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ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2008-048
Final

Fuel Starvation – Mt Isa, Qld

17th July 2008

Abstract

On 17 July 2008, at approximately 0915 Eastern Standard Time, the pilot of a Piper Navajo PA-31 aircraft, registered VH-IHR, was en route from Century Mine, Qld to Mt Isa, Qld when the left engine lost power. Shortly after, the right engine lost power and the pilot attempted to land the aircraft in sparsley wooded bushland about 4 km from the Barkly Highway. The pilot received serious injuries and the aircraft was seriously damaged.

A subsequent check of the aircraft found that the loss of power to both engines was due to fuel starvation.

FACTUAL INFORMATION

History of the flight

On 17 July 2008, at approximately 0915 Eastern Standard Time[1], the pilot of a Piper Navajo PA-31 aircraft, registered VH-IHR, was en route from Century Mine, Qld to Mt Isa, Qld when the left engine lost power. The pilot transmitted an urgency broadcast (PAN) to air traffic control (ATC). A short time later, the right engine also lost power. The pilot then transmitted a distress signal (MAYDAY) to ATC stating his intention to carry out an off-field emergency landing. The aircraft impacted terrain 22 km north of Mt Isa, about 4 km from the Barkly Highway, in relatively flat, sparsely wooded bushland (Figure 1). The pilot, who was the sole occupant, sustained serious injuries.

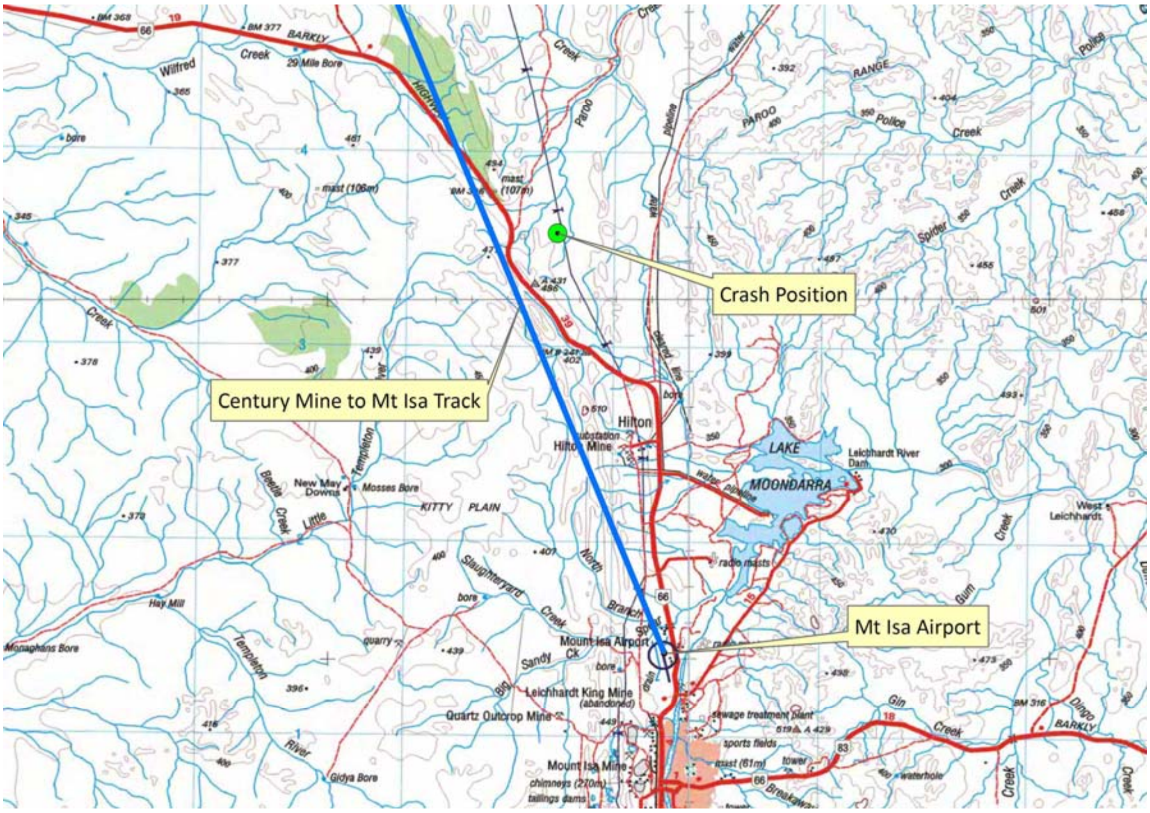
The pilot advised the Australian Transport Safety Bureau (ATSB) investigation team that he had commenced duty in Mt Isa and had fuelled the aircraft for a round trip Mt Isa - Century Mine - Mt Isa. The pilot estimated that the fuel required for the trip was 450 L. The total amount of fuel on board the aircraft at Mount Isa was 557 L. The flight to Century Mine was uneventful and the pilot disembarked five passengers and their baggage. He departed for Mt Isa at about 0830.

Due to the amount of fuel required for the planned trip, it was necessary to load fuel in both the inboard and outboard tanks of each wing of the aircraft. During flight, the pilot was required to use fuel from both inboard and outboard tanks. The pilot reported departing from Century Mine with the inboard tanks selected and changing to the outboard tanks prior to reaching the cruise altitude.

The pilot reported that approximately 33 km from Mt Isa, on descent, at about 3,000 ft, the left engine lost power and the aircraft yawed left. The pilot recalled being 'shocked' when the engine lost power. He transmitted the PAN call and carried out the initial actions of an engine failure drill. The pilot reported that the drill was to advance the mixture, propeller and throttle levers and to confirm that the gear and flap were up. The engine indications that the pilot observed led him to believe that the left engine was still producing some power. He advised that he used manifold pressure, engine RPM, exhaust gas temperature, engine oil temperature and pressure gauges to identify the malfunctioning engine. A short time later, the right engine lost power and the aircraft yawed to the right. The engine indications

1 The 24-hour clock is used in this report to describe the local time of day Eastern Standard Time (E.ST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) + 10 hours.

Figure 1: Map of site



he observed also led him to believe that the right engine was still producing some power. Consequently, he did not feather either propeller.

The pilot then transmitted a MAYDAY[2] call, activated the aircraft's emergency locator transmitter (ELT), and prepared for an off-field emergency landing. The pilot reported that when the power loss occurred, controlling the aircraft was his main priority. He advised that the yaw felt during the power loss was similar to that which he had experienced during training for engine failure after takeoff scenarios.

The pilot could not recall if the flaps had been extended and stated that lowering the landing gear was left until late in the descent, ensuring clearance over trees on the approach and to avoid 'flipping over'.

Pilot qualifications and experience

The pilot commenced flying training in February 2002, and in May 2007 was issued with a Commercial Pilots Licence (CPL). In January 2008, he gained a multi-engine command instrument rating. The pilot completed three aircraft endorsements (Beechcraft Baron, Duchess and Piper Navajo) in the 2 months before the accident. The Beechcraft Baron and Duchess aircraft use normally aspirated engines and the Piper Navajo was fitted with turbocharged engines. Prior to those endorsements, the pilot had accumulated 343.9 hrs in single-engine aircraft. Since May 2008, the pilot had accrued another 125.4 hrs. The pilot's total experience on the Navajo was approximately 30 hrs.

The pilot's logbook and licence indicated the following:

- licence class - CPL
- instrument rating - command multi-engine
- last Class-1 medical - 28 Feb 2008
- total flying hours - 469.3 hrs
- total time on PA-31 - approximately 30 hrs
- total time last 28 days - 66.3 hrs.

The endorsement training the pilot received covered a number of areas including normal and abnormal procedures that involved engine failure recognition and handling procedures. Those

2 International call for urgent assistance.

endorsements had been issued without restriction or reservation.

The pilot completed the Piper Navajo endorsement on 27 May 2008. It consisted of ground instruction and 2 hours flight time. The pilot was instructed on the use of that aircraft's fuel system and its operation. The instructor reported that the pilot handled the engine failure sequences to the required standard. The instructor also advised that he had assumed the pilot had prior knowledge of engine failure recognition and response, as it was the pilot's third twin-engine aircraft endorsement.

It was unclear if the characteristics of turbocharged and normally aspirated engines were taught in any great detail during the pilot's Navajo endorsement training.

Pilot actions

Examination of the aircraft flight log, fuel log and manifest indicated that all entries were consistent with the operator's procedures.

The pilot was able to confirm the Pilot's Operating Handbook (POH) guidelines and the operator's instructions with regard to fuel management and the use of the Digiflow[3] meter. The pilot reported it was common practice to take off using the inboard left and right tanks and change to outboard left and right tanks, if they contained fuel, near top of climb,. The outboard tanks would then be used until near empty, and then changed back to the inboard tanks when the aircraft was on descent.

On this particular flight, the pilot advised that he followed this procedure, with the exception of changing back to inboard tanks on descent.

At interview, the pilot indicated that even though he was anticipating a change to inboard tanks when the engines lost power, he diagnosed the problem as an engine malfunction rather than a fuel starvation problem.

The pilot said that he did not use other indicators that were available to him for engine performance such as the Digiflow meter or the fuel pressure and fuel quantity gauges.

Aircraft operating procedures

The aircraft POH gave guidance to pilots operating the aircraft.

With respect to the fuel system, the POH stated:-

> Before take off
>
> Inboard fuel tanks must be used for takeoff.
>
> Cruise
>
> Outboard tanks should be used during coordinated level flight only. If outboard tanks are used during climbs, descents or prolonged uncoordinated level flight, power loss may result even if there is appreciable fuel remaining. Since inboard tanks must be used for landing, be sure to retain sufficient fuel in the inboard tanks for normal descent and landing in addition to reserve fuel for the possible go-around.
>
> Descent
>
> Set fuel selectors on inboard tanks and set power as required for descent.

In the emergency procedures section of the POH, there were guidelines for handling an engine failure during flight (above 76 KIAS[4]).

With respect to the fuel system, the POH stated:-

> Prior to securing the inoperative engine, check to make sure the fuel flow to the engine is sufficient. If the fuel flow is deficient, turn ON the emergency fuel pump. Check the fuel quantity on the inoperative engine side and switch the fuel selector to the other tank if a sufficient supply is indicated. Check the oil pressure and oil temperature and ensure that the magneto switches are on.

Another section of the emergency procedures

3 The aircraft manufacturer's original fuel flow gauge had been replaced with a digital model, a Fuel Scan FS-450M Twin known as a Digiflow. This unit used small turbine transducers that measure the fuel flowing into each engine and displayed fuel flow, fuel used and total fuel in the cockpit. The unit had the capability of storing fuel remaining information in memory.

4 Knots indicated airspeed.

provided guidance for engine roughness:-

> If an engine falters or runs erratically, the cause may be fuel flow interruption, fuel contamination, icing or air starvation, or ignition problems. If roughness occurs, turn the emergency fuel pumps ON. Scan the engine instruments to see if the cause can be determined. Adjust the mixture controls for maximum smoothness; if the mixture is too rich or to lean, engine roughness may result. Open the alternate air control; a blocked induction system can cause roughness. If cylinder head temperatures are to high or to low, adjust the cowl flaps as required.
>
> If the problem is in the fuel system, selecting another tank containing fuel may remedy the situation.

Fuel system description

The aircraft fuel system utilises four flexible fuel cells (two in each wing). The outboard fuel cells had a capacity of 151.6 L each and the inboard fuel cells 212.2 L each, providing a total capacity of 727.7 L, of which 695 L were usable.

The right and left wing fuel systems were independent and under normal operation fuel was routed from the fuel cells in each wing to the respective engine (for example, the left wing outboard or inboard fuel tanks provided fuel to the left engine).

The fuel management controls were located in the fuel system control panel mounted between the two front seats. Located on the fuel control panel were the fuel tank selectors, firewall fuel shut-offs, and the cross-feed controls.

Selection of the controls on the right side of the control panel provided fuel from the right outboard or inboard fuel cells to the right engine and left fuel control selection provided fuel from the left outboard or inboard fuel cells to the left engine.

Two electric fuel quantity gauges were mounted on the copilot's instrument panel. The right fuel quantity gauge indicated the quantity of the fuel in the selected right fuel system tank (right inboard or right outboard) and similarly for the left fuel system. The gauges were connected electrically to microswitches mounted on the fuel selector console. When a fuel tank was selected, its corresponding microswitches were activated, providing a visual indication of the fuel quantity in the selected tank.

The fuel pressure gauge for the left and right engine systems were monitored by a dual fuel pressure gauge. This gauge was mounted on the instrument panel above and to the right of the co-pilot's control column. It measured fuel pressure in pounds per square inch (psi) for both left and right fuel systems.

Right and left fuel flow warning lights illuminated to warn the pilot of an impending fuel flow interruption. The lights were activated by a sensing probe mounted near each inboard fuel tank outlet (not associated with the outboard tank). In the event the fuel level near the tank outlet p to a point where a fuel flow interruption and power loss could occur, the sensing probe would illuminate its corresponding warning light. The warning lights were incorporated in the annunciator panel below the glare shield on the centre console.

Wreckage and site information

Examination of the aircraft showed no evidence of pre-impact damage. The damage to the left wing and nose area (Figure 2) of the aircraft indicated that the aircraft impacted the ground at an angle of approximately 30 degrees left-wing down and 30 degrees nose down. The aircraft fuselage showed signs of compression rippling on the under surface and the rudder mass balance weight was bent over to the right at the tip. The distance from the initial impact point to the main wreckage was 17 m. This evidence indicated that the aircraft had a very high rate of decent and low forward airspeed at the time of impact.

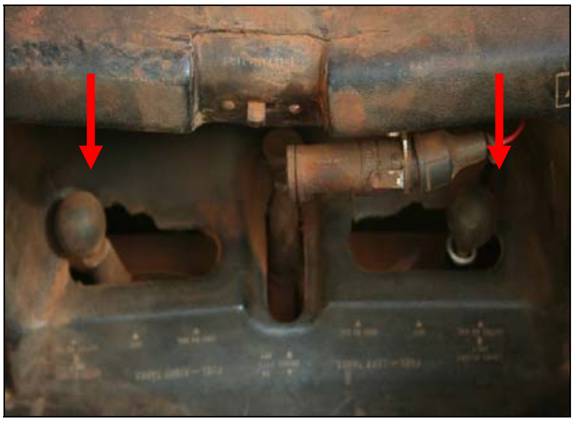
Figure 2: Aircraft wreckage

The flaps were in the zero (retracted) position as was the cockpit flap indicator and selector. Damage to the landing gear doors indicated that the landing gear may have been partially extended on impact. The landing gear lever was noted to be in the down position.

Fuel system

Both fuel selector handles were found set to the outboard fuel tank positions indicated by red arrows in Figure 3. The emergency fuel pumps were selected OFF.

Figure 3: Fuel management panel



Due to extensive structural damage of the left wing, both left wing fuel tanks had ruptured, resulting in the remaining fuel in that wing draining into the ground. There were indications of fuel draining into the ground under the inboard fuel tank but not under the outboard fuel tank.

The right wing was relatively intact. Both fuel tanks appeared to be undamaged. The right outboard fuel tank appeared to be visually empty and the fuel tank caps were noted to be fitted and secure.

The right inboard fuel tank appeared to have a large quantity of fuel remaining. The wing was inspected from underneath and there did not appear to be any indication of fuel leaks on the wing or on the ground below. The remaining fuel in the right inboard fuel tank was decanted and measured. Approximately 168 L of fuel was removed from the right inboard tank.

The fuel that was drained from the right inboard tank was used to fill the right outboard tank. Approximately 165 L of fuel was put into the right outboard tank which had a normal usable capacity of 151.6 L (this filled the tank up to the flange of its fill point). After 1 hour, the fuel tank was inspected and the fuel level at the fill point had not changed.

The Digiflow meter was removed from the aircraft and examined at the ATSB's technical facilities in Canberra. The instrument indicated that when electrical power was lost, the last total fuel remaining figure was 298 L.

Propeller and engine examination

The damage to the propellers indicated that they were not in the feathered position and that the engines were delivering little or no power on impact (Figures 4 and 5).

Figure 4: Left engine and propeller

Figure 5: Right engine and propeller

The engines were inspected externally with no pre-impact defects identified. The engine fuel systems were disconnected at the main fuel inlets and only a small amount of fuel was present.

At the time of the occurrence, the aircraft maintenance release was current and there were no outstanding defects or maintenance.

ANALYSIS

Examination of the wreckage clearly indicated that there was sufficient fuel on board the aircraft to complete the flight safely. Had the pilot selected the fuel selectors to the inboard tanks when the engine surged and subsequent power loss occurred, normal operation would have been restored.

This analysis considers the factors that contributed to the pilot not selecting the inboard tanks.

Fuel management

The pilot had ensured the aircraft had adequate fuel for the return flight. While the Navajo's fuel system is more complex than the fuel systems on other aircraft types he had previously flown, had the pilot been monitoring fuel usage during the fight, he would have been aware that the outboard tanks were in a low fuel state and that a need to change to the inboard tanks was imminent.

Pilot's response

The pilot's recall of the incident was limited. It is apparent that the pilot did not adequately diagnose the problem to enable him to restore normal operation. The pilot knew that there was sufficient fuel onboard for the flight and a check of the appropriate engine instruments would have given some clues as to the cause of the engines' power loss. The Pilot's Operating Handbook gives guidance on procedures to carry out when those clues are presented. However, the link between the engine surge - power loss and the appropriate checklists was not made.

The pilot relied on his training and knowledge acquired in the recent endorsement sequences, and completed engine failure after take-off drills. The use of manifold pressure and engine RPM as the primary means to identify an engine failure can be deceiving. It may limit a pilot's ability to diagnose the problem, leading to the misidentification of the failed engine. It is probable that the pilot was distracted in trying to control the aircraft to the detriment of correctly diagnosing the problem.

Engine power loss and pilot training

An endorsement process should review aircraft systems, and normal and emergency procedures in varying take-off and landing configurations. The student may not have had to demonstrate all sequences (as some are generic to all aircraft), but the instructor should ensure proficiency in the critical sequences, such as engine failure after takeoff, rejected takeoff and missed approach procedures. The assumption being, that if a pilot is proficient at dealing with an engine failure at the most critical phase of flight, he will be proficient at altitude, with time to be able to analyse the situation and take appropriate action.

The pilot's training appeared to be sufficient to issue the endorsement certification for the aircraft. That training included demonstration of proficiency in an engine failure after takeoff and in the other areas of competency that were deemed necessary. However, double engine failure was not discussed, as the possibility of this happening was considered remote. In-flight engine failure would have been covered extensively in single-engine aircraft basic training.

Had the pilot actioned engine failure during flight or engine roughness procedures, it may have provided another opportunity to correctly diagnose the situation.

Forced landing

Having incorrectly diagnosed the situation, the pilot believed that the engines were still producing power. Consequently, he did not feather the propellers which increased the amount of drag on the aircraft. This resulted in a high rate of descent and reduced the glide range and time available to the pilot to prepare for a landing.

Once a forced landing was inevitable, preparation should have included, but not been limited to:-

- selecting a suitable landing area
- configuring the aircraft for the landing
- slowing the aircraft using flap and landing gear
- securing the engines if possible.

Due to the high rate of descent, the pilot had limited time available to analyse and select a suitable site and to prepare the aircraft for landing. The Barkly Highway was less than 4 km from the crash site and may have been a suitable landing area if the aircraft had been configured to maximise the glide range. As it was, the aircraft struck the ground in an uncontrolled state.

FINDINGS

From the evidence available, the following findings are made with respect to the fuel starvation event and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The pilot did not monitor outboard fuel tank quantity during the flight.
- The pilot incorrectly diagnosed the engine power losses.
- The aircraft was not in the correct configuration for the forced landing.

SOURCES AND SUBMISSIONS

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

A draft of this report was provided to the pilot, the operator and the Civil Aviation Safety Authority.

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