of the nominated maintenance schedule, all 200 series aircraft, including the Cessna 210B, were required to be compliant with the applicable SIDs by 31 March 2016.

At the request of the owner, on 14 December 2015, CASA issued a special flight permit for a single flight from Albany, WA to Manjimup, WA, to allow maintenance to be conducted.

On arrival in Manjimup, the aircraft was withdrawn from service for a periodic inspection and compliance with the Cessna SIDs. The ATSB reviewed the aircraft logbooks and maintenance worksheets, which recorded that a CASA-approved maintenance organisation carried out the applicable elements of the CASA maintenance schedule and complied with applicable airworthiness directives and service bulletins.

The approved maintenance organisation recorded compliance with the applicable SIDs in their maintenance worksheets and in the aircraft logbook. These records showed that no significant defects were identified and no specialised non-destructive inspections were carried out. Final certification as to coordination of maintenance was carried out on 20 May 2017 and a maintenance release valid for 12 months or 100 hours of operation was issued for the aircraft. At this time, the aircraft total time in service was recorded as 9,380 hours.

No further maintenance was recorded in the aircraft logbook and the current maintenance release was not recovered. At the time of the accident, the aircraft was within the calendar-time and probably within the time-in-service validity periods of the maintenance release. It is not known if there were any defects endorsed on the maintenance release but no one reported that the pilot had any concerns about the serviceability of the aircraft.

Following the maintenance, the owner-pilot flew the aircraft to a private airstrip east of Perth for it to be painted. The spray painter advised that aviation products were used and the only disassembly carried out during the process was removal of some access panels and fairings for painting. The flight control surfaces were reportedly not painted or otherwise disturbed. Although there were no logbook certifications for the maintenance activities of paint-stripping and repainting, the ATSB considered there was a low risk that those processes had any adverse effect on the continuing airworthiness of the aircraft.

CASA participated in the examination of the aircraft wreckage and reviewed the maintenance records to assess the implications, if any, of this accident for the continuing airworthiness status of the aircraft type and ageing aircraft in general. No concerns were reported to the ATSB.

The ATSB reviewed the records of routine CASA surveillance of the approved maintenance organisation that carried out the recent periodic inspection and SIDs. In the two audits carried out in the 5 years preceding the accident, CASA auditors identified some non-conformances in the control of tooling, storage of aircraft parts, in-progress tracking of maintenance tasks, and certification protocols. Based on advice and evidence of corrective action, CASA acquitted the non-conformances.

In periodic assessments of the performance of the approved maintenance organisation, CASA did not identify any significant risks. For the type of maintenance carried out on VH-DBU, the ATSB considered there was a low risk that the process conformance deficiencies identified by CASA auditors had any adverse effect on the continuing airworthiness of that aircraft.

Pilot information

The pilot had held a Commercial Pilot (Aeroplane) Licence since 1997. Between January 2002 and November 2003, the pilot operated a Cessna 206 aircraft for a charter company operating in north Queensland. During that period, in May 2003, the pilot qualified for an Instrument Flight Rating applicable to single engine aircraft.

From December 2004 to March 2006, the pilot was engaged in training for aerial agricultural operations and gaining related experience. In March 2006, the pilot added an Agricultural Pilot (Aeroplane) Rating to his licence. After two years of operating piston-engine agricultural aircraft, he progressively gained endorsements on turbine-powered agricultural aircraft. In July 2011, the pilot qualified for a Class 1 Agricultural Pilot Rating and aerial firefighting approval.

Since October 2013, the pilot had been employed on a seasonal basis as a firefighting pilot based at Albany. Each year the pilot completed a pre-season proficiency check with an aerial firefighting operator. This satisfied the requirement for a flight review.

After the 2016-17 firefighting season ended in March 2017, the pilot provided contract flying services to two aerial agricultural operators. The pilot completed employment with one of those operators as pre-arranged the day before the accident.

At the time of the accident, the pilot held a pilot's licence issued in accordance with Part 61 of the Civil Aviation Safety Regulations 1998. This licence included class ratings for single and multi-engine aircraft and design feature endorsements such as manual propeller control and retractable undercarriage. As such, the pilot was qualified to operate the Cessna 210B.

The pilot's logbook for the period after 30 January 2012 was not recovered; however, based on CASA and operator records, the ATSB estimated that the pilot's total aeronautical experience was 6,500 hours, of which 4,200 hours was aerial application.

A search of the ATSB occurrence database did not identify any other occurrences involving the pilot. From other sources, there was a report that the pilot experienced a birdstrike in July 2014 with minor facial injuries and no ongoing health effects. There was also report of a wirestrike in 2010 but no details were available.

The pilot held an aviation medical certificate with Class 1 validity until 16 December 2017. Further information about aviation medical examinations is in a following section.

A general practitioner (GP) reported that while he had not been involved in the pilot's medical care, the pilot's family had a history of coronary and cerebro vascular disease with associated events suffered by two close relatives when they were in their sixties. In at least one of those cases, there were no preceding symptoms or events. In addition, a family member advised the GP that the pilot was a long-term smoker and had a poor diet with a high intake of 'fast food'.

According to the GP:

> … given [the pilot's] significant family history combined with his lifestyle risk factors, the probability of sudden cardiac event leading to in-flight collapse/death resulting in loss of control of the aircraft with the subsequent crash would be within the realm of reasonable possibility.

While the GP suggested the potential for a medical condition, there was no direct evidence that the 40-year-old pilot had been diagnosed with any significant medical condition or had been taking any prescribed medication. No one reported that the pilot was showing signs of ill-health before the accident.

Post mortem examination and toxicology analysis

Toxicology results

Forensic pathologists carried out a post mortem examination at the direction of the coroner. The findings of their report were consistent with injuries characteristic of an aircraft accident. The examiners found no evidence of significant underlying natural disease.

A NATA-accredited[4] forensic science laboratory also carried out a toxicological examination. It was not possible to conduct screening analysis of blood samples. Analysis of liver samples was

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[4] National Association of Testing Authorities, Australia.

possible for some substances and this detected a significant concentration of methylamphetamine and a lower concentration of amphetamine. The toxicology report noted that the sample was in an advanced state of decomposition and that interpretation of results must be made in the context of the entire case details.

Methylamphetamine, commonly known as 'ice', is a highly addictive central nervous system stimulant that is administered most commonly by smoking, but may also be administered orally and by intravenous injection. People who use the drug in large doses or frequently, almost always administer it intravenously or by smoking.

Amphetamine is a metabolite of methylamphetamine, and is commonly found in the body when methylamphetamine is present. It has effects similar to methylamphetamine but is less potent.

In Australia, methylamphetamine is not prescribed for pharmaceutical purposes and is only available as an illicit drug. There is no evidence that methylamphetamine is produced naturally in the human body by any biochemical processes (ante or post mortem), and few prescription drugs are known to metabolise to methylamphetamine. In this case, there was no recorded medical evidence that the pilot was taking any prescribed medication, and therefore no legitimate (non-illicit) source for the methylamphetamine.

There was insufficient information for the ATSB to establish the method or timing of administration of methylamphetamine. In the case of intravenous administration, the peak effects occur within a few minutes. When methylamphetamine is smoked or taken orally, the drug is absorbed into the blood and the concentration will gradually rise until a peak concentration is reached after approximately 2.5 to 3 hours. After reaching the peak, the concentration will gradually decline. The decline rate is highly variable between individuals, but the average half-life[5] is approximately 10 hours.

Methylamphetamine and amphetamine concentrations can vary significantly between individuals and studies show a substantial overlap in methylamphetamine concentration between drug-caused deaths (due to the direct toxic effects of the drug) and drug-related deaths (present but not considered the direct cause – recreational use).[6] Similarly, the effect on individuals and the duration of those effects can vary significantly, the latter usually over 4-6 hours but may last somewhat longer if administered by smoking or orally.

Analysis of toxicology results

The toxicology results indicated a significant concentration of methylamphetamine and amphetamine in a liver sample showing an advanced state of decomposition.

The ATSB sought the assistance of the Bioaeronautical Sciences Research Branch of the Civil Aerospace Medical Institute within the US Federal Aviation Administration (FAA) to review the methodology and results of the liver tissue toxicology. The FAA expert toxicologist advised that:

- the reported methodology produces a low risk of false positive results
- the presence of methylamphetamine and amphetamine (as metabolite) at their respective concentrations are consistent with the expected ratios
- the concentrations may be falsely elevated by evaporation of tissue fluids due to the fire (post-impact) and decomposition/dehydration of the liver (post mortem)
- the interpretation of effects on an individual at a particular time is not possible from tissue concentrations
- the individual was exposed to the compound.

[5] Half-life is the time taken for the concentration to decrease by 50 per cent.

[6] Logan, Fligner & Haddix (1998) Cause and manner of death in fatalities involving methamphetamine. *Journal of Forensic Sciences* 43: 28-34

The ATSB noted the toxicologist advice that drug concentrations may undergo post-mortem changes and interpretation of individual effects during a specific time period was not possible. Nevertheless, since the toxicology review advised that the individual was exposed to the compound, the ATSB considered that there would be a safety investigation benefit to further explore the potential effects on the performance of the pilot.

For this assessment, the ATSB engaged a consultant with a PhD in Psychology and post-doctoral training in pharmacology. The consultant had extensive experience in the treatment of alcohol and drug problems and contributed to publications on topics including the effects of drugs on the brain and behaviour, role of alcohol and drugs in road accidents, and psychopharmacology. This assessment was peer reviewed by two independent consultants specialising in forensic pathology and aviation medicine.

Based on empirical data and the toxicology report, the consultant advised it was reasonable to conclude that at the time of the accident, the concentration of methylamphetamine was at least sufficiently high for the pilot to have been significantly affected by the drug. It is possible that the pilot was very markedly affected and there was potential for lethal effects of the drug, most commonly as a result of effects on cardiac function.

Both the aviation medical specialist and the forensic pathologist agreed that the detected presence of methamphetamine and amphetamine were likely to have significantly affected the performance of the pilot.

Aviation safety considerations

Research[7] has found that methylamphetamine can have a significant adverse effect on the user. However, the range of dosage and the corresponding effect can vary significantly between individuals. Nonetheless, it is recognised that no dose is considered safe in an aviation context.

From a safety education perspective, the effects can be increased heart rate and subjective feelings of methylamphetamine intoxication. Exaggerated confidence may be associated with risky, impulsive or reckless behaviour as well as impairment of cognitive function. The ability to concentrate on the operation of an aircraft can be impaired and there is a risk of experiencing psychotic symptoms, particularly paranoia. At relatively high concentrations, there is some risk of death due to the cardiac effects of methylamphetamine.

Management of alcohol and other drugs risk in aviation

Introduction

A key objective of ATSB occurrence investigations is to identify the occurrence events, actions, and local conditions that increased risk and those that contributed to the incident/accident. In more complex investigations, the ATSB will also review the risk controls and organisational influences that relate to identified safety factors and are expected to reduce the likelihood or consequences of those factors.

Given the toxicology result and pilot engagement in commercial operations, the ATSB reviewed the alcohol and other drugs risk controls in the aviation industry. The ATSB also sought to inform pilots of the means available to seek treatment and return to flying. Following is an outline of the main elements of the applicable risk control framework.

Regulatory framework

From a regulatory perspective, the risk of alcohol and other drugs in civil aviation was managed through Civil Aviation Safety Regulation (1998) Part 99 (CASR Part 99). This required certain organisations to implement drug and alcohol management plans (DAMPs) covering their

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7 Logan, Fligner & Haddix (1998) Cause and manner of death in fatalities involving methamphetamine. *Journal of Forensic Sciences* 43: 28-34.

personnel, including contractors, who performed safety sensitive aviation activities (SSAA). It also established a program for CASA to conduct no-notice (also known as random) testing for alcohol and other drugs (AOD).

Another regulatory provision that addressed the risk of alcohol and other drugs was Civil Aviation Safety Regulation Part 67 (CASR Part 67). This prescribed the requirements for medical certification of personnel including the appointment of Designated Aviation Medical Examiners (DAMEs) and standards for issue of medical certificates.

Drug and alcohol management plans

For organisations required to have a DAMP, the regulations stipulated that the plan include the following programs:

- drug and alcohol education – initial then refresher every 30 months, satisfied in some cases by CASA eLearning online course
- drug and alcohol testing
- drug and alcohol response – following a non-negative drug test result.

With regard to the testing program, the regulations stipulated that personnel be tested prior to conducting SSAA for the organisation and in the following circumstances:

- after an accident or serious incident involving personnel performing a SSAA
- if the organisation's DAMP supervisor has reasonable grounds to believe that personnel performing SSAA may be affected by a testable drug or alcohol
- if personnel that would be performing SSAA return to work after a period of exclusion from SSAA due to testable drug use.

Although the regulations specified that DAMP organisations submit a bi-annual report, a post-implementation review found that the initial data set was incomplete or inconsistent and the cost to DAMP organisations and CASA was not warranted. Consequently, CASA issued successive exemptions that removed the reporting requirement.

Drug and alcohol management plans – related operation

In the 12 months preceding the accident, the pilot contracted to three aerial application operators at different times. As holders of an Air Operators Certificate, each operator had implemented a DAMP that applied to the pilot who was performing SSAA on behalf of the operator. The following is a summary of the pilot's interaction with each DAMP.

Operator A: The pilot had been employed as a contractor in previous seasons and received AOD education and testing when the pilot was inducted in 2013. Those test results were negative. In subsequent seasons, the operator repeated the AOD education without further AOD testing, consistent with the operator's DAMP. The operator recalled that the pilot had been tested for drugs in a previous season (possibly 2015) due to a report that the pilot might have been so affected. Those test results were negative and no further action was taken or required.

Operator B: The pilot was a new contractor. The operator arranged AOD testing in June 2017 when the pilot was inducted. Those test results were negative. The operator did not establish the pilot's history of AOD education and none was arranged. The operator provided records of employee AOD education and testing provided to employees.

Operator C: The pilot was a new contractor. The operator did not establish the pilot's history of AOD education, or arrange for AOD testing that was required by operator's DAMP. This was reportedly due to logistical constraints that also applied to other new pilots that season.

The ATSB noted that, consistent with CASR Part 99, the operator DAMPs did not require regular or no-notice/random AOD testing.

Alcohol and other drugs education

The online course provided by CASA for personnel performing SSAA described the effects of alcohol and other drugs, outlined the operation of DAMPs, and advised of CASA testing. It was noted that amphetamines were addressed as a substance within the group of stimulants. The risk of stimulants as a group was summarised as impairment of attention and increased risk taking.

The course material relating to DAMPs was consistent with the regulations and the guidance provided by CASA. It was clear that if DAMP-related testing or CASA no-notice testing produced a non-negative result, the consequences included an immediate stop to SSAA activities and initiation of a strict legal process with limited choices. Alternatively, if someone self-referred and sought help, there was more opportunity for the individual to choose from support and assistance programs. These included public and private health drug and alcohol treatment centres, mental health organisations, the CASA wellbeing webpage, and employee assistance programs.

In response to a request from the ATSB, CASA advised that the pilot had a user account for the CASA Learning Management System but there was no record of the pilot having completed the online AOD/DAMP course. This was qualified by CASA with advice that the third-party provider who hosted the training prior to 2014 did not have any records of completion.

Operator A provided AOD education to pilots during induction in 2013. The course material provided to the ATSB was comprehensive and clear about the AOD testing that would be carried out with serious consequences of a non-negative result. The ATSB noted that the course communicated a zero tolerance approach and did not provide any guidance about self-referral for treatment or provision of support services.

As adopters of the CASA micro-business DAMP, operators B and C referred employees to the CASA on-line AOD course.

Alcohol and Other Drugs testing by CASA

The ATSB obtained data from CASA regarding no-notice testing carried out in 2015, 2016, and 2017. This data is presented in Table 1.

Table 1: CASA no-notice testing in 2015, 2016, and 2017

	2015	2016	2017
Number of drug tests conducted	4,450	4,039	3,480
Positive tests (all drugs)	5	2	3
% tests positive (all drugs)	0.11%	0.05%	0.09%
Positive tests (meth/amphetamine)	2	1	1
% tests positive (meth/amphetamine)	0.04%	0.02%	0.03%

Similar drug use levels have been observed in other aviation jurisdictions. In a study published in 2011, it was reported that the US Federal Aviation Administration (FAA) conducted 1.13 million random drug tests between 1995 and 2005.[8] The FAA found a prevalence rate of drug violations of between 0.61 and 0.65 per cent, and a prevalence of drug violations in flight crew members of 0.05 per cent (position-specific figures limited to 2003-2005). The FAA found that between 1995 and 2005, amphetamine-type drug violations as a proportion of all drug violations increased from 3.4 per cent to 10.3 per cent.

[8] Li, Baker, Zhao, Brady, Lang, Rebok and Di Maggio. (2011) Drug violations and aviation accidents: findings from the US mandatory drug testing programs. *Addiction*. 21: 1287-1292.

Of note, the FAA data only cover employees of major airlines, commuter air carriers and air taxis, and do not cover individuals engaged in general aviation. The authors of the FAA study note that:

> Given the differences in demographic characteristics, flight environments, and regulations between commercial aviation and general aviation, (this research is) unlikely to be applicable to private flights.

Aviation medical certification

In all three aviation medical standards specified in CASR Part 67, the following behavioural characteristic applied: 'does not engage in any problematic use of substances.' If there was personal history of such use, the requirements extended to certification of abstinence, no ongoing safety-relevant effects, and evidence of successful therapy.

It was a requirement that the holder of a class 1 medical certificate and a commercial pilot's licence tell CASA or a DAME about a medically significant condition that continued for longer than 7 days and impaired their ability to perform the actions authorised by the licence. As defined by CASA, drug addiction and drug dependence were medically significant conditions. CASA did not have any record of a report from the pilot about any medically significant conditions.

Since 1996, the pilot had been subject to regular medical examinations by a DAME and these were conducted annually from 2002. The questionnaire part of the examination includes questions relating to mental health problems and use of alcohol and drugs. In all but one of those examinations, the pilot's responses are recorded as 'no'. The exception was in November 2015 when the pilot disclosed an event in 2010 of driving with a low-range blood alcohol content.[9] The DAME was also required in each examination to assess if there was any clinical evidence of alcohol, drug or other substance abuse. In each case the DAME response was 'no'.

CASA advised the ATSB that due to variations between the old paper question-set and old medical records system questions-set, non-disclosures were difficult to notice. With the release of the new medical records system in March 2016, these are easier to note and act upon. At the time of the medical records assessment in 2015, the disclosure of the 2010 event was not noted as a previous non-disclosure.

If there are indications of problematic use of alcohol or other drugs by a certificate applicant or holder, CASA will request further information that may include alcohol and drug testing. For confirmed cases, CASA will suspend the certificate until the applicant or holder can demonstrate that they meet the relevant medical standard. CASA advised the ATSB that this process to address suspected or confirmed problematic AOD use was applied to 691 individuals during the period 2015-2017. Of that group, 576 individuals were subsequently issued with a certificate and 115 individuals withdrew their application or were refused a certificate. On average, CASA issues about 42,000 aviation medical certificates per year.

Industry association

The Aerial Application Association of Australia (AAAA) advised that information related to AOD risk management was integrated into a number of resources currently provided to members. This included guidance about general health and alcohol risks for pilots. Alcohol risk was also addressed in a course for chief pilots that was pending CASA approval. The AAAA did not have data related to problematic AOD use by personnel in their industry sector and were under no obligation to gather such data.

Self-referral and support services

In addition to the regulatory provisions of CASR 67 and CASR 99, CASA promoted the wellbeing of pilots on their website. The stated CASA approach was to encourage an environment of trust where pilots feel comfortable reporting any wellbeing issues, so they can receive the help and support they need to continue with their aviation career. In addition to the supports referenced in

[9] Low-range blood alcohol content (BAC) is between 0.05 mg/L and 0.079 mg/L of breath.

the on-line AOD course, CASA referred to an external organisation, the Human Intervention Motivation Study (HIMS), which provides peer support to pilots.

HIMS is a structured peer support and accountability process to assist pilots diagnosed with a substance use problem, to navigate the treatment and monitoring requirements. It is modelled on well-established overseas programs that have assisted 6,000 pilots return to work in the US over a 40-year period. Note that HIMS is not a regulatory process or recovery program.

Although the number of pilots that have self-referred to HIMS Australia is relatively small (less than 20), all of those were assisted by pilots within the HIMS network to satisfy the medical standards for return to work. Some of the pilots involved were general aviation pilots. HIMS Australia expects that the long-term success rate for self-referrals and assistance from HIMS will be similar to the US, which is 90 per cent.

Other occurrences and reviews

In-flight break-up

The ATSB identified four other in-flight break-ups involving Cessna 210 series aircraft in Australia. All four break-ups were to cantilever (no strut) wing models (unlike the 210B model) and three of those were associated with severe weather, including an in-flight break-up near Darwin on 23 October 2017, the day before this accident.[10]

An in-flight break-up not involving severe weather occurred to Cessna 210L, VH-DJT, 26 km east-south-east of Cloncurry, Queensland, on 11 June 1976.[11] The investigation carried out by a predecessor to the ATSB found that the left wing failed as a result of torsional loading in excess of design limits. That torsional overload resulted from rapid application of a large amount of right-wing-down aileron control when the aircraft was flying at a speed considerably greater than the specified manoeuvring speed. A reason for the critical aileron input was not determined but consideration was given to pilot incapacitation and potential for a birdstrike.

A search of the ATSB database for in-flight break-ups of any aircraft type since 1969 identified 15 occurrences involving certified aeroplanes, including the four involving Cessna 210 aircraft.

- Eight were associated with severe weather or non-visual meteorological conditions.
- Another three were attributed to structural deficiencies such as metal fatigue.
- In the remaining four, the primary factors were related to aircraft handling or were unverified, including one in which tailplane flutter was a possible factor in the break-up of an ex-military Strikemaster aircraft.[12]

Alcohol and Other Drugs

In June 2006, the ATSB published *Accidents and incidents involving alcohol and drugs in Australian civil aviation 1 January 1975 to 31 March 2006* (B2006/0169). This reported that the prevalence of drug and alcohol accidents was very low in Australian civil aviation. However, the author considered that where alcohol and drugs were reported as being involved, there was a very high chance of an accident, especially a fatal one.[13] The report anticipated the introduction of a mandatory drug and alcohol-testing program with education and training to reduce the risk of pilots attempting to fly while impaired by alcohol or drugs.

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[10] ATSB investigation AO-2017-102 In-flight breakup involving Cessna 210, VH-HWY, 22 km E of Darwin Airport, Northern Territory, on 23 October 2017.

[11] Investigation number 197600023 Cessna Aircraft Company 210L, VH-DJT, 26 km ESE of Cloncurry, Queensland, 11 June 1976.

[12] Investigation number 200605843 In-flight break-up 20 km NE Bathurst, NSW, 5 October 2006 BAC 167 Strikemaster, VH-AKY.

[13] This is probably influenced by under-reporting of alcohol and drugs for incidents, and the more thorough testing for substances in fatal accidents via post-mortem toxicology tests.

Indirectly relevant to this accident is ATSB study *Pilot incapacitation occurrences 2010-2014*, published by the ATSB in February 2016. In this study, the ATSB found that there was an average of 23 flight crew incapacitation occurrences per year across the 5-year period 2010-2014, with 25 per cent of these affecting low capacity air transport and general aviation. Although this grouping had fewer occurrences than high capacity air transport, there was a wider variation of causes of incapacitation. In this group there was one incapacitation specifically linked to illicit drugs.

The ATSB conducted a search of the database for occurrences involving alcohol and other drug factors since 1 April 2006. This yielded seven occurrences including four fatal accidents. Some of these were occurrences where a drug/alcohol was in the pilot's body at the time but may not have played a major or any role in the accident. A summary of these occurrences is provided in the table below.

Table 2: Occurrences since April 2006 where alcohol or drug were present

Occurrence severity	Alcohol or Other Drug use	Influence	Occurrence description
Fatal accident	Cannabis (recent)	Possible impaired motor skills and reduced cognitive capacity	Collision with terrain following engine problems in a helicopter
Fatal accident	Alcohol (recent)	Increased risk taking and delayed reaction times	Wirestrike after flying the helicopter at tree top level
Fatal accident	Cannabis (previous or exposure only)	No evidence of impairment from cannabis at time of accident	Collision with terrain
Fatal accident	Methylamphetamine and amphetamine (traces)	No evidence of impairment from non-recent substance use	Collision with terrain in dark night conditions
Accident	Alcohol (recent)	Increased risk taking and delayed reaction times	Wirestrike during aerial application
Serious incident	Methylamphetamine (4 days previous)	Affected sleep cycle resulting in fatigue	Pilot was unconscious during the flight
Serious incident	Alcohol (night before)	Affected sleep and eating resulting in fatigue/sickness	Pilot was unconscious during the flight

The ATSB notes that pilots engaged in non-commercial flying are generally not subject to mandatory AOD testing following an aircraft incident or accident (non-fatal). Although pilots are required to report occurrences to the ATSB, there was no assurance that pilots would include details of any problematic AOD use in their reporting.

To qualify further the ATSB occurrence data, there was no requirement for DAMP organisations to report the results of post incident or accident AOD testing to the ATSB unless it was specifically requested in accordance with the *Transport Safety Investigation Act 2003*.

It is probable that AOD use by flight crew involved in incidents and non-fatal accidents was under-reported to the ATSB.

Safety analysis

Introduction

It was apparent from the distribution of the aircraft wreckage that the Cessna 210B, registered as VH-DBU, had broken up in flight. From analysis of the available evidence, the ATSB was able to discount a number of potential factors commonly associated with in-flight break-ups. The ATSB identified two safety factors that led to a review of the associated risk controls and a general finding.

In-flight break-up scenarios

Contextual information

In the absence of information about the aircraft flight path immediately before the break-up, the ATSB was reliant on interpretation of the accident site and wreckage characteristics in conjunction with witness information to ascertain the likely sequence of events.

It was apparent that substantial aerodynamic stresses were applied to the aircraft and the break-up likely started with separation of the right wing tip and progressed rapidly inboard. As that occurred, the aircraft would have immediately become uncontrollable and that would have generated further abnormal aerodynamic loading with consequent disruption.

The break-up of the right wing was notable in terms of the degree of fragmentation and the high level of torsional and reverse bending. This is not characteristic of a simple overstress situation where the excessive aerodynamic forces on the wings are generally symmetric in direction and magnitude. In that case, if the aircraft breaks up in flight, the sequence typically begins with separation of a substantial piece of each outboard wing. The failure characteristics of both wings is likely to be consistent and further in-flight disruption would be variable but not necessarily extensive.

According to the witnesses, the first indication of something wrong with the aircraft was a loud and distinctive noise described by witnesses as a sharp bang, crack of a whip, gunshot or thunder. This is consistent with a sudden structural failure caused by a high degree of aerodynamic stress, which was probably the initial failure of the right wing. The subsequent period of other noises and the witness observation of the aircraft in a steep dive are consistent with abnormal flight and progressive break-up as a consequence of right wing failure. Witness information was not instructive as to development of the break-up.

Given the break-up likely started with complex and excessive aerodynamic forces on the right wing, the ATSB considered two scenarios in which a high level of torsional and reverse bending could be generated.

Aeroelastic flutter scenario

Aeroelastic flutter is a high-speed phenomenon involving the oscillation of a structure under the combined influence of aerodynamic, inertial and elastic forces. If unchecked, the structure will be subjected to divergent bending and torsion until the structure is overstressed and breaks up.

Certified aircraft are designed so that flutter will not occur during operation within the approved flight envelope. Based on the margins applied to establish the Vne of 196 kt for the Cessna 210B, the aircraft type was demonstrated to be resistant to flutter at airspeeds up to 218 kt.

If, however, an aircraft does not conform to the design standard, the airspeed at which flutter occurs may be lower than designed. Following are examples of airworthiness deficiencies that may reduce the airspeed at which flutter can occur:

- a reduction in structural stiffness

- unbalanced control surfaces
- incorrect control system cable tensions
- changes in the mass distribution of the wings.

The ATSB found that damage to the primary structure was consistent with aerodynamic loading and that structural integrity was not compromised by material fatigue or corrosion. There was no evidence of any defects, non-conforming repairs, or modifications that would have diminished structural strength. This was consistent with the maintenance records that showed the aircraft had been maintained in accordance with the applicable requirements including the Supplementary Inspection Documents.

Although there was no evidence of any airworthiness deficiencies, the ATSB considered the possibility that the major repairs carried out in 1972 following overstress deformation of the wings subtly affected structural stiffness of the right wing. This could not be discounted, in part because of the lack of maintenance records and fragmentation of the wing. Nevertheless, any alteration to structural stiffness was not considered to be significant, given the aircraft was subsequently operated for 5,500 hours over 45 years, including multiple maintenance inspections, without any apparent related problem. Furthermore, the left wing was repaired at the same time but was not similarly affected.

The fragmentation of the aircraft prevented a conclusive finding regarding the balance-state of the control surfaces and control system cable tensions prior to the break-up. There was nothing to indicate these were non-conforming as the recent aircraft repaint did not include the flight control surfaces and the aircraft had recently been returned to service after extensive inspection.

Another consideration in this scenario was that the abnormally high airspeed required for aeroelastic flutter to occur did not disrupt the left wing to the same degree as the right wing. This was not fully reconciled, but the ATSB considered that subtle differences between the wing shape and structure, and a variation of aerodynamic forces from control inputs and manoeuvring, could account for the observed asymmetry of effect. Additionally, as the right wing broke up, the aerodynamic loading of the left wing would be significantly altered with consequent variation in effect.

Based on analysis of the wreckage and consideration of aerodynamic principles, the ATSB found that aeroelastic flutter scenario was a viable explanation for the complex and excessive aerodynamic forces on the right wing. Given there was no metal fatigue or corrosion and no evidence of any airworthiness deficiency, there were probably no conditions that would lower the resistance of the right wing to flutter. The operational implications of this scenario are considered in a following section.

Aileron input scenario

The other scenario considered by the ATSB—aileron input—was identified as a factor in the Cessna 210L occurrence near Cloncurry in 1976 in which the left wing failed in overload. A direct comparison between the Cloncurry event and this event was not feasible because of limited information and VH-DBU was fitted with a strut-braced wing that was different in structural configuration and aerodynamic properties to the cantilever wing of the Cessna 210L.

Nevertheless, the same scenario could apply in which the pilot rotates the control column which deflects the ailerons differentially, as designed, to create an upward force on one wing (aileron down) and a corresponding downward, or reduced upward, force on the other wing (aileron up). If the control column is rotated rapidly and to a large degree while the airspeed is above the manoeuvring speed, the aerodynamic loading on the outboard section of the wing influenced by the ailerons can exceed the design strength.

The ATSB considered the capacity of the relatively long span ailerons of Cessna 210B models to generate torsional loading over a larger area of the wing than would be the case for later model 210 aircraft with different wing design. It was noted that one area of disruption of the right wing was roughly coincident with the span of the ailerons, which could be related to aileron input but could also be attributed to the span-wise variation in wing strength and stiffness. Even if the wing design did account in part for the pattern of disruption, there is no evidence that the design did not meet the required standard or was problematic in this occurrence.

Another consideration in this scenario was accounting for the variation in magnitude between right and left wing damage. Although aileron deflections are differential, the down-going wing (aileron up) in normal manoeuvring flight results in a reduction of lift whereas the up-going wing (aileron down) results in an increase of lift. This produces higher aerodynamic loading on the up-going wing, which in this scenario would be the right wing.

A single large aileron input would not produce the reverse bending observed in the wreckage. This may be attributable to multiple reverse control inputs, or complex loading of the wing during the break-up sequence.

Aileron inputs also induce torsional loads in the wing, which due to the differential aileron inputs would be in opposite directions on the left and right wings. There was no clear indications of opposing torsional (twisting) deformation in the wings; however, the magnitude of these loads before failure of the structure may not have been sufficient to have left evidence.

Based on analysis of the wreckage and consideration of aerodynamic principles, the ATSB found that there was not strong evidence for the aileron input scenario but it could not be discounted. The operational implications of this scenario are considered in the next section.

Operational considerations

Contextual information

The pilot’s radio transmission after getting airborne at Albany indicated the pilot would track to the north-west towards Bunbury and climb to a cruising altitude of 6,500 ft above mean sea level (AMSL). If the pilot had departed as indicated, the aircraft would have passed over the area 30 km to the north-west of Albany at around 1045, at or close to 6,500 ft.

This, however, did not occur as the pilot did some flying in the local area and was then observed operating to the north-west of Albany before the in-flight break-up occurred at about 1100. The pilot’s intentions regarding this local flying are not known but the apparent variation to the pilot’s departure broadcast was not necessarily significant for operations outside of controlled airspace.

Aircraft limitations and handling

The Cessna 210B airspeed limitations relate to the aerodynamic forces the aircraft could sustain without structural damage. With regard to the flutter scenario, the key limitation was Vne as any airspeed above that figure reduced the margin to onset of divergent and destructive aeroelastic forces.

For the aileron input scenario, the key limitation was maximum manoeuvring speed (Va). Essentially, if the indicated airspeed (IAS) was above 115 kt and the pilot made abrupt or large control inputs, the consequent aerodynamic forces could exceed the design strength of the aircraft. As the IAS increases, the risk of excessive aerodynamic forces from control inputs increases at a disproportionately higher rate according to the square of the airspeed value.

Based on the likely airworthiness of the aircraft and the absence of any significant weather, it follows that for both scenarios, aeroelastic flutter and aileron input, the aircraft was operated outside of the relevant airspeed or handling limitations up to the point of failure of the right wing. This is analysed in terms of the pilot functioning normally and, in the following section, in terms of pilot impairment or incapacitation.

The pilot was qualified for the flight and was reported to be competent and experienced in the challenging field of aerial application operations. No one reported that the pilot was in the habit of handling aircraft aggressively or was inclined to perform aerobatic-type manoeuvres. There was no apparent reason for the pilot to operate outside of the limitations.

It is possible that the pilot of VH-DBU encountered a large bird in the vicinity of the accident and acted instinctively to avoid a collision with excessive control inputs. The pilot reportedly sustained injuries from a birdstrike in July 2014 and that experience might have influenced the pilot to respond differently to any subsequent bird encounters. There was no evidence that a bird hazard was involved in the accident but the ATSB could not rule it out as a possibility.

Given the pilot operated the C210B in the private category on the basis of a class endorsement and flight reviews in other aircraft types, there were no records relating to pilot awareness and understanding of C210B operating limitations. Nevertheless, it is likely that the experienced commercial pilot was aware of limitations such as the Vne (never exceed airspeed) marked on the airspeed indicator and the Va (manoeuvring airspeed) as specified on an instrument panel placard and defined in the *Owner's Manual*.

The ATSB notes that the Va was specified as 132 mph which has equivalent value as an airspeed indication of 115 kt. If the pilot had applied large control inputs on the basis that a safe indicated airspeed for that manoeuvring was 132 kt (rather than 132 mph/115 kt), there would have been increased risk of aircraft overstress at indicated airspeeds above 115 kt. It is likely that the experienced commercial pilot was aware of the variation between the two airspeed units and operated accordingly.

In relation to the pilot's general awareness, the airspeed limitations of other aircraft types flown by the pilot were similar to or lower than the Cessna 210B's. The aerial application aircraft flown by the pilot are typically certified in the utility category with higher maximum load factors but the difference and the potential effect was not significant.

Normal category aircraft such as the Cessna 210B are not generally equipped with G indication or warning systems so pilots rely on feedback from the flight control systems and physiological indications to ascertain the approximate load factor exerted on the aircraft. Although these methods are imprecise, in normal circumstances a pilot (and especially an experienced pilot) would be expected to recognise development of an abnormally high load factor as it related to the aircraft as a whole, and respond accordingly.

The situation is more complex in the aileron input scenario because flight load factor is not directly related to torsional loading of the wings. If rapid rolling motion is induced during a high-G manoeuvre to produce additional and imperceptible asymmetric loading known as 'rolling G', the pilot may not be aware that the cumulative effect exceeds the maximum load factors.

A key factor in both scenarios is airspeed. In the absence of direct information about airspeed, the ATSB considered the cruise airspeed of 145 kts to be a useful reference point. In normal operation of a Cessna 210B, the indicated airspeed will be above the Va of 115 kt once the aircraft is in cruise or descent.

To exceed the Vne of 196 kt, the aircraft would need to be in a steep descent with substantial engine power. There is no direct evidence of this but there is insufficient information about the flight path and engine power to disqualify it as a possibility.

Based on the information available to the ATSB, there was no evidence of any conditions that would dispose the pilot in normal circumstances to exceed the operational limitations of the aircraft. In this context, the ATSB analysis below considers the abnormal circumstances of pilot impairment or incapacitation.

Pilot incapacitation or impairment

Pilot incapacitation or impairment can occur due to a number of reasons, such as a medical condition or the effects of drugs or alcohol.

The medical history of other family members and the reported lifestyle risk factors indicated to the family GP that a sudden cardiac event was a reasonable possibility. However, the post mortem examination did not identify any cardiac disease and the aviation medical examinations did not detect any cardiac condition that would increase susceptibility to incapacitation due to cardiac arrest. Irrespective of whether the pilot was at elevated risk of a cardiac event, the presence of methylamphetamine in this case increased risk of pilot incapacitation.

Based on expert opinion, the ATSB considered that the concentration of methylamphetamine detected in the liver corresponded to a likely concentration in the blood at the time of the accident that exceeded therapeutic levels.

The effects of methylamphetamine at any particular time will vary according to method and timing of administration, substance amount, individual physiology, and history of use. However, methylamphetamine can significantly impair important cognitive and psychomotor functions necessary for safe operation of an aircraft. In this case, details about administration and dosage were not available.

Although the presence of methylamphetamine in the pilot's system was established, the lack of information about dosage and variability in the effects of methylamphetamine on individuals prevented the ATSB making a finding as to its influence on this accident.

Nevertheless, the ATSB was not able to discount that the presence of methylamphetamine in the pilot's system had an adverse effect on the accident and found that it increased the risk of operational misjudgements or mishandling due to impairment and involuntary action or inaction due to incapacitation. Examples of involuntary actions are slumping forward with forward pressure on control column, erratic control inputs, and no control inputs in response to developing loss of control.

Management of alcohol and other drugs in aviation

The ATSB acknowledges the complexities and sensitivities of substance use and considers that deliberation of the pilot's personal circumstances and motivations would not enhance aviation safety. It should be noted, also, that there is no evidence that the pilot operated any flights, other than the accident flight, while under the influence of alcohol or other drugs.

Although the in-flight break-up occurred during a private flight, the pilot held a commercial pilots licence with a Class 1 aviation medical certificate and was active in the aerial application industry. As such, the ATSB sought to understand how the risk of substance use was being managed by organisations in relation to the pilot and more generally.

As the aviation safety regulator, the Civil Aviation Safety Authority (CASA) had an important role in managing five key activities:

- oversight of organisations to ensure implementation and compliance of Drug and Alcohol Management Plans (DAMP)
- on-line alcohol and other drug (AOD) education
- no-notice AOD testing across the aviation industry
- certification of pilots and other licence holders according to medical standards
- promotion of flight crew wellbeing, self-referral, and treatment.

Based on the sample of three aerial application operators and this pilot, and on 3 years of no-notice test data, there was evidence that CASA was carrying out the regulatory activities as prescribed. It was beyond the scope of this investigation to establish whether the scope, frequency and implementation of no-notice testing was effective in deterrence and detection of drug use.

In general, the aviation medical certification process was identifying individuals at risk of problematic AOD use and for confirmed cases was preventing further operation until the individual demonstrated ongoing conformance with the medical standard. A relatively large proportion of identified individuals were issued with an aviation medical certificate and there was no data to indicate that the process was ineffective. In relation to this accident, the pilot did not disclose relevant information during annual medical examinations and, when the pilot disclosed a driving under the influence of alcohol offence from a previous period, CASA did not identify this as a risk indicator.

The ATSB observes that as a once a year, or less frequent, snapshot of medical status and with reliance in part on pilot disclosure, the aviation medical certification process has limited opportunities to identify problematic AOD use.

The promotion of wellbeing and facilitation of self-referral plays an important part in reducing the risk posed by alcohol and other drugs. This was a developing area of CASA activity. Outside of the regulatory framework, the aerial application industry association provided guidance about AOD to pilots and operators with an emphasis on the risk of alcohol. This did not extend to advisory information about self-referral or support organisations.

Aircraft operators have an important role in implementing DAMPs, as the three operators that employed the pilot in the 12 months prior to the accident had done. In the five-year period before the accident, the pilot had been AOD-tested three times, each with no detection of alcohol or drugs.

The pilot received AOD education in 2013, which informed that the use of substances such as methamphetamine are not compatible with aviation, and that pilots could be tested at any time. This training explained the serious consequences of non-negative test results, but did not identify that self-referral was an option that allowed for a return to employment. It was reported that this AOD education was repeated in following seasons.

As was the case for CASA no-notice testing, the ATSB notes that there are inherent limitations to induction AOD testing and other DAMP testing in the ongoing detection of problematic AOD use. In the case of pilots employed seasonally and as contractors, sometimes in remote locations, there are relatively less opportunities for operators to educate, test and monitor.

As part of the review of AOD risk controls the ATSB reviewed the following studies and data:

- ATSB study of occurrences involving alcohol and other drugs for period 1969–2006
- ATSB study of data for incapacitation 2010-2014
- CASA no-notice testing data for 2015-2017
- CASA Aviation Medicine data for 2015-2017
- research on no-notice testing by the US FAA from 1995-2005
- Australian aviation occurrence data.

Although infrequent, past occurrences have shown that there is potential for alcohol and other drugs to contribute to accidents either through cognitive impairment or incapacitation.

Overall, these studies and data did not indicate that the use of alcohol and other drugs was problematic across the aviation sector. However, the ATSB study of occurrences involving alcohol and other drugs was completed 12 years ago (before implementation of DAMPs) and situational factors may have changed during the intervening period. There was also no aggregate data about DAMP testing results or self-referrals managed through DAMPs.

In summary, the ATSB found that the required risk controls for problematic AOD use were in place and generally operated in a compliant manner. There was no data that indicated AOD use was a systemic problem within aviation.

Nonetheless, the ATSB considered that there were opportunities for organisations to collect more data and to enhance the extant risk controls for problematic AOD use.

The ATSB acknowledges that self-referral by a pilot with problematic AOD use to a Designated Aviation Medical Examiner (DAME), DAMP, or CASA may be perceived as a threat to ongoing employment in aviation. However, problematic AOD use is a clear threat to aviation safety and self-referral initiates a defined process to counter the hazard while providing an opportunity to return to work with support. In other words, the risks to pilots associated with self-referral are less than the health, safety, and legal risks of continuing to operate with problematic substance use.

A defined protocol exists within the CASA aviation medical framework for pilots in stable remission from the problematic use of substances to return to work. Employer and independent peer support organisations, such as the Human Intervention Motivation Study (HIMS), are becoming more widely available to assist pilots with the safe return to work.

The ATSB acknowledges that CASA is providing information to pilots about the self-referral pathway and suggests that operators and industry associations consider the availability of information and services to pilots and safety sensitive aviation activities within their area of influence.

Findings

From the evidence available, the following findings are made with respect to the in-flight break-up involving a Cessna Aircraft Company C210B, registered VH-DBU, 30 km north-west of Albany, Western Australia on 24 October 2017. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- For reasons that were not established, abnormal operation of the aircraft produced high levels of unusual aerodynamic loading on the right wing that exceeded the strength of the wing and initiated an in-flight break-up that fatally injured the pilot.

Other factors that increased risk

- The presence of methylamphetamine in the pilot's system increased the risk of operational misjudgements, aircraft mishandling, and incapacitation.

Other findings

- No structural deficiency or damage that would have contributed to the in-flight break-up were identified and the local meteorological conditions were not conducive to inadvertent overstress.
- The required risk controls for problematic alcohol and other drug (AOD) use were in place and generally operated in a compliant manner. In addition, there was no data that indicated a systemic problem with problematic AOD use in aviation.

General details

Occurrence details

Date and time:	24 October 2017 – 1100 WST approximately	
Occurrence category:	Accident	
Primary occurrence type:	In-flight break-up	
Location:	30 km north-west of Albany, Western Australia	
Main wreckage:	Latitude: 34° 50.672’ S	Longitude: 117° 30.657’ E

Pilot details

Licence details:	Commercial Pilot (Aeroplane) Licence (Part 61) issued November 2016 (Initial issue April 1997)
Class Ratings:	Single Engine Aeroplane, Multi Engine Aeroplane.
Design Feature Endorsements:	Tail wheel Undercarriage, Manual Propeller Pitch Control; Retractable Undercarriage, Gas Turbine Engine.
Operational Ratings:	Single Engine Aeroplanes: Instrument Rating, Night VFR, Private IFR, Aerial Application.
Medical certificate:	Class 1, valid to December 2017
Aeronautical experience:	Approximately 6,500 hours
Last flight review:	October 2016

Aircraft details

Manufacturer and model:	Cessna Aircraft Company 210B	
Year of manufacture:	1962	
Registration:	VH-DBU	
Operator:	Owner-pilot	
Serial number:	21057989	
Total Time In Service	9,380 hours (as of last annual inspection)	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – nil
Injuries:	Crew – fatal	
Damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- Civil Aviation Safety Authority
- Textron Aviation (Type Certificate Holder for Cessna Aircraft)
- Aircraft operators
- Aircraft maintenance organisations
- Expert pharmacologist

The ATSB acknowledges the support of Western Australia Police in Albany, Parks and Wildlife Service (Department of Biodiversity, Conservation and Attractions) personnel in Albany and Walpole, and State Emergency Service personnel in Albany and Denmark.

References

Li, Baker, Zhao, Brady, Lang, Rebok and Di Maggio. (2011) Drug violations and aviation accidents: findings from the US mandatory drug testing programs. *Addiction*. 21: 1287-1292.

Logan, Fligner & Haddix (1998) Cause and manner of death in fatalities involving methamphetamine. *Journal of Forensic Sciences* 43: 28-34.

McIntyre, Hamm & Bader (2011) Postmortem methamphetamine distribution. *Journal of Forensic Research* 2: 122 doi: 10.4172/2157-7145.1000122

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Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the Civil Aviation Safety Authority and other organisations that provided input to the report. Any submissions from those parties will be reviewed and where considered appropriate, the text of the draft report will be amended accordingly.

Australian Transport Safety Bureau

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

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

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

Purpose of safety investigations

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

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

Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

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

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

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Terminology used in this report

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing factor: a factor that, had it not occurred or existed at the time of an occurrence, then either:

(a) the occurrence would probably not have occurred; or

(b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or

(c) another contributing factor would probably not have occurred or existed.

Other factors that increased risk: a safety factor identified during an occurrence investigation, which did not meet the definition of contributing factor but was still considered to be important to communicate in an investigation report in the interest of improved transport safety.

Other findings: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which ‘saved the day’ or played an important role in reducing the risk associated with an occurrence.