Australian Government
Australian Transport Safety Bureau

Collision with terrain involving Cessna 310R, VH-BWZ

near Mildura Airport, Victoria | 6 November 2015

Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
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Addendum

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Safety summary

What happened

On 6 November 2015, at about 1829 Eastern Daylight Saving Time, the pilot of a Cessna Aircraft Company 310R registered VH-BWZ, on a private flight from Moorabbin to Mildura, Victoria lost control of the aircraft near Mildura Airport and collided with terrain. The pilot was fatally injured and the aircraft destroyed.

What the ATSB found

Witnesses reported that when on final approach to land at Mildura, at low altitude, the aircraft yawed to the left, dropped its left wing and rapidly lost altitude. A number of factors contributed to the loss of control. The aircraft's left engine was found to have been starved of fuel and at the time of the accident was not producing power. The left propeller was found to be towards fine pitch, not feathered (rotation of propeller blades to an edge-on angle to the airflow to minimise aircraft drag following an in-flight engine failure or shutdown), and the flaps and landing gear were fully extended, consistent with a normal landing configuration. In that configuration with the engine not producing power, the aircraft's performance would have degraded to the extent that altitude could not be maintained.

The ATSB was unable to ascertain why the left engine was starved of fuel, nor could it be determined when the engine was starved of fuel. The ATSB did establish that it was likely the aircraft was carrying a substantial amount of fuel on board for continued flight and that the left engine and left propeller were capable of normal operation.

Several components recovered from the aircraft were tested. Some abnormalities were identified, however, it was unlikely that these contributed to the accident. No mechanical defects were identified that may have contributed to the accident. However, examination of the aircraft was limited due to the extent of the damage resulting from the post-impact fire.

It was likely that the combination of the inoperative left engine with the propeller in the fine pitch and the right engine at high power resulted in asymmetric thrust. Whilst at low altitude in a landing configuration with asymmetric thrust, the pilot lost control of the aircraft.

Safety message

In situations such as an inoperative engine condition, the aircraft's landing gear, flaps and or propeller management can potentially impose increased drag impacting significantly on the aircraft's performance. Low airspeed in critical phases of flight such as take-off and landing can further exacerbate the situation. Pilots need to train, maintain their skills and constantly monitor aircraft systems to be prepared for abnormal flight situations, especially during critical phases of flight where greater attentional focus is required.

While ATSB research has found that the rate of power loss accidents in multi-engine aircraft occur less than that in single-engine aircraft, they are more likely to be fatal and overwhelmingly due to the potential for loss of control. In particular, the approach phase of flight is considered riskier due to lower altitudes and lower available aircraft energy.

This accident has emphasised the adverse consequences of aircraft configuration on performance with one-engine inoperative, particularly when at low altitudes. It reinforced the importance of pilots remaining well versed in engine failure response procedures and being aware of the drag penalties associated with varying configurations. It also highlighted the challenges associated with recognising an asymmetric condition when in a descent or at a low power setting. When faced with an inoperative engine in a multi-engine aircraft, attention to both aircraft control and performance is crucial for safe flight.

The occurrence

On 3 November 2015, the pilot of a Cessna Aircraft Company 310R, registered VH-BWZ, departed Mildura, Victoria on a private flight to Latrobe Valley. The pilot had intended to return to Mildura the next day, however, due to poor weather, he elected to fly to Moorabbin. On 5 November, the pilot was again unable to return to Mildura due to poor weather and took the opportunity to have some minor maintenance performed on the aircraft while at Moorabbin where a wire was repaired to the tachometer.

On 6 November, at about 1650 Eastern Daylight-saving Time,[1] the pilot departed Moorabbin for Mildura, operating under instrument flight rules.[2] Despite the pilot having some difficulties shortly after departing, including a transient transponder code issue, navigating in poor weather and reporting a 'downward force on the aircraft', the pilot appeared to resolve these issues and stated to air traffic control (ATC) an intention 'to continue to Mildura'. ATC subsequently issued vectors to depart Melbourne airspace for Mildura.

The flight between Melbourne and Mildura appeared to continue uneventfully. Airservices Australia surveillance radar data showed the aircraft tracking direct from Melbourne to Mildura at an altitude of 6,000 ft until radar services were no longer available.

While en route, the pilot sent several text messages, and telephoned the Mildura automatic weather information service and a family member. During this latter communication, the pilot indicated that he experienced difficulties while departing Moorabbin, however, the pilot did not state any specific mechanical defects or problems with the aircraft. The pilot was reported to have sounded normal during that conversation.

At about 1814, the pilot made a broadcast on the Melbourne Centre ATC frequency that the aircraft was 38 NM (70 km) from Mildura, at top of descent. No further broadcasts were made by the pilot on this frequency. It was unknown if the pilot made a call on the Mildura common traffic advisory frequency as broadcasts were not recorded.

Several witnesses situated to the south and east of Mildura Airport observed the aircraft approaching from the north, consistent with being on final approach to runway 18. One witness described the aircraft to be flying 'in a nose-up attitude or yawing'.[3] At about 1829, when about 1.9 km north-north-east from the runway at low altitude, several witnesses described the aircraft as yawing left, the left wing dropping, the aircraft then rotating in an anti-clockwise direction and rapidly lose altitude before colliding with terrain.

The aircraft collided with steel trestles mounted on wooden poles that were strung with heavy gauge single strand wires, used to support grape vines. The aircraft came to rest on four strands of 11,000 volt high tension (HT) power lines that were strung across the property from the road. A post impact fuel-fire ensued. The pilot, the sole occupant, was fatally injured and the aircraft destroyed.

Pilot information

The pilot held a Private Pilot (Aeroplane) Licence issued on 25 June 2006. The pilot was endorsed on the Cessna 310 in September 2012 and last completed a multi-engine flight review in December 2013, valid until December 2015. The pilot was also the owner of VH-BWZ.

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1 Eastern Daylight-saving time (EDT): Coordinated Universal Time (UTC) + 11 hours.

2 Instrument flight rules (IFR): a set of regulations that permit the pilot to operate an aircraft in instrument meteorological conditions (IMC), which have much lower weather minimums than visual flight rules (VFR). Procedures and training are significantly more complex as a pilot must demonstrate competency in IMC conditions while controlling the aircraft solely by reference to instruments. IFR-capable aircraft have greater equipment and maintenance requirements.

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

Extracts from the pilot's logbook found at the accident site showed a total flying experience of about 511 hours. The pilot's experience on the Cessna 310 was estimated at about 113 hours, based on a combination of entries on the aircraft's maintenance release and the pilot's logbook. It appeared that the pilot had not flown in the period February to October 2015. However, on 14 October 2015, the pilot completed an instrument landing system endorsement for the private instrument rating with a Civil Aviation Safety Authority (CASA) approved testing officer. During the endorsement, the pilot was subjected to several simulated one-engine inoperative exercises in the approach phase-of-flight. The testing officer reported that the pilot's response to these exercises were considered 'normal'.

The pilot held a valid Class 2 Medical Certificate with the requirement for reading correction to be available while exercising the privileges of the licence. While a post-mortem medical examination found that the pilot had a mild heart enlargement, there was no evidence of any pre-existing conditions identified that may have contributed to the accident.

The investigation included an assessment of whether the pilot may have been experiencing a level of fatigue known to have an effect on performance. Consideration was made of the pilot's sleep obtained, time awake at the time of the occurrence, time on task, potential workload and environmental factors. However, given the limited data available in relation to the pilot's sleep history in the 72 hours prior to the accident and the nature of the individual actions leading up to the accident, there was insufficient evidence to determine whether fatigue contributed to the accident.

Aircraft information

The aircraft was maintained by a provider approved by CASA. About 4 months prior to the accident, a periodic inspection was conducted and the aircraft was released to service. The maintenance provider reported that during the pre-maintenance engine run check the autopilot was operated while holding the elevator trim wheel. This test established that, while the autopilot was operating the trim could be arrested manually, establishing that the elevator trim could be overridden if unintentionally activated.

The aircraft's fuel system consisted of two main tanks located on the tip of each wing and two auxiliary tanks located within each wing. The combined usable capacity was about 100 US Gallons (378 L) for the two main tanks, and 63 US Gallons (238 L) for the auxiliary tanks. The main tanks were integrally sealed aluminium tanks, which were vented to the atmosphere. Each auxiliary fuel tank consisted of two interconnected bladder-type fuel cells that were located between the wing spars in the outboard section of each wing.

Two fuel selectors, one for each engine, were located on the floor in between the pilot and co-pilot seats. These allowed selection of main tank fuel, auxiliary fuel, cross-feed and no fuel through the wing selector valves located in each respective wing.

Meteorological information

The Mildura aerodrome forecast, issued at 1613 and valid between 1700 on 6 November to 0500 on 7 November 2015 indicated that conditions were forecast as CAVOK[4] with a wind direction of 210° at 10 kt. The Bureau of Meteorology provided the ATSB with data recorded by the automatic weather station at Mildura which indicated at the time of the accident (1829), the wind was 220° at 11 kt gusting to 12 kt.

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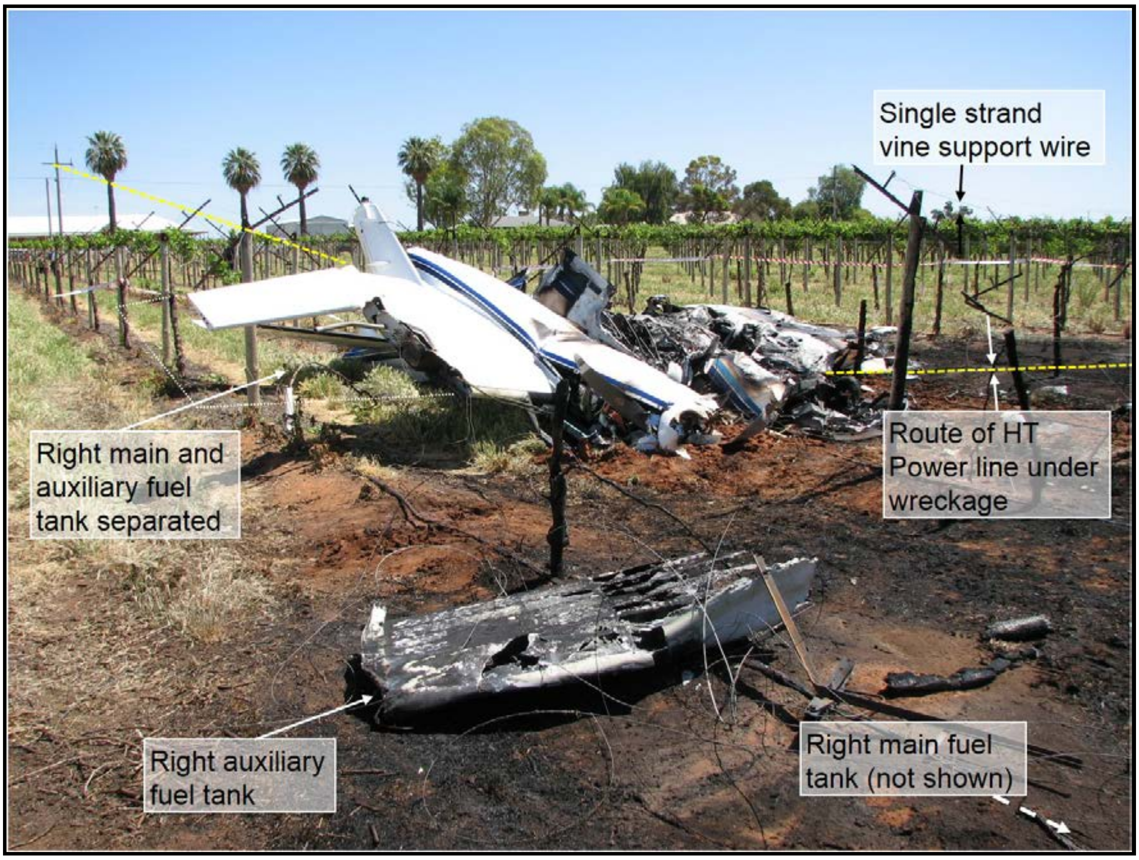
4 Ceiling and visibility OK, meaning that the visibility, cloud and present weather are better than prescribed conditions. For an aerodrome weather report, those conditions are visibility 10 km or more, no significant cloud below 5,000 ft or cumulonimbus cloud and no other significant weather within 9 km of the aerodrome.

Wreckage and impact information

The aircraft was found in a left-wing, nose-down attitude and had come to rest on four strands of 11,000 volt HT power lines that were strung across the nearby property from the road. Ground scars of ruts, and soil and vegetation built up on one side of the landing gear and wings, indicated that the aircraft was rotating in an anti-clockwise direction during the impact sequence. The aircraft was destroyed by the impact forces and a post impact fuel-fed fire. The ATSB examined the wreckage and found:

- The landing gear was down and flaps fully extended.
- Continuity of all flight controls was established.
- The elevator, rudder and aileron trims were found in the neutral position.
- There was nil evidence of a pre-impact structural failure or in-flight fire.
- All fuel caps were identified in the wreckage in a closed locked position. The left wing main fuel tank was found attached to the left wing tip, while the right main tank had separated from the wing and had been thrown forward about 10 m. Both were significantly melted, consistent with the fuel-fed fire. The outer section of the right auxiliary fuel tank had fractured and separated due to the impact forces, and was found forward of the main wreckage, also significantly melted (Figure1). The inner section of the right wing auxiliary fuel tank did not burn and contained an adequate quantity of fuel to obtain a sample. That sample was field tested and found to be consistent with aviation fuel of a suitable quality. In contrast, the left auxiliary fuel tank displayed only some degree of melting. In consideration of the left wing-down attitude at the time of impact, it was unlikely that the left auxiliary fuel tank contained a significant quantity of fuel.

Figure 1 : Aircraft wreckage with evidence of fire and right wing auxiliary fuel tank in the foreground



Source: ATSB

- The right engine propeller blades were towards the fine pitch[5] and displayed significant bending, torsional twisting and chord wise (across the width of the blade) scratching. The bolt holes of the engine crankshaft propeller flange, where the propeller mounted to the crankshaft with bolts and locating dowels, were elongated opposite to the direction to the crankshaft rotation. This was consistent with the right engine producing significant power when colliding with terrain.
- The left engine propeller displayed no evidence of torsional bending or chord wise scoring, nor was the engine crankshaft propeller mount flange distorted. The angle of the propeller blades were consistent with being towards the fine pitch. In addition, one HT power line was found routed through the left propeller arc and engine cowling, then under the wing and through the landing gear. There was no evidence of the HT power line or the single strand wires used to support the grape vines being wrapped around the engine crankshaft. Similarly, there was evidence of arcing and mechanical abrasion on one of the propeller blades from contact with a HT power line while in-flight. This was limited to the leading edge of the propeller blade only. Collectively, these elements indicated that at the time of the collision the left engine was not producing power nor was the propeller producing thrust.
- The cockpit and cabin were severely fire damaged, consistent with a significant fuel-fed fire supplied from the right inboard section of the auxiliary fuel tank.
- The fuel selectors located in the cockpit were melted. Examination of the wing fuel selector valves, operated through push pull rods from the cockpit, showed that the right valve was selected to the right main fuel tank. In that position, the right engine received fuel from the right main fuel tank. The left wing fuel selector valve was in between the left auxiliary and cross-feed positions. The ATSB could not establish if that valve position was:
  - representative of the tank selection during normal operations,
  - selected in response to a left engine issue, or
  - a result of the impact sequence.
- For each engine, the fuel line between the engine and fuel control unit and the engine and the wing were disconnected by the ATSB. The right engine fuel lines contained fuel. In contrast, no fuel was observed in the fuel lines of the left engine. No mechanical defects were identified that may have prevented normal operation of the left engine.

The source of ignition that led to the fire could not be established, however, the aircraft battery, damaged aircraft electrical wiring, hot engine and turbo charger, HT power lines and collision with steel were all possible sources of ignition. No mechanical defects were identified that may have contributed to the accident.

The left engine and propeller were recovered from the wreckage and transported to a CASA approved overhaul facility for detailed inspection under the supervision of the ATSB. The autopilot pitch and roll servos, and elevator trim actuator were also removed and sent to the United States for inspection under the supervision of the Federal Aviation Administration (FAA) and aircraft manufacturer. These components were tested in accordance with the manufacturer's system of maintenance (refer to section titled *Test and research*).

Test and research

Left engine fuel system

The left engine fuel control fuel filter and fuel manifold top cap were removed and examined. No foreign object debris or fuel was identified in either component.

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[5] Fine pitch (or low pitch blade angle) yields good low speed acceleration used during take-off and landing. In contrast, course pitch (or high pitch blade angle) is used in cruise and optimises high speed performance and economy.

Left engine and propeller examination

Left engine internal components used to achieve normal engine operation, including the crankshaft, connecting rods, pistons, pushrods, cylinders, valves, camshaft, bearings and gears were inspected and found to have continuity. External accessories such as the fuel pump, magnetos, propeller governor and fuel injector were inspected and tested for correct operation. Other components such as the turbo charger and associated components were visually inspected.

The left propeller was also disassembled and inspected. Witness marks of the propeller blade situated in the cuff and bearing race damage found within the propeller established that, at the time of the collision, the propeller was towards the fine pitch position. Nothing was identified from those inspections or tests that may have prevented normal engine or propeller operation.

Autopilot pitch and roll servo, and elevator electric trim actuator

The servo drive motor for the autopilot pitch mode operated when power was applied. When an over voltage is detected in the system, the unit should trip the autopilot off-line and stop the motor; this function was inoperative. The motor clutch assembly was tested and slipped at 17 in lb in the clockwise direction and 21 in lb in the anti-clockwise direction. The specification for this unit is 14 ±1 in lb in either direction. The actuator mount clutch on the capstan did not breakaway until 70 in lb in both directions. The specification for this clutch to slip is 20 ±2 in lbs.

The servo drive motor for the autopilot roll mode and the electric elevator trim actuator were also tested. Some minor breakout torque discrepancies were identified, however, were not considered significant.

Operational information

Fuel quantity

The pilot’s personal fuel records showed that 219.69 L was uplifted at Latrobe Valley on 4 November. The ATSB could not determine if that fuel was placed in the main and/or auxiliary fuel tanks. However, a witness at Latrobe Valley reported observing the main fuel tanks full. There were no fuel records identified to indicate any fuel uplift at Moorabbin.

The combined flight time from Latrobe Valley to Moorabbin and Moorabbin to Mildura was about 110 minutes, excluding taxi time. A pilot that had previously flown the aircraft reported that it had an average fuel burn rate of 60 litres per hour per engine (120 litres per hour total).

The Cessna Aircraft Company’s *Pilot Safety and Warning Supplements*, dated 1 June 1998, stated that:

> Many twin engine Cessna airplanes incorporate auxiliary fuel tanks to increase range and endurance. These tanks are usually bladder type fuel cells located symmetrically in the outboard wing areas and contain no internal fuel pumps. When selected, the fuel from these tanks is routed to the engine driven fuel pump.
>
> If the auxiliary fuel tanks are to be used, the pilot must first select main tank (tip tank) fuel for at least 90 minutes of flight with use of 63-gallon auxiliary fuel tanks. This is necessary to provide space in the main fuel tanks for vapour and fuel returned from the engine driven fuel pumps when operating on the auxiliary fuel tanks. If sufficient space is not available in the main tanks for this returned fuel, the tanks can overflow through the overboard fuel vents. Since part of the fuel from the auxiliary fuel tanks is diverted back to the main tanks instead of being consumed by the engines, the auxiliary tanks will empty sooner than may be anticipated. However, the main tank volume or quantity will be increased by the returned fuel.

As the ATSB was unable to establish the amount of total fuel on-board the aircraft when it departed Latrobe Valley or Moorabbin, or the pilot’s fuel management practices, the fuel remaining in each tank at the time of the accident could not be determined.

Asymmetric operations

The aircraft was fitted with two Teledyne Continental IO-520-MB piston engines and two three-bladed McCauley propellers. Both engines rotated clockwise as viewed from the pilot's seat.

When discussing the differences between single-engine and multi-engine aircraft, the FAA *Airplane Flying Handbook* (2016) stated that:

> The basic difference between operating a multiengine airplane and a single-engine airplane is the potential problem involving an engine failure. The penalties for loss of an engine are twofold: performance and control. The most obvious problem is the loss of 50 percent of power, which reduces climb performance 80 to 90 percent, sometimes even more. The other is the control problem caused by the remaining thrust, which is now asymmetrical. Attention to both these factors is crucial for safe OEI [one-engine inoperative] flight.

The majority of light multi-engine aircraft such as the Cessna 310 have two wing-mounted engines that produce symmetrical propeller thrust during normal operation. One-engine inoperative operations on these aircraft result in asymmetric thrust and drag due to the offset position of the engines from the aircraft's centreline. This results in a tendency for the nose of the aircraft to yaw in the direction of the inoperative engine. The extent of the yaw may vary depending on which engine becomes inoperative. The engine whose failure would most adversely affect an aircraft's performance and handling qualities is termed the 'critical' engine. As the Cessna 310 engines turn in a clockwise direction, the left engine is the critical engine.

The asymmetric yawing tendency may be countered through the application of rudder and aileron control inputs. However, the minimum control speed of 80 kt[6] for the Cessna 310 must be achieved to ensure that the rudder and aileron retain sufficient control authority to maintain directional control of the aircraft. The Cessna 310 *Pilot's operating handbook* stated that, the aircraft is controllable at this speed, but performance is so far below optimum that continued flight near the ground is improbable. Consequently, the handbook indicated that a more suitable recommended safe single-engine speed was 92 kt. At this speed, altitude could be maintained more easily with the landing gear retracted and the propeller feathered[7]. This speed is similar to the all engines landing approach speed of 93 kt with full flaps selected.

In addition, the CASA Civil Aviation Advisory Publication 5.23-1(2) stated that the majority of engine failures were not instantaneous. For example, if an engine failed as a result of fuel starvation or low fuel pressure, the engine will usually cough and splutter before stopping. However, the FAA recognised that:

> An engine failure in a descent or other low power setting can be deceiving. The dramatic yaw and performance loss will be absent. At very low power settings, the pilot may not even be aware of a failure.

Pilot actions

The Cessna 310 *Pilot's operating handbook* states that, following an engine failure, the pilot's first consideration is to maintain control of the aircraft and ensure the airspeed remains above the minimum control speed. It then states that the pilot needs to identify the inoperative engine, adjust the operative engine as required, and perform a number of checks relating to fuel flow, tank selection and quantity; engine oil pressure and temperatures; magneto switches and mixture. If the engine does not re-start, the pilot must 'secure' or shutdown the engine, which includes feathering the propeller. The FAA flying handbook highlighted that completely securing a failed engine may not be necessary or even desirable depending upon the failure mode, altitude, and time available.

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[6] With an angle of bank of less than 5°, one-engine inoperative, and the remaining engine at take-off power.

[7] Rotation of propeller blades to an edge-on angle to the airflow to minimise aircraft drag following an in-flight engine failure or shutdown

Aircraft performance degradation

The aircraft manufacturer advised that the Cessna 310 had a single-engine climb rate of about 375 feet per minute (at sea level and at maximum landing weight). However, with drag penalties of an unfeathered windmilling[8] propeller, landing gear extended and full flap, the aircraft's single-engine climb performance would degrade. Under these conditions, one-engine inoperative performance would result in a descent at 875 feet per minute.

Various other sources have also highlighted these adverse consequences on aircraft single-engine performance. For example, Multi-Engine Pilot Manual by Jeppesen Sanderson (1992) stated:

> It is important that the pilot be familiar with the correct order for drag reduction following an engine failure. Normally, a windmilling propeller contributes the greatest amount of drag, followed by full flaps, extended landing gear, and the control deflections required to stop the airplane from turning. Since it is considered unwise to immediately feather an engine before it has been positively identified, drag is normally reduced by first retracting flaps and gear. Next, the failed engine is identified and the propeller is feathered. However, the specific order of drag reduction may vary between types of twin-engine airplanes, so the manufacturer's recommendations should be followed.
>
> Generally, the landing gear is not extended during the approach until the airplane is established at approach airspeed and the pilot is positively assured of reaching the desired runway. This timing is important since the extension of the landing gear adds sufficient drag to create a 300 to 500 f.p.m. [feet per minute] rate of descent without power reduction.
>
> The wing flaps should be used as little as possible, preferably not at all until the landing gear is extended and the landing is assured.

The FAA *Airplane Flying Handbook* (2016) stated:

> A single-engine go-around must be avoided. As a practical matter in single-engine approaches, once the airplane is on final approach with landing gear and flaps extended, it is committed to land on the intended runway, on another runway, a taxiway, or grassy infield. The light-twin does not have the performance to climb on one engine with landing gear and flaps extended. Considerable altitude is lost while maintaining V_{YSE}[9] and retracting landing gear and flaps. Losses of 500 feet or more are not unusual. If the landing gear has been lowered with an alternate means of extension, retraction may not be possible, virtually negating any climb capability.

The CASA Civil Aviation Advisory Publication 5.23-1(2) stated:

> A windmilling propeller causes the largest component of drag on an aircraft that suffers an engine failure. If the propeller is not feathered following an actual failure…the aircraft's climb performance cannot be guaranteed. In many cases, it is likely that the aeroplane will only be able to maintain a descent.

Multi-engine power loss accidents

An ATSB research report, *Power loss related accidents involving twin-engine aircraft* (Research and analysis report B2005/0085), found that power loss accident rates in twin-engine aircraft were almost half of the rate for single-engine aircraft.[10] However, a power loss accident in a twin-engine aircraft was more likely to be fatal and overwhelmingly the result of in-flight loss of control. Of the 58 accidents identified between 1993 and 2002 that resulted in damage following the power loss, seven accidents occurred during the approach phase of flight. Three of these involved a loss of control, including one fatal accident. Given the approach phase was a relatively small portion of the overall flight, this was considered a more risky time, with low altitude and only a little more energy available than during the take-off phase.

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8 Windmilling: a rotating propeller being driven by the airflow rather than by engine power, and results in increased drag at normal propeller blade angles.

9 V_{YSE}: Best rate-of-climb speed with one-engine inoperative.

10 Only aircraft below 5,700 kg maximum take-off weight were included in the analysis.

Safety analysis

Introduction

When on final approach to runway 18 at Mildura, witnesses reported seeing the accident aircraft at low altitude yaw to the left, followed by the left wing drop where the aircraft rapidly lost altitude. The aircraft subsequently impacted powerlines before colliding with terrain. The pilot was fatally injured and the aircraft destroyed. The ATSB examined air traffic control recorded data, the aircraft wreckage, the pilot’s training and medical records, post mortem and toxicology reports, aircraft maintenance history and witness interviews. Aircraft components, including the left engine, left propeller and aircraft auto-pilot servo units were recovered from the wreckage for further examination.

The pilot was appropriately qualified to conduct the flight and was declared medically fit. Despite having relatively low flying hours on the aircraft type and twin-engine aircraft operations, the pilot demonstrated proficiency about one month prior to the accident where he completed an instrument landing system endorsement for the private instrument rating in the accident aircraft. During that endorsement he was subject to several simulated one-engine inoperative exercises during the approach phase for the ILS endorsement.

Four months prior to the accident, the maintenance provider performed a simple operational test of the autopilot and held the elevator trim wheel, proving that the elevator electric trim could be overridden manually. The ATSB did identify some anomalies with the auto-pilot elevator clutch assembly but could not determine if those abnormalities were pre-existing or were a result of the collision with terrain The ATSB did not consider the identified abnormalities factors contributing to the accident.

Examination of the left engine and propeller determined the engine was not producing power nor was the propeller producing thrust. This was most likely due to fuel starvation to that engine. No mechanical defects were identified that may have contributed to the occurrence. However, the examination of the wreckage was limited due to the extent of the fire damage sustained to the aircraft.

The following analysis will examine fuel starvation of the left engine and the subsequent power loss. The adverse consequence of this on aircraft performance, combined with the aircraft’s configuration, will also be discussed.

Left engine and fuel

Disassembly, inspection and examination of the left engine, left engine accessories and the left propeller at the accident site and during the post onsite detailed examination did not identify any mechanical defects or abnormalities that may have prevented normal engine or propeller operation.

However, examination of the engine fuel system identified no fuel in the left engine fuel manifold and supply fuel lines, which is situated between the wing fuel selector and the engine. The right fuel manifold and supply fuel line did contain fuel.

The aircraft departed Latrobe Valley with both main fuel tanks full, a total of at least 378 L of usable fuel on board. The flight time from Latrobe Valley to Mildura via Moorabbin was about 110 minutes. Based on that data and in consideration of an average fuel burn of 2 litres per minute, there should have been at least 158 litres of fuel remaining on board when the aircraft reached Mildura, not taking into account any fuel in the auxiliary fuel tanks. On that basis, it is likely that the aircraft had a significant amount of fuel on board at the time of the accident and the left engine had been starved of fuel.

The severe disruption of the left and right main fuel tanks and the right auxiliary fuel tank, including burning and melting indicated that those tanks held a significant amount of fuel at the time of the collision. In contrast, the left auxiliary fuel tank did not display the same level of disruption, including burning and melting of the aluminium structure or bladder fuel cell indicating that it is likely the left wing auxiliary fuel tank did not have a significant quantity of fuel at the time of the accident.

The position of the wing fuel selector valves during flight was inconclusive as it could not be determined if the pilot had selected the fuel selector to the position found during the wreckage examination, or whether it was a result of the accident sequence.

The reason for the starvation of fuel to the left engine and the disparity of fuel quantity between the left and right auxiliary fuel tanks could not be quantified or determined due to the damage to the aircraft from impact forces and post impact fire.

Asymmetric condition

Witnesses observed the aircraft yawing to the left prior to loss of aircraft control and evidence located at the accident site showing the aircraft rotating in an anticlockwise direction during ground impact sequence was consistent with asymmetric thrust. It was likely the inoperative engine (which was the critical engine), with its propeller towards the fine pitch and the opposite engine at high power, resulted in an asymmetric thrust condition. To maintain control of the aircraft and counteract asymmetric thrust the pilot needed to apply rudder and if necessary the aileron to counteract the forces generated from the drag of the non-performing engine and high thrust from the performing engine. Rudder and aileron input also increases drag and contributes to the decay of airspeed.

Aircraft performance degraded

The ATSB could not determine when the engine failed, nor could it be determined if or when the pilot was aware of the failure. At the time of impact, the aircraft landing gear and flaps were fully down, the flight control trim devices were in the neutral position and both propellers were towards the fine pitch, consistent with a normal landing configuration. In this configuration, combined with the left engine not producing power the drag penalties were such that altitude could not be maintained.

It is possible that the pilot may have been in the initial stages of responding to the engine failure and was not in a position to secure the engine, which included feathering the propeller. Further, it is not known if the landing gear and flap positions were selected prior to the asymmetric condition in preparation for a normal landing or after, as the pilot may have believed an engine inoperative landing onto the runway could be assured. Irrespective, in this configuration the aircraft’s performance would have degraded to the point at which altitude could not be maintained to assure a landing.

This accident highlights the adverse consequences of aircraft configuration on one-engine inoperative performance, particularly when at low altitudes. It further demonstrates the challenges of asymmetric operations and the importance of pilots being aware of the drag penalties and associated consequences.

Findings

From the evidence available, the following findings are made regarding the collision with terrain involving a Cessna Aircraft Company 310R, registered VH-BWZ, which occurred 1.9 km north-north-east of Mildura Airport, Victoria, on 6 November 2015. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- For undetermined reasons the left engine was starved of fuel, which resulted in a loss of power during flight.
- The left engine's loss of power while the aircraft was in a landing configuration resulted in the pilot being unable to maintain aircraft control and the aircraft subsequently collided with terrain.

General details

Occurrence details

Date and time:	6 November 2015 – 1829 EDT	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	Near Mildura Airport, Victoria	
	Latitude: 34° 13.75' S	Longitude: 142° 05.13' E

Pilot details

Licence details:	Private Pilot (Aeroplane) Licence, issued June 2006
Endorsements:	Manual Propeller Pitch Control; Retractable Undercarriage; Single Engine Aeroplanes less than 5,700 kg Maximum Take-off Weight; Multi Engine Aeroplane; Private Instrument Flight Rules
Ratings:	Nil
Medical certificate:	Class 2, valid to 1 September 2017
Aeronautical experience:	511 hours
Last flight review:	December 2013

Aircraft details

Manufacturer and model:	Cessna Aircraft Company 310R	
Year of manufacture:	1979	
Registration:	VH-BWZ	
Serial number:	310R1611	
Total Time In Service	4,121 hrs as at 6 November 2015	
Type of operation:	Private	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 1 (Fatal)	Passengers – 0
Damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- Airservices Australia
- a number of witnesses
- Textron Aviation
- the Civil Aviation Safety Authority
- United States Federal Aviation Administration
- Victoria Police.

References

Jeppesen Sanderson Inc 1992, *Multi-Engine Pilot Manual*, Jeppesen Sanderson, Colorado.

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, Airservices Australia, Textron Aviation, the aircraft maintenance provider, National Transportation Safety Board and the operator of the aircraft.

Submissions were received from the Civil Aviation Safety Authority. The submissions were reviewed and where considered appropriate, the text of the report was 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.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation
Collision with terrain involving Cessna 310R, VH-BWZ
near Mildura Airport, Victoria on 6 November 2015

AO-2015-129
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