Australian Government

Australian Transport Safety Bureau

Engine power loss involving Piper Aircraft Inc. PA-36, VH-TVU

Near Latrobe Valley Airport, Victoria, on 12 August 2019

ATSB Transport Safety Report
Aviation Occurrence Investigation (Short)
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Addendum

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Safety summary

What happened

On 12 August 2019, a Piper Aircraft Inc. PA-36-300, registered VH-TVU (TVU), departed Latrobe Regional Airport, Victoria, at 0830 Eastern Standard Time, on a ferry flight to Coffs Harbour, New South Wales. The aircraft had recently been sold and the new owner had arranged for the aircraft to be ferried to New Zealand. Shortly after take-off, the engine power reduced to below idle. Faced with limited options, the pilot conducted a forced landing into a paddock. During the approach, the aircraft struck power lines and subsequently contacted a fence and tree stumps during the landing. The pilot suffered minor injuries and the aircraft was substantially damaged.

What the ATSB found

The ATSB found that the engine power loss was probably the result of water-contaminated fuel, and that the methods used to detect and remove the water before the flight were unreliable. An inspection of the fuel control unit also detected additional contamination that may have hindered fuel flow to the engine.

Finally, the aircraft was utilising the chemical hopper as a ferry fuel tank, contrary to the recommendation of the aircraft manufacturer, and no approved technical data could be provided on the installed fuel system.

Safety message

This accident highlights the danger of water-contaminated fuel, a topic discussed in CASA Airworthiness Bulletin AWB 28-008. While this bulletin is related to aircraft using AVGAS or MOGAS, it is also relevant to the use of turbine fuel. It discusses the issue of water entering the fuel system through poor fitting, unapproved, incorrectly adjusted, or failed seals on the fuel caps or damaged/distorted tank filler necks.

When conducting fuel contamination checks, it is important that the check is positive and does not rely on sensory perceptions of colour and smell, as these can be deceptive. There are a number of ways this can be done:

- place a small quantity of known fuel in container before taking the fuel sample
- use a water-detecting paper or paste
- check for cloudiness or other evidence of suspended water droplets, particularly in turbine fuel.

The accident also illustrates the importance of being mentally prepared for an emergency. In this case, the pilot had secured the seatbelts over their flying suit prior to take-off. The pilot had also conducted a pre-take-off brief, so was prepared to take immediate action when an engine power loss occurred. An article in *Flight Safety Australia* 'Your one and only: mitigating the risk of engine failure in singles' advises that:

> Rather than passively waiting for power loss and falling back on trained responses, pilots must actively defend their aircraft against the consequences of engine failure. Know your aircraft and procedures. Fly as high as practical, keep your options open and have a clear plan rehearsed for engine failure during every sequence of flight.

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 12 August 2019, at around 0820 Eastern Standard Time,[1] a Piper Aircraft Inc. PA-36-300, registered VH-TVU (TVU), departed Latrobe Regional Airport, Victoria, on a flight to Coffs Harbour, New South Wales, the first leg of a ferry flight to New Zealand.

On the day before the accident, the pilot detected water in the fuel within the chemical hopper (hopper), which was being used as a fuel tank, and consequently fully drained approximately 40 L of fuel from the hopper by opening the bottom cam lock. The aircraft was then refuelled to full, including the hopper, and the pilot reported that they[2] conducted a fuel drain to check for water contamination. The fuel was drained from each aircraft fuel tank into two opaque 3-litre containers. Fuel from one container was ignited to confirm it was fuel. The second container was examined a significant time after the accident, and a small amount of water was identified. The pilot advised it was not raining when the aircraft was refuelled, but it had been raining in the days prior.

The pilot arrived at the aircraft on the morning of the accident, and conducted a pre-flight inspection, including another fuel drain. The fuel was checked by sight and smell and the pilot did not detect any water.

The plan was to fly to Coffs Harbour where the aircraft would be refuelled and then flown to Lord Howe Island, for the first section of the over-water flight to New Zealand. The pilot was prepared for a long, cold flight that day and wore a thick neoprene flying suit with Nomex flying gloves. They were not wearing a helmet, because the flight was not an agricultural operation. After entering the cockpit, the pilot adjusted the four-point harness to fit tightly over their flying suit.

The pre-take off checklist was actioned, and the main fuel tanks were selected for the take-off, with the hopper fuel tank selected OFF. The pilot conducted a pre-take-off safety brief and lined up on runway 21 with a crosswind, as this runway provided more landing options if the engine failed after take-off. After the departure, a left turn on to the crosswind leg of the circuit was conducted followed by a turn to the north, staying below the overcast cloud at around 500 ft above ground level. The pilot planned to track east of the airport over a semi-rural area (Figure 1), continuing in a northerly direction before joining the departure track to avoid a township further to the east.

As the take-off flap was raised and the departure course set, the engine power reduced to below idle and the aircraft could not maintain height. The pilot immediately selected the electric fuel pump to ON and set the igniters to continuously ON. A paddock was selected, which the pilot later advised was not ideal as it had a downwind component, but was the best landing site option among the properties in the area.

[1] Eastern Standard Time (EST): Coordinated Universal Time (UTC) + 10 hours.
[2] Gender-neutral plural pronouns are used throughout the report to refer to an individual (i.e. they, them and their).

Figure 1: Latrobe Valley Airport and the accident site

Source: Google Earth annotated by ATSB

During the approach to the paddock, the pilot detected power lines directly ahead and elected to descend below them. While flying under these, the propeller struck and cut a smaller power line running beneath the main lines on the same poles, which the pilot had not seen.

The selected paddock had a fence running down the middle. To ensure this was not struck while the aircraft was airborne, the pilot intentionally landed the aircraft hard before reaching the fence. The right wing struck one of the fence posts resulting in separation of the outboard wing section. A number of tree stumps in the paddock were also struck, removing the undercarriage legs (Figure 2).

As the aircraft came to a stop, the pilot undid the harness and moved away from the aircraft in case it caught fire. When this did not occur, they returned and, as the engine was still running, pulled the condition lever back to idle and selected the master switch to OFF.

The pilot did not dump the fuel in the hopper during the forced landing sequence, to avoid contaminating the houses in the area.

Figure 2: VH-TVU after the accident with undercarriage and right wing section missing.

Source: Pilot

Context

Aircraft

The aircraft was a Piper Aircraft Inc. PA-36-300 single engine, low-wing, agricultural aircraft, which had been fitted with a Pratt & Whitney Canada PT6A-20 turboprop engine. The aircraft had recently been refurbished and a hot section inspection had been completed on the engine. It had received an export certificate of airworthiness, indicating that all required maintenance had been completed.

Weather

Weather observations at Latrobe Valley Airport showed that there had been significant rainfall in the days before the accident (Table 1).

Table 1: Rainfall at Latrobe Valley

Date	Rainfall
8 August 2019	13.4 mm
9 August 2019	3.8 mm
10 August 2019	26.2 mm
11 August 2019	31.0 mm

Source: Bureau of Meteorology

The pilot advised the aircraft had been flown to Latrobe Valley Airport the week before the accident and had been parked on the apron since.

Main fuel system

Each wing had a bladder-type fuel tank filled with reticulated polyurethane foam to prevent fuel sloshing in the tank. The tanks were filled separately through a cap on each wing. They each fed into a small header tank, with a single on/off valve. An electric fuel pump acted as a primer and as a back-up fuel pump if the engine driven fuel pump failed. Fuel drains were located on the underside of both wings, on the fuel filter and on the underside of the fuselage, which was the drain for the header tank.

An inspection of the fuel caps following the accident found that the seals were in good condition. It also showed that the necks on the fuel tanks were raised to avoid water running into the tanks.

According to the United States Federal Aviation Administration Advisory Circular AC 20-125:

> Water can enter the aircraft fuel system through leaks in the vents, seals, or poorly fitting fuel caps on filler openings during rain … by condensation and precipitation (especially when an aircraft has partially filled tanks) …

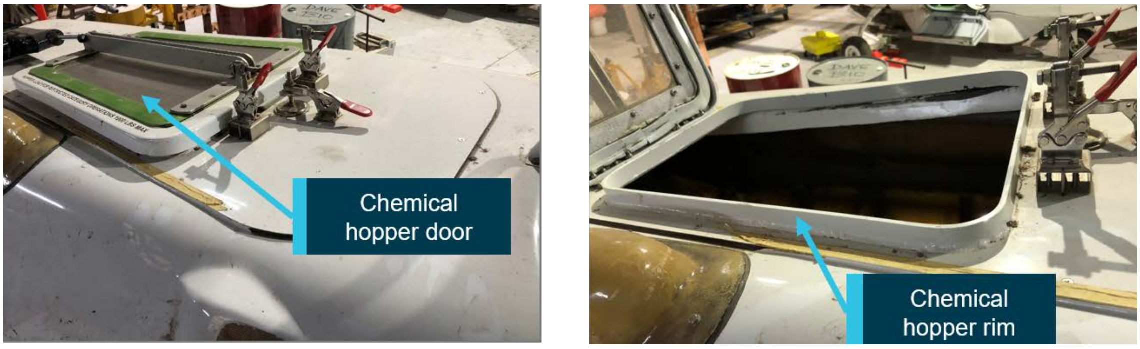
and that:

> Water occurs in aviation fuel in two forms: dissolved and free:
>
> > Dissolved water: all aviation fuels dissolve water in varying amounts depending upon the fuel composition and temperature. Dissolved water in fuel is similar to humidity in air. Lowering the fuel temperature will cause dissolved water to come out of solution as free water.
> >
> > Free water: Any water in excess of that which will dissolve is called free water. Free water can appear either as water slugs or as entrained water (suspended tiny droplets of water in fuel).
> >
> > Aircraft engines can tolerate a small amount of free water (30 parts per million is usually considered maximum) if it is in a fine and uniformly dispersed state.
> >
> > Smaller amounts of entrained water can be detected by testing with a clean and dry clear glass bottle. If fuel is acceptably dry it will appear bright with fluorescent appearance and will not be cloudy or hazy.

Chemical hopper

The aircraft had been configured to use the hopper as a ferry fuel tank. The door for the hopper hinged at the rear and sat over a raised rim that pressed into a seal (Figure 3).

Figure 3: Chemical hopper



Source: Supplied

The hopper fuel tank was selected ON using an ON/OFF tap in the cockpit. This connected to the main fuel system before the main fuel filter, ensuring the fuel passed through two filters before it entered the fuel system. No approved technical data could be provided to show how the system was installed in the aircraft.

Additionally, the pilot's operating handbook stated that:

> The chemical hopper is not designed for the storage of fuel; therefore, the use of the hopper as a spare fuel tank is not recommended.

Aircraft fuel checks

Civil Aviation Order 20.2 *Air service operations – Safety precautions before flight* part 5 'Fuel system inspection' advised:

> It is important that checks for water contamination of fuel drainage samples be positive in nature and do not rely solely on sensory perceptions of colour and smell, both of which can be highly deceptive. The following methods are acceptable:

> 1. Place a small quantity of fuel into the container before taking samples from tank or filter drain points. The presence of water will then be revealed by a visible surface of demarcation between the two fluids in the container.
> 2. Check the drainage samples by chemical means such as water detecting paper or paste, where a change in colour of the detecting medium will give clear indication of the presence of water.
> 3. In the case of turbine fuel samples, tests should also include inspection for persistent cloudiness or other evidence of the presence of suspended water droplets, which will not necessarily be detected by methods mentioned in notes 1 and 2. Should any doubt exist of the suitability of the fuel, the checks specified in the aircraft Operators Maintenance Manual should be followed. It is advisable to allow turbine fuel a reasonable period of stagnation before drawing test samples from fuel drain points; this allows settling of suspended water which is a slower process in turbine fuel than in aviation gasoline.

This order also stated:

> If, at any time, a significant quantity of water is found to be present in an aircraft fuel system, the operator and pilot in command must ensure that all traces of it are removed from the fuel system, including the fuel filters, before further flight.
>
> Note In eliminating water from an aircraft fuel system, it is important that consideration be given to the possibility of water lying in portions of the tanks or fuel lines where, because of the design of the system or the existing attitude of the aircraft, it is not immediately accessible to a drain point.

Pilot experience

The pilot had around 24,500 hours of flying experience with about 400 hours on the aircraft type. They had flown TVU extensively a number of years previously and had recently ferried it to Latrobe Valley Airport. The pilot had about 6,000 hours flying in aircraft with PT6 engines.

Engine inspection

An inspection of the engine, conducted 7 weeks after the accident, did not find any defect or degradation that would have contributed to the engine power loss. However, the inspection identified a significant quantity of water in the fuel system, including in the airframe fuel bowl, fuel pump, and the fuel control unit (drained at the flow divider) (Figure 4).

Figure 4: Photographs of water detected in the fuel system

Source: Provided by aircraft insurer, annotated by ATSB

Based on engine data (Figure 5), there was no indication of an engine surge that caused the power reduction. Unexplained variation of fuel flow was recorded prior the power reduction. Pratt and Whitney Canada reviewed the data and consider the fuel flow recording is inaccurate.

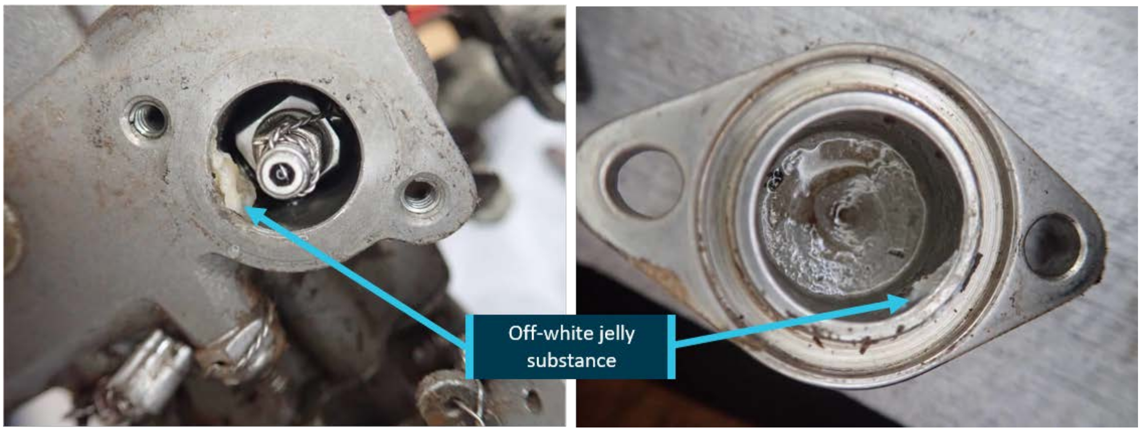
Figure 5: Engine data

Legend: ITT - Interstage turbine temperature: WF - Fuel flow; NG - Gas generator rotation speed indication
Source: Provided by the aircraft insurer

Fuel control unit

The fuel control unit (FCU) was sent to a specialist PT6 engine accessory overhaul facility for detailed technical examination. That investigation determined that there was contamination (an off-white jelly substance that could be the result of incorrectly mixed anti-icing additive) in the fuel section of the FCU, which may have hindered or resulted in abnormal fuel flow (Figure 6). The pilot advised that they did not use anti-ice additives. Evidence of blue grease was present at the drive shaft bearing retaining plate. This was indicative of a previous fuel or oil leak with the potential to damage the FCU bearing due to insufficient lubrication. No further detail was available at the time of writing.

Figure 6: Contamination within the fuel control unit



The photograph on the left shows the off-white jelly substance detected within the fuel section of the torsion shaft. The photograph on the right shows the same substance detected in the ratio lever cap.
Source: Provided by the aircraft insurer, annotated by ATSB

Safety analysis

During the departure, when the aircraft was operating at about 500 ft to avoid low-level cloud, the power level reduced below idle. The low altitude left the pilot with little choice in the selection of the area to conduct the forced landing. Consequently, the landing was conducted with a downwind component, in a paddock with obstacles, resulting in substantial aircraft damage.

Based on the significant quantity of water identified in the aircraft fuel system components after the accident, and the absence of any other engine defect, the ATSB concluded that the engine power loss was probably the result of water contamination. The water detected in the hopper during the aircraft inspection on the day before the accident indicated that, despite the seal and lip, water could enter the chemical hopper. Therefore, it was considered a possible source of water contamination to the fuel system. However, as the ferry fuel system was reportedly not used during the accident flight, there was no obvious mechanism for such contamination to enter the aircraft's fuel system. It is also possible that the water entered the wing tanks while the aircraft was exposed to rain in the days leading up to the accident, as the fuel tanks were only partially filled.

The methods used to check for water in the fuel—opaque sampling containers/fuel sight and smell were not in accordance with the Civil Aviation Safety Authority and United States Federal Aviation Authority guidance for pre-flight fuel testing and did not assure that there was no suspended water droplets—a particular risk with turbine fuel. Nor did they ensure that the fuel drain conducted on the morning of the flight, was free of water.

Given the elapsed time between refuelling and the accident flight, it is possible that any suspended water separated out overnight as the fuel cooled. In that case, the change in aircraft attitude associated with the departure and level off may have permitted water to move to the fuel pick up in the fuel tanks, resulting in the power loss.

However, the engine data showed that the engine did not surge when the power loss occurred. This could indicate that the water droplets had stayed in suspension and resulted in the engine not producing enough power to maintain flight. The time between the accident and the engine inspection would have allowed any water droplets to separate out of suspension from the fuel, as found during the examination.

In addition to the water found in the fuel, the examination of the fuel control unit showed additional contamination and grease washout, which may have also hindered the fuel flow to the engine. However, there was insufficient available information to determine if that occurred.

Finally, the use of the chemical hopper as a ferry tank was contrary the manufacturer's advice and no approved technical data was available for the modification. Using approved and documented engineering processes to make changes to a safety-critical aircraft system is important, as it ensures the design complies with applicable airworthiness standards or an equivalent level of safety.

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 power loss and forced landing involving a Piper Aircraft Inc. PA-36-300, registered VH-TVU that occurred near Latrobe Valley Airport, Victoria on the 12 August 2019.

Contributing safety factors

- Due to a layer of low cloud, the aircraft was operating at low level over a semi-rural area when the engine power reduced to a level below that required to maintain altitude.
- The engine power loss was probably due to undetected water contamination in the fuel and possibly additional contamination/mechanical issues with the fuel control unit.

Other factors that increased risk

- The chemical hopper was being used as a ferry tank contrary to the recommendation of the aircraft manufacturer and no approved technical data could be provided on the installed fuel system.

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- pilot's recollection of the accident flight
- photographs taken on the day of the accident
- Bureau of Meteorology
- maintenance organisation for VH-TVU
- aircraft and engine manufacturers
- Civil Aviation Safety Authority.

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:

- pilot of the accident flight
- aircraft owner
- previous aircraft owner
- Civil Aviation Safety Authority
- aircraft maintainer
- Pratt & Whitney Canada
- the Transportation Safety Board of Canada
- the National Transport Safety Board
- Piper Aircraft Incorporated.

Submissions were received from:

- pilot of the accident flight
- Pratt & Whitney Canada.

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

General details

Occurrence details

Date and time:	12 August 2019 - 0825 EST	
Occurrence category:	Accident	
Primary occurrence type:	Engine power loss/malfunction	
Location:	Near Latrobe Valley Airport	
	Latitude: 38º 12.15’ S	Longitude: 146º 29.68' E

Aircraft details

Manufacturer and model:	Piper Aircraft Inc	
Registration:	VH-TVU	
Operator:	Fairglen Nominees Pty Ltd	
Serial number:	36-7760088	
Type of operation:	Ferry flight	
Activity:	General Aviation - Other flying - Ferry flight	
Departure:	Latrobe Regional Airport, Victoria	
Destination:	Coffs Harbour, New South Wales	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – Minor	Passengers – N/A
Aircraft damage:	Substantial	