Australian Government
Australian Transport Safety Bureau

Engine power loss and collision with terrain involving Piper PA-32-300, VH-CWK

near Moorabbin Airport, Victoria on 22 June 2021

ATSB Transport Safety Report
Aviation Occurrence Investigation (Short)
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Published by: Australian Transport Safety Bureau
Postal address: PO Box 967, Civic Square ACT 2608
Office: 12 Moore Street Canberra, ACT 2601
Telephone: 1800 020 616, from overseas +61 2 6257 2463
Accident and incident notification: 1800 011 034 (24 hours)
Email: atsbinfo@atsb.gov.au
Website: www.atsb.gov.au

Addendum

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Executive summary

What happened

On the morning of 22 June 2021, the pilot of a Piper PA-32-300 Cherokee Six, registered VH-CWK, prepared for a private flight at Moorabbin Airport. The pilot was the only occupant and intended to conduct several circuits during the flight to maintain experience in the aircraft type.

Between 1129 and 1200 Eastern Standard Time, the pilot conducted an engine run up and completed 3 circuits using runway 35 right without any incident or abnormal engine indications.

At 1200, as the aircraft climbed through 505 ft above ground level to complete a fourth circuit fuel flow to the engine significantly reduced and within 12 seconds, the engine lost power.

Soon after the engine power loss, the aircraft commenced descending. The pilot identified one of few clear areas available for a forced landing and manoeuvred the aircraft towards that area. As the aircraft approached the selected landing area, the pilot recognised that insufficient height remained to clear trees along the southern edge of the selected landing area. The aircraft impacted the trees before colliding with rising ground about 35 m beyond the trees. The aircraft was destroyed, and the pilot sustained serious injuries.

What the ATSB found

The ATSB found that as the aircraft climbed upwind from the departure runway, fuel flow reduced and the engine lost power. Despite extensive examination, the reason for the fuel flow reduction could not be determined.

It was also identified that the incorrect engine variant for the aircraft serial number was inadvertently fitted to the aircraft. This did not affect the operation of the aircraft or contribute to the power loss.

Safety message

This accident highlights the challenges pilots face when confronted with a loss of engine power at low level and with few suitable forced landing areas within the glide capability of the aircraft.

Pilots can best mitigate the effects of a power loss by forward planning, which reduces your mental workload under stress, and always maintaining control of your aircraft. Maintain glide speed and use no more than a moderate bank angle to avoid entering a stall and/or spin. During the forced landing, aim to arrive at the ground with wings level and the aircraft level with the ground, which improves your prospects of survivability. The ATSB research publication *Managing partial power loss after take-off in single-engine aircraft* provides further guidance, which is also applicable to a complete power loss.

The investigation also found that while in this case the fitment of an incorrect engine variant did not contribute to the accident, it underlines the importance of the correct interpretation of the manufacturer's type certificate documentation. If the guidance is unclear, a maintainer should contact the Civil Aviation Safety Authority or the original equipment manufacturer for clarity on permitted action.

The investigation

Decisions regarding whether to conduct an investigation, and the scope of an investigation, are based on many factors, including the level of safety benefit likely to be obtained from an investigation. For this occurrence, a limited-scope investigation was conducted in order to produce a short investigation report, and allow for greater industry awareness of findings that affect safety and potential learning opportunities.

The occurrence

On the morning of 22 June 2021, the pilot of a Piper PA-32-300 Cherokee Six, registered VH-CWK, prepared for a private flight at Moorabbin Airport. The pilot was the only occupant and intended to conduct several circuits to maintain experience in the aircraft type.

Between 1129 and 1200 Eastern Standard Time (EST),[1] the pilot conducted an engine run up and completed 3 circuits using runway 35 right without any incident or abnormal engine indications.

At 1200, the aircraft climbed through 505 ft above ground level (AGL) to complete a fourth circuit. At that time, as was the pilot's usual practice, engine RPM was reduced from about 2,700 to the desired climb power of 2,500 RPM and the throttle was left at a full open setting. At the same time as the RPM reduced, fuel flow to the engine significantly reduced and within 12 seconds, the engine lost power. Soon after the power loss, the aircraft commenced descending and the pilot made a MAYDAY[2] broadcast stating '…I've got a power loss'.

As the descent continued, the pilot targeted a glide speed of 90 kt and searched for a landing site within a 30° arc either side of the aircraft's nose (Figure 1). The pilot identified one of few clear areas available for a forced landing within the gliding capability of the aircraft and manoeuvred the aircraft for a forced landing in that area (see the section titled *Aircraft details*).

As the aircraft approached the selected landing area, the pilot recognised that the aircraft was close to stalling and that insufficient height remained to clear trees along the southern edge of the selected landing area. The left wing subsequently impacted the trees about 14 m AGL and separated from the aircraft. The aircraft then rolled left and pitched nose down before impacting rising ground about 35 m beyond the trees. The aircraft was destroyed and the pilot sustained serious injuries, including to their head, which significantly impaired the pilot's recollection of the flight.

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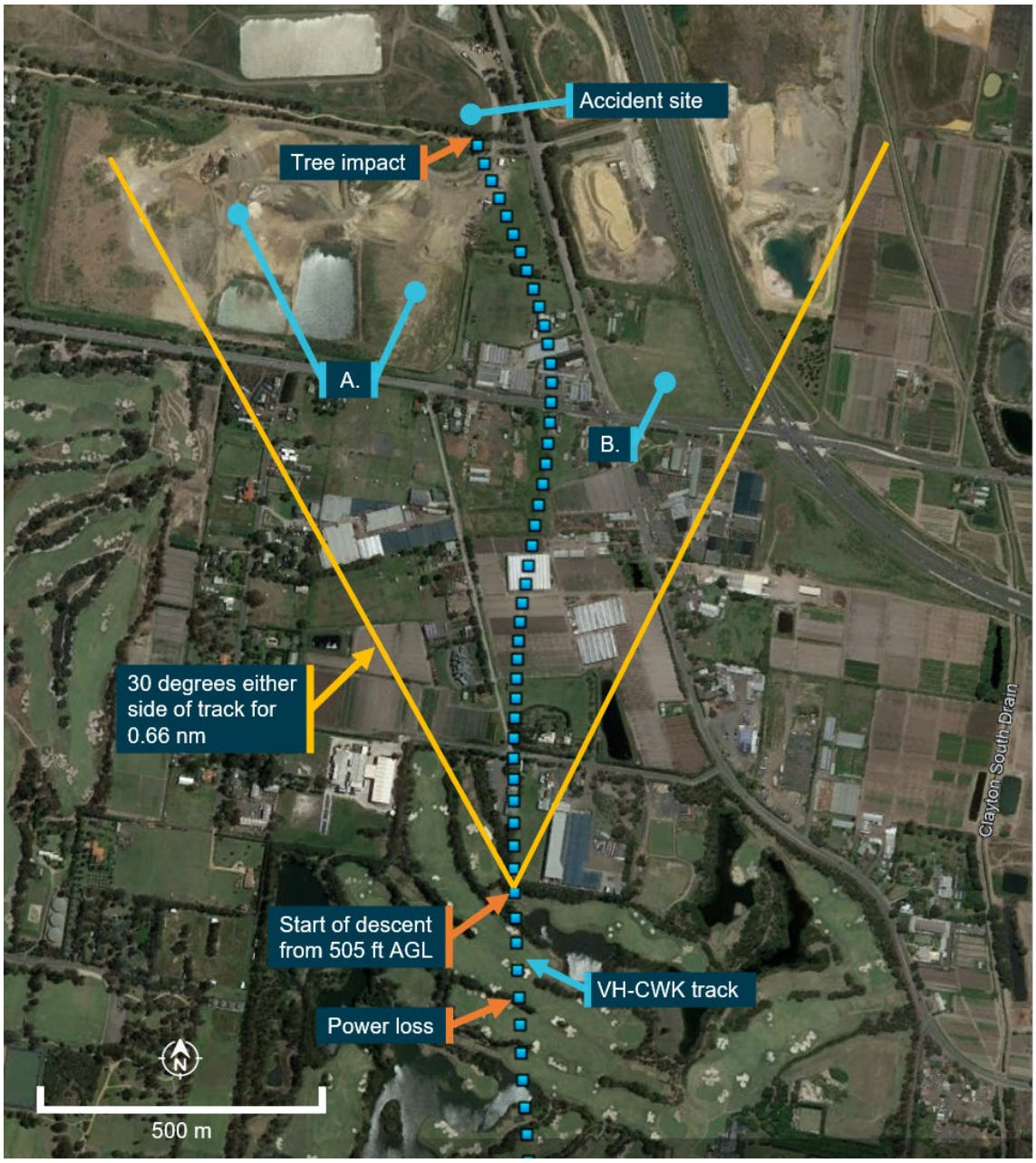
1 Eastern Standard Time (EST): Universal Coordinated Time (UTC) + 10 hours.

2 MAYDAY: an internationally recognised radio call announcing a distress condition where an aircraft or its occupants are being threatened by serious and/or imminent danger and the flight crew require immediate assistance.

Figure 1: Overview of the flightpath after the power loss



Source: Google Earth and OzRunways, annotated by ATSB
Note: Area 'A' was an excavated quarry. Area 'B' had been developed after the satellite imagery was captured and before the accident.

Context

Aircraft details

The Piper PA-32-300 Cherokee Six is a low-wing, piston-engine aircraft with a two-blade variable-pitch propeller, fixed tricycle landing gear and could be fitted with up to 7 seats. VH-CWK, serial number 32-7840052 (Figure 2), was manufactured in the United States in 1977 and first registered in Australia in 1978.

Prior to the accident flight, the aircraft had not flown for 4 weeks. On the morning of the accident, the aircraft was fitted with two overhauled magnetos, a test run of the engine was carried out and the aircraft was released for service.

Figure 2: VH-CWK

Source: David Carter

The ATSB estimated the weight of the aircraft at the time of the accident as 1,281 kg (1,542 kg maximum allowable). The information manual for the aircraft provided best range glide speeds of 87 kt for an aircraft weight of 1,542 kg and 78 kt for 1,315 kg. The information manual indicated that the maximum glide range from 505 ft AGL was 0.66 NM (no wind).[3]

The aircraft was fitted with a main and a wingtip fuel tank in each wing. The combined capacity of the 4 tanks was 318 litres (315 litres usable). The aircraft was reported to have departed with full fuel in the right wingtip and two main tanks. The left wingtip tank had been used for the engine run earlier in the day and was reported to be close to full. The pilot recalled intending to use the right main fuel tank for the entire flight. This tank contained sufficient fuel for the planned flight.

Engine

The PA-32-300 was equipped with a fuel-injected Lycoming IO-540 series engine of 300 horsepower. The aircraft type certificate data sheet (TCDS) stated that the aircraft type could be fitted with either an IO-540-K1A5 or an IO-540-K1G5 engine variant.

During its operating life, VH-CWK had been fitted with both K1G5 (factory installed) and K1A5 variants. Including K1A5 variants fitted by several maintenance organisations. In July 2020, VH-CWK was fitted with an IO-540-K1A5 that had been rebuilt following a propeller strike in another aircraft. Prior to the accident flight, this engine had completed about 55 hours since being fitted to VH-CWK, and a total of 1,413.3 hours in service.

The difference between the K1A5 and K1G5 engine variants was the fuel pump type. The K1A5 variant was fitted with a vane type fuel pump, the K1G5 was fitted with a diaphragm type. The K1G5 variant was also 1 pound (0.454 kg) lighter than the K1A5.[4] Both variants operated in the same fuel pressure range and no fuel system or other airframe differences applied to the fitment of either variant.

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[3] The glide range capability of an aircraft reduces with an increase in headwind.

[4] VH-CWK was reweighed after the fitment of the K1A5 variant of engine.

The TCDS did not specify a specific serial number range for the fitment of a K1A5 engine variant, but did so for the K1G5 variant as follows:

> PA-32-300
>
> Engine
>
> - Lycoming IO-540-K1A5, Bendix injector type RSA-10ED1
> - Lycoming IO-540-K1G5 (See NOTE 12)
>
> NOTE 12:
>
> - Lycoming engine Model IO-540-K1G5 with Hartzell propeller HC-C2YK-1(F), Blade Model 8475D-4, S/N 32-7640066 (only) and S/N 32-7640072 through 32-7940290.

When reviewing the TCDS, the maintainer responsible for installation of the engine in July 2020 interpreted the allowable engine variants as follows:

> …the K1A5 was an allowed engine as there was no notes or restrictions…while noting if using a K1G5 that could only be installed in certain serial range.

As a consequence of that interpretation, a K1A5 variant was fitted to the aircraft. Past fitment of this variant by several maintenance organisations indicated a similar interpretation of the TCDS.

However, the manufacturer stated the following as the correct interpretation of the TCDS:

> The type design specifies the engine model IO-540-K1G5 for Piper Model PA-32-300 serial numbers 32-7640066, 32-7640072 and up (ending 32-7940290). All other PA-32-300 aircraft serial numbers had engine model IO-540-K1A5 defined.

This interpretation is summarised in Table 1.

Table 1: PA-32-300 engine variant serial number applicability

Serial number	Engine variant	Note
32-7440001 to 32-7640065	K1A5	
32-7640066	K1G5	
32-7640067 to 32-7640071	K1A5	
32-7640072 to 32-7940290	K1G5	Includes VH-CWK

The Civil Aviation Safety Authority approved aircraft flight manual, the information manual and the illustrated parts catalogue also referred to a K1G5 variant as the appropriate engine for installation in VH-CWK.

Meteorological information

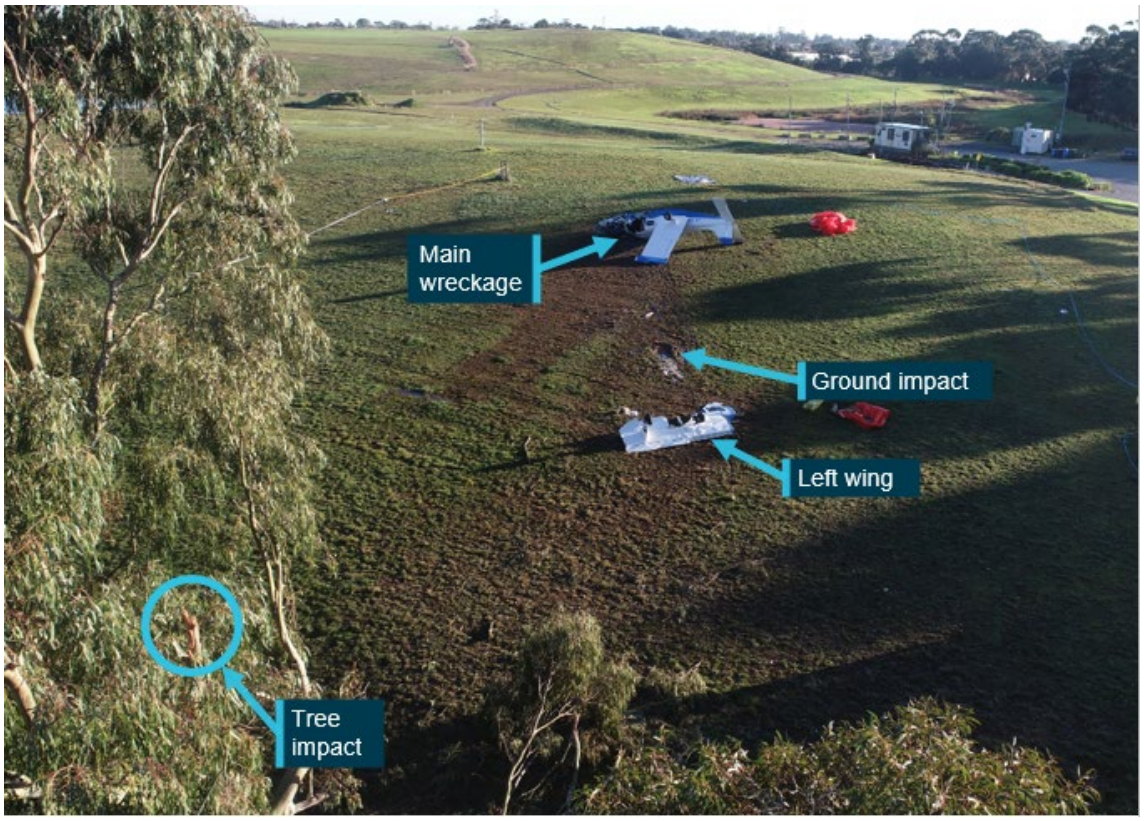
A meteorological report for Moorabbin Airport, recorded at 1200, included a northerly wind of 9 kt, visibility greater than 10 km, no cloud, and a temperature of 14 °C.

Wreckage information

The aircraft impacted the tree about 14 m (Figure 4) above its base with the wing flaps retracted.

The left wing contacted the tree first and separated from the aircraft. Ground impact scars were located on an upslope 35 m from the tree base, 10.2 m below the height of the tree impact. After ground impact, the right wing also separated from the fuselage. The engine and fuselage were the last items in the wreckage trail, coming to rest 55 m from the tree.

Figure 3: Accident site viewed in the direction of flight



Source: ATSB
Note: The red objects were tarpaulins provided by first responders to the accident.

Fuel system

First responders to the accident drained a significant amount of fuel from the right main fuel tank.

While examination of the fuel system was limited by accident damage, the on-site examination identified that the:

- left main fuel tank, along with both tip tanks, were breached during the accident and empty
- left main and both tip tank caps were fitted and secure
- right main tank was not breached
- right main tank was selector lever was in the right tank position and the selector valve inlet port was connected to the supply line from the right main tank.
- right main tank cap had been removed by first responders

In addition:

- all fuel tank vents were clear of obstructions
- the electric fuel pump switch was selected on and functioned correctly
- no pre-existing defects were found with the supply lines and hoses
- the in-cabin fuel sump drain lever was secured behind a fastened panel

The fuel selector valve and fuel filter were retained for further examination. Fuel collected from the right main tank and fuel selector was tested and found to be of the correct type and free of contaminants.

Engine controls and propeller

The engine struck the ground on its left forward cylinder area, separated from its mount and rotated 90° around the aircraft centreline. The throttle and mixture cables fractured and separated during the impact. The throttle lever was found in the full position and the propeller control was in

the maximum RPM position. The mixture lever was positioned at about half of its range of travel. However, it could not be determined if the levers had moved from pre-impact positions as a result of impact forces or during efforts to extract the pilot.

The bending damage to the propeller blades indicated that little or no power was being delivered to the propeller at the time of impact.

The engine and associated accessories were retained for further examination.

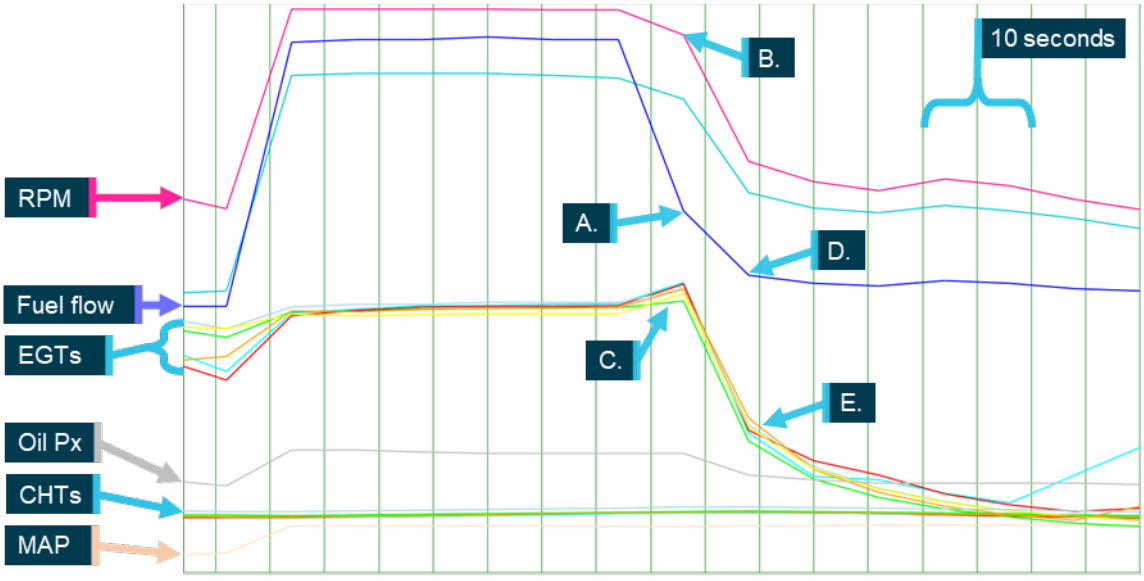
Recorded information

The aircraft was fitted with a J.P. Instruments EDM-830 Engine Data Management system. Data recovered from this unit captured data points every 6 seconds and included the power loss (Figure 5).

The first abnormal indication was a reduction in fuel flow from 113 litres per hour (l/h) to 47 l/h at 1200:49 (A). At the same time, RPM reduced from about 2,700 to about 2,500 (B) and exhaust gas temperature (EGT) increased across all cylinders (C). The next data point at 1200:55 showed the fuel flow reduced further to 22 l/h (D) and all EGT values, along with RPM, reduced significantly as power was lost (E). Following the power loss, fuel flow varied between 20 l/h and 16 l/h in conjunction with changes in RPM from the windmilling propeller.

No abnormal cylinder head temperature (CHT), manifold pressure (MAP) or oil pressure (Oil Px) indications were recorded before or after the power loss.

Figure 4: Graphical representation of data recovered from VH-CWK



Source: ATSB

Airservices provided recorded surveillance data of the flight. The aircraft was recorded commencing descent at 1200:53 at a groundspeed of 80 kt (headwind component was at least 9 kt). During the descent the groundspeed reduced further to between 68-60 kt.

Engine, fuel selector and filter examination

In December 2021,[5] the engine was disassembled and examined at a CASA-approved engine overhaul facility under the supervision of the ATSB.

The engine condition was consistent with the engine's recorded time in service since overhaul. No internal or external damage was identified that may have prevented the engine from operating

[5] Examination of the engine was delayed due to Coronavirus related travel and working restrictions. During the period between the accident and examination, the engine was inhibited and stored in a secure location.

normally prior to the accident. No defects were identified in the induction system components, core engine, or cylinder assemblies that may have affected its pre-accident operation.

The ATSB examined the control positions required to replicate the recorded RPM and fuel flow indications. It was determined that to reproduce a fuel flow of 20 l/h with the throttle fully open, the mixture control needed to be moved close to the cut-off position. The propeller control movement needed to reduce RPM from 2,700 to 2,500 was significantly less. However, it was noted that control rigging variations could produce slightly different control movement ranges.

The ignition system components and fuel system components, including both fuel pumps, were tested. No defect was identified with these components that could have contributed to the power loss.

The fuel selector was examined at the ATSB's technical facilities in Canberra, and it was found to function as designed.

Safety analysis

Engine power loss and collision with terrain

During the fourth circuit in a session of circuits, as the aircraft climbed through about 505 ft above ground level, the engine lost power. Following the power loss, the pilot established a glide at a speed below that targeted, but close to the correct speed for the aircraft weight. This led to near optimum glide performance. However, few suitable landing areas were available within the glide capability of the aircraft. The pilot selected an open area, but the aircraft did not clear trees along the southern boundary of the area. The aircraft impacted these trees separating the left wing before impacting the ground.

The on-site examination of the wreckage and later engine examinations and analysis of the recorded data found no indications of an induction issue, including icing, an ignition system or fuel system problem.

The recorded data showed that a significant reduction in fuel flow led to the power loss. Notably, after the power loss, the fuel flow did not reduce to zero, but varied between 20 and 16 l/h (in conjunction with RPM changes) indicating that fuel starvation did not lead to the power loss. Further, wreckage examination, flight records and witness reports indicated that there was sufficient fuel on board, and in any tank, to power the engine.

The ATSB considered the possibility that the pilot inadvertently reduced the mixture control instead of, or at the same time, as manipulating the propeller control. However, the pilot's head injuries greatly limited their recollection of actions taken before and after the power loss. The recorded data showed that RPM reduced at the time, and by the amount, that the pilot intended to reduce RPM. Therefore, it is almost certain that the pilot manipulated the propeller control as intended.

At the same time, the fuel flow reduced significantly from 113 l/h to 22 l/h. The mixture lever movement required to produce this fuel flow reduction was significantly larger than that associated with the intended RPM change and required the lever to be positioned near the cut-off stop. After the accident, the mixture lever was found to be at a mid-travel position, but as the impact had caused significant damage to the engine controls, including breaking the mixture control actuating arm, the pre-impact position could not be determined. Overall, there was insufficient evidence to determine if the mixture control was inadvertently moved.

While damage limited the examination of the fuel system, no defect was identified that could have led to the fuel flow reduction. The engine was dismantled, examined and all fuel system components were tested. These components functioned correctly when examined. In summary, a reason for the fuel flow reduction could not be determined.

Incorrect engine variant

The type certificate data sheet did not specify a specific serial number range for the fitment of a K1A5 engine variant but did so for the K1G5 variant. This led the maintainer to interpret the aircraft type certificate data sheet as permitting the fitment of an K1A5 to VH-CWK instead of the correct K1G5. Past fitment of the K1A5 variant by other maintenance organisations indicated they had similarly assessed the TCDS as permitting this combination of engine variant and aircraft serial number.

However, the aircraft flight manual and the illustrated parts catalogue stated the only applicable engine variant for VH-CWK to be a K1G5, which was also confirmed by the aircraft manufacturer.

The differences between the fitted variant and the correct variant were minor and did not affect the operation of the aircraft, nor did they contribute to the power loss and collision with terrain.

Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition 'other findings' may be included to provide important information about topics other than safety factors.

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

From the evidence available, the following findings are made with respect to the collision with terrain involving a Piper PA-32-300 aircraft, VH-CWK, near Moorabbin Airport, Victoria on 22 June 2021.

Contributing factors

- As the aircraft climbed through 505 ft above ground level, fuel flow reduced and the engine lost power. During the subsequent forced landing the aircraft collided with terrain. The reason for the fuel flow reduction could not be determined.

Additional finding

- The incorrect engine variant for the aircraft serial number was inadvertently fitted to the aircraft. This did not affect the operation of the aircraft or contribute to the power loss.

Sources and submissions

Sources of information

The sources of information during the investigation included:

- the pilot
- the aircraft owner and maintainer
- Piper Aircraft (aircraft manufacturer)
- Lycoming Engines (engine manufacturer)
- engine data monitor
- Airservices Australia
- OzRunways
- Bureau of Meteorology

References

Australian Transport Safety Bureau, Avoidable Accidents No. 3 - *Managing partial power loss after takeoff in single-engine aircraft*

Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section 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 following directly involved parties:

- the pilot
- the aircraft owner and maintainer
- Piper Aircraft
- Lycoming Engines

Submissions were received from:

- the pilot
- the aircraft owner and maintainer
- Piper Aircraft

The submissions were reviewed and, where considered appropriate, the text of the report was be amended accordingly.

General details

Occurrence details

Date and time:	22 June 2021 – 1201 EST	
Occurrence class:	Accident	
Occurrence categories:	Engine failure or malfunction, collision with terrain.	
Location:	near Moorabbin Airport, Victoria	
	Latitude: 37º 57.080' S	Longitude: 145º 05.486' E

Aircraft details

Manufacturer and model:	Piper Aircraft Corp	
Registration:	VH-CWK	
Serial number:	32-7840052	
Type of operation:	General Aviation	
Activity:	Private	
Departure:	Moorabbin, Victoria	
Destination:	Moorabbin, Victoria	
Persons on board:	Crew – 1	
Injuries:	Crew – 1 (Serious)	Passengers – Nil
Aircraft damage:	Destroyed	Passengers – Nil